2018 Report on the Impact of Electric Vehicles to the Road Use Tax Fund

A Report to the Iowa Legislature, pursuant to Iowa Acts Chapter 1077 Section 3 – 87 (2018 Regular General Assembly)

Prepared by the Iowa Department of Transportation

December 31, 2018

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Executive Summary

Recognizing the current and future growth of electric vehicle (EV) usage in Iowa, the legislature directed the Iowa Department of Transportation (DOT) to forecast EV growth and the impact on the state Road Use Tax Fund (RUTF) that would occur because those vehicles do not currently pay a state fuel tax.

As of September 2018, there were 800 Battery Electric Vehicles (BEV) registered in Iowa which is double the number of those vehicles from April 2017. In addition, there are another 1,900 Plug-In Hybrid Electric Vehicles (PHEV). There is a wide variation in national forecasts of electric vehicle growth; therefore, several forecast scenarios developed for Iowa. From those scenarios, an estimate of RUTF impacts due to electric vehicle usage, both today and in the future, were developed and are summarized in the table below:

Reduction in RUTF due to BEV and PHEV

Year	Low Scenario	Medium Scenario	High Scenario
2018	$317,000	$317,000	$317,000
2020	$488,000	$520,000	$564,000
2025	$1,858,000	$2,684,000	$11,117,000
2030	$7,083,000	$14,207,000	$45,221,000
2035	$19,603,000	$47,748,000	$129,260,000
2040	$39,975,000	$115,200,000	$241,316,000

To mitigate those impacts, Iowa DOT assessed existing and potential funding mechanisms with a goal of developing recommendations that provide equity, have low administrative costs, result in no net change in RUTF revenue, have Iowa Constitutional protection that assures revenue collected can only be spent on road and bridge maintenance and improvement, and captures all users (i.e. passenger vehicles, commercial trucks, and out-of-state vehicles). Based on that analysis, the Iowa DOT recommends the following:

Recommendation 1: Add a per kilowatt hour excise tax for charging at non-residential charging locations. Effective July 1, 2020, begin collecting $0.026 per kWh for charging of vehicles at non-residential charging locations. This would not apply to charging of vehicles that occur at the residence where it is estimated 80 to 90 percent of all passenger EV charging occurs. This recommendation assures collection of a user fee from out-of-state EVs and commercial truck EVs.

Recommendation 2: Add a supplemental registration fee for passenger electric vehicles. Effective January 1, 2020, begin collecting a supplemental registration fee of $130 per year for BEV, $65 per year for PHEV, and $9 per year for electric motorcycles. These rates reflect the average vehicle fuel tax generated in a year for those vehicle types with a downward adjustment to reflect the charging that typically occurs away from the residence (estimated to be 15 percent) that would be subject to the per kWh fee.

Recommendation 3: Add a hydrogen fuel excise tax. Effective January 1, 2020, begin collecting $0.65 per diesel gallon equivalent (2.49 pounds of hydrogen) for hydrogen fuel cell EVs. This recommendation assures collection of a user fee from out-of-state and commercial truck hydrogen fuel cell EVs.

Introduction

The primary source of funding to improve and maintain Iowa's public roadways comes from Iowa's Road Use Tax Fund (RUTF). Transportation revenues deposited into the RUTF are distributed to state and local governments through several different processes and programs. Primary sources of funding deposited in the RUTF include state excise taxes on motor fuel, annual vehicle registration fees, and the fee for new registration. Over time, increases in construction costs and changes in vehicle technology impact the ability of RUTF to adequately meet the needs of Iowa's public roadways. One such change in vehicle technology which has the potential to significantly impact the RUTF is the emergence of electric vehicle (EV) technology.

In recognition of that challenge, the legislature passed a bill (section 3 of House File 2256, Eighty-seventh general assembly), signed by Governor Reynolds on April 4, 2018, that requires the Iowa Department of Transportation (DOT) to develop a report that includes estimates of the impact of increased usage of electric, hybrid, and other high-efficiency motor vehicles on future revenues to the State's RUTF. The bill specifically requires the following:

> The department of transportation shall estimate the impact of increased usage of electric, hybrid, and other high-efficiency motor vehicles in this state on future revenues to the road use tax fund. The department shall evaluate and may recommend the creation of alternative funding mechanisms or the alteration of existing funding mechanisms to mitigate any estimated decrease in future revenues to the road use tax fund related to increased usage of electric, hybrid, and other high-efficiency motor vehicles. The department shall submit a report, in paper or electronic format, containing the department's estimate, evaluation, and any recommendations to the general assembly and the state transportation commission on or before December 31, 2018.

This report explores and presents a range of estimated impacts and a review of possible mitigation strategies to address revenue losses. The possible mitigation strategies are examined based on factors including ease of implementation, applicability to out-of-state drivers, ability to levy upon commercial trucks, and equity, among others.

Background

Iowa's motor fuel excise taxes make up the largest single source of revenue deposited to the RUTF. For state fiscal year (FY) 2019 fuel taxes are estimated to total approximately $656 million of the $1.45 billion deposited into the RUTF, or approximately 45 percent of the total. As the average fuel efficiency of vehicles has increased over time, fuel tax contributions to the RUTF have declined on a per mile driven basis.

The decline has accelerated, in part, due to the introduction of Hybrid-Electric Vehicles (HEV) into the United States (U.S.) commercial market in 1997. Hybrid vehicles, such as the Toyota Prius and Honda Insight, combine a conventional internal combustion engine with some form of electric propulsion.

While these vehicles continue to use motor fuel, they obtain significant fuel economy increases over similar vehicles that are powered solely by an internal combustion engine.

While fuel efficiency by vehicle make and model vary significantly, for nearly a century it held true that nearly all vehicles on public roads used motor fuels, upon which taxes were levied. Within the last decade, EV technology has increased sufficiently to make possible the introduction of both Plug-In Hybrid Electric Vehicles (PHEV) and fully electric Battery Electric Vehicles (BEV). PHEVs, such as the Chevrolet Volt, were first introduced to the U.S. market in 2010. PHEVs use a rechargeable battery in conjunction with an internal combustion engine and can travel solely upon their electrical drivetrain for a certain number of miles, typically between 20 and 50, before the vehicle is propelled by its backup internal combustion engine. Due to significant increases in battery technology, automotive manufacturers have now also introduced vehicles that contain only electrical drivetrain components. These BEVs, such as the Chevrolet Bolt and Tesla Model S, offer drivers extended driving ranges of approximately 300 miles solely on electrical power.

Advancements in EV technology are not limited solely to passenger vehicles. Several vehicle manufacturers have announced plans to introduce Class 4 through 8 commercial EVs to the market in the near future. These vehicles, just like passenger car EVs, will have a significant negative impact to fuel tax collections through the reduced use of diesel fuel.

PHEVs and BEVs traveling solely on electric power are not subject to motor fuel excise taxes and consequently there is an equity issue in paying for the use of the roadway system between traditional motor fuel powered vehicles and electric powered vehicles. With the anticipated rapid growth of EVs and longer range EVs into the statewide fleet, the impact of those vehicles not generating fuel tax revenue is becoming a significant issue.

Current Market Conditions

Iowa

Currently, the EV marketplace, even when including HEVs, is quite small in Iowa. The first BEVs were registered in the state in 2008. Between 2008 and 2016, BEV registrations more than doubled on an average annual basis. However, it is important to note that the very early exponential growth skews that analysis. A review of registration data from April 2017 and September 2018 shows that BEV growth in Iowa continues to be significant. Over that time, BEVs in Iowa increased from approximately 400 to nearly 800 vehicles. The September 2018 registration data shows that PHEVs currently total approximately 1,900 vehicles in Iowa.

National

Like the current market in Iowa, passenger EVs make up only a very small portion of the overall vehicle fleet in the U. S. According to Inside EVs[1] monthly sales data, approximately 750,000 PHEVs and BEVs

[1] Information obtained from Inside EVs monthly sale data accessed at https://insideevs.com/monthly-plug-in-sales-scorecard/

had been sold in the United States by the end of 2017. These vehicles make up significantly less than one percent of the total passenger car fleet nationally. However, even though PHEV and BEV represent only a small fraction of the overall market, it is important to consider their growth since debuting in 2010. As shown in Figure 1, EV sales growth in the U.S. has increased substantially. Overall growth of the EV fleet has increased by at least 35 percent annually since 2012. Growth in the sale of EVs continues to increase in 2018. A review of the 11-month period from January through November finds EV sales of approximately 313,000 vehicles. This compares to nearly 174,000 for the same period in 2017; a growth of approximately 80 percent.

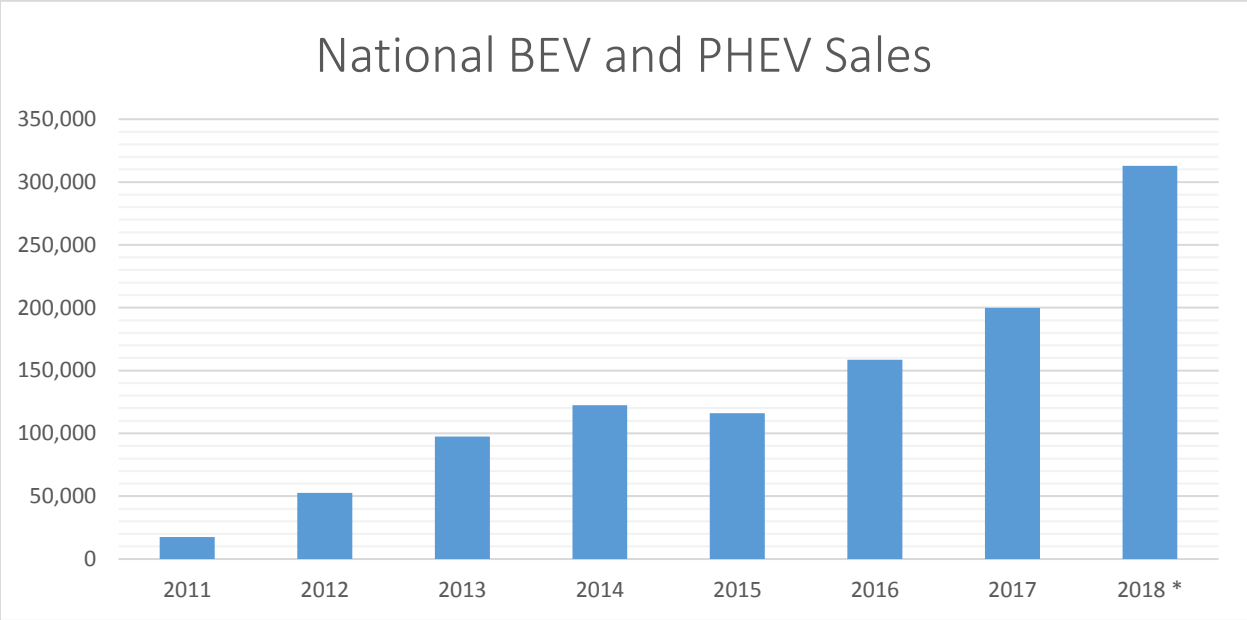

Figure 1: National BEV and PHEV Sales (source: InsideEVs) * through November 2018

The electric commercial truck market is more difficult to track and evaluate. Overall, the market share of EVs within the commercial truck market has not kept pace with passenger vehicle market share. However, several major manufacturers have announced that short, medium, and long-range BEV commercial trucks will be available by 2022 with some available as soon as 2020. These manufacturers include Volkswagen, Tesla, Volvo, Cummins, and Daimler. In addition to BEV, the possibility exists for hydrogen powered fuel cell EVs to become prevalent within the commercial truck marketplace. These vehicles will utilize hydrogen as their fuel source, rather than diesel, and as such, would not pay motor fuel excise taxes into the RUTF.

Current Impact on RUTF in Iowa

There is little data available regarding the driving habits of EV owners within the state making estimating their impact on RUTF collections challenging. Several assumptions were made to produce RUTF revenue impacts for calendar year 2018. Assumptions include:

- BEV and PHEV growth would continue through the last quarter of 2018 and increase Iowa's fleet of BEVs and PHEVs to 3,000 vehicles

- PHEVs drive 55 percent of miles under electric power[2]
- Average miles driven per year equals 11,500[3]
- Average light duty vehicle (e.g. cars, SUVs, passenger vehicles such as pickups, etc.) fuel efficiency equals 22.0 miles per gallon[4]
- Iowa motor fuel excise tax rate of $0.295 per gallon (weighted average of ethanol and gasoline tax rates based on usage)
- There is no commercial truck EV mileage driven in Iowa in 2018

As noted above it was assumed that Iowa's fleet of PHEV and BEV totaled 3,000 vehicles for 2018. These vehicles, based on the assumptions outlined above, are estimated to result in lost fuel tax revenues of approximately $317,000 during calendar year 2018. For purposes of this estimate, out-of-state passenger car EVs were not included due to the limited driving range of existing EVs and therefore, the minimal number of miles driven in the state.

Forecast of EV Growth

Because of the many factors likely to impact EVs, forecasts of EV growth into the future vary widely. Even the most cautious forecasts of long term EV growth estimate EV market share to grow beyond 10 percent of the total light duty fleet. For example, the Energy Information Administration's 2018 Annual Energy Outlook forecasts BEVs and PHEVs to comprise 14 percent of the light duty fleet sales by 2050. Other forecasts, including forecasts made by Bloomberg New Energy Finance[5] and Energy Innovation: Policy and Technology, LLC[6], contain significantly higher rates of EV growth. Bloomberg New Energy Finance forecasts EVs to comprise nearly 60 percent of light duty fleet sales by 2040 while Energy Innovation: Policy and Technology, LLC forecasts the light duty fleet to be nearly 60 percent EVs by 2050.

Several factors will impact growth of the EV market including; availability of charging infrastructure, number of EV models, vehicle cost, incentives, and other variables. While difficult to determine which of these issues has the most impact, there can be little doubt that as these issues are resolved the market place for EVs will improve.

While the BEVs of today have ranges of up to 300 miles, the matter of range anxiety continues to exist in the marketplace. As additional charging locations become available, range anxiety should be, at least in part, mitigated. Issues with charging exist beyond simply the number of available chargers. For example, availability of charging infrastructure at multi-family housing dwellings continues to be a significant hurdle keeping residents of those dwellings predominately out of the EV market.

When charging infrastructure reaches the point at which the market no longer has concerns over vehicle charging, automotive manufacturers still need to provide potential buyers with a mix of vehicles types to

[2] Based on current industry standard SAE J2841
[3] Based on national data published in Federal Highway Administration's Highway Statistics 2016 Table VM-1
[4] Based on national data provided by United States Department of Transportation Bureau of Transportation Statistics
[5] Bloomberg New Energy Finance 2017 Long Term Electric Vehicle Outlook
[6] Energy Innovation Policy & Technology LLC Energy: Energy Policy Simulator base forecast data

adequately cover the full range of buyers. Currently, a limited number of BEVs and PHEVs are offered for sale. Nearly all currently available BEVs and PHEVs are compact class vehicles. As a result, customers looking for different vehicle types are left out of the EV market place. To address this issue, manufacturers have announced significant increases in the number of BEV and PHEV models within the next five years. Chevrolet has announced that by 2023 it intends to launch 20 new BEV models to the worldwide market. Similarly, Ford has announced that it intends to offer 40 electrified models (16 BEV and 24 PHEV) to the global market by 2022.

Another barrier to greater EV market share is vehicle cost. On average, BEVs and PHEVs are considerably more expensive than similar vehicles powered through traditional mechanisms. While costs have declined for primary components, such as batteries, EVs have not yet achieved purchase prices similar to internal combustion powered vehicles. The rate at which costs continue to decline plays a significant role in the growth of EVs in the U.S. and Iowa.

Various financial incentives exist to promote EV growth by reducing the cost differential between EVs and traditional vehicles. For example, a federal income tax credit of $2,500 to $7,500 is available for newly purchased EVs. The tax credit is available for the first 200,000 EVs sold by a manufacturer before the tax credit is phased out. There is some uncertainty about the future of this federal tax credit but, while it continues, it serves as an incentive to purchase vehicles utilizing electric powertrains. Various state, utility, and private incentives also exist. While difficult to determine to what extent, the continued availability of subsidies will play a part in the rate of EV growth in the future.

Many other variables exist which make forecasting EV growth difficult. The role of marketing will have a significant impact on increasing public awareness and acceptance of the emerging EV market. The cost of oil and resulting gasoline and diesel fuel prices also have a significant impact on the growth of the EV market. For example, a future scenario with significantly higher gasoline and diesel costs coupled with a greater public understanding of EVs would likely result in an accelerated transition from internal combustion engines to electric technology.

For commercial trucks the most likely introduction to the market will be their use in shorter range hub and spoke uses. This use will fall within the range of the first commercial truck EVs which allows them to return to a central facility which can provide vehicle charging infrastructure. As high-speed charging and high-capacity battery infrastructure becomes more prevalent, the commercial truck EV market is likely to expand to longer haul commercial truck operations.

Due to the many variables described, any single forecast of EV growth is likely to vary significantly from actual growth in the future. For this report low, medium, and high forecasts of EVs were prepared to present a range of growth scenarios. Evaluating multiple scenarios provides scale and context to the potential impact of varying EV growth scenarios.

Forecasts of national level EV growth were reviewed and served as the basis for forecasting Iowa's EV fleet into the future. These national forecasts were produced by the United States Energy Information Administration [7], Bloomberg New Energy Finance [8], and Energy Innovation: Policy & Technology [9].

Forecasted passenger car BEV and PHEV numbers in Iowa are shown in Figure 2. Between 2018 and 2040 BEV and PHEV numbers are forecast to increase from their current level of approximately 3,000 vehicles to nearly 1,100,000 vehicles in the high growth scenario. Over the forecast period the distribution of PHEVs and BEVs is forecast to change significantly from the current distribution in Iowa. Currently in Iowa, there are approximately two PHEVs registered for every BEV. By 2040, BEVs are forecast to dominate the marketplace and make up approximately 80 percent of the total number of registered BEVs and PHEVs in Iowa. This increase in the share of BEVs is assumed to remain constant between the low, medium, and high forecast scenarios.

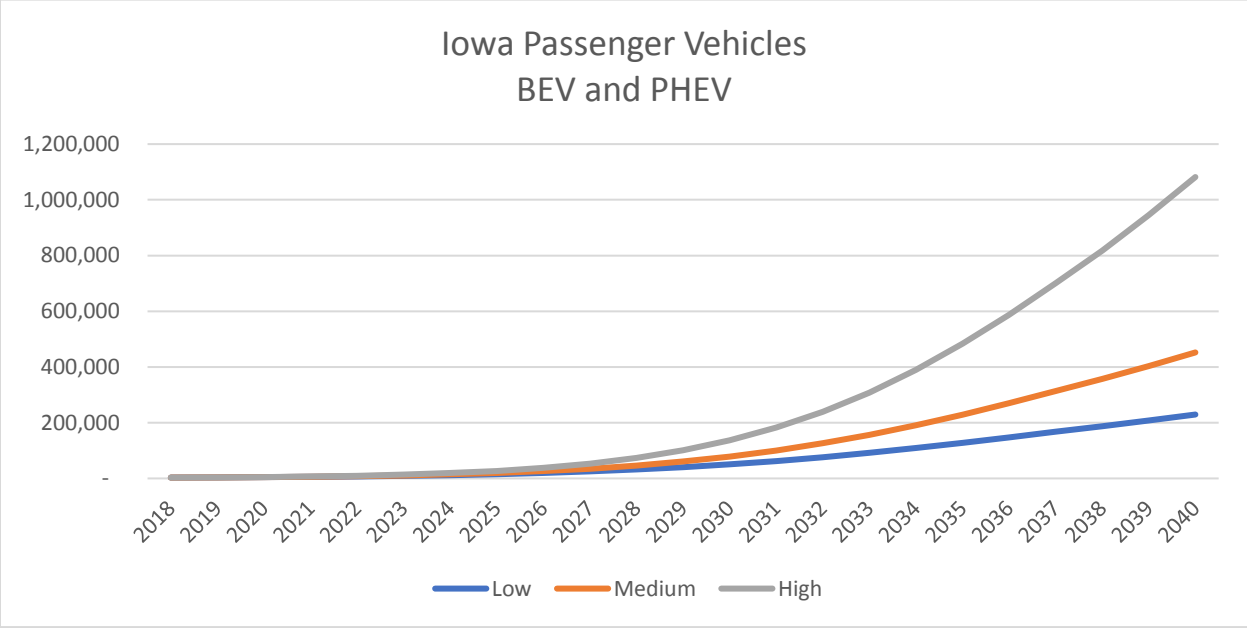

Figure 2: Forecast of passenger car BEVs and PHEVs in Iowa

Forecasts of commercial truck EVs were also produced to quantify impacts on the RUTF. Commercial truck EV forecasts were based in part on forecasted passenger EV growth but were adjusted to account for later availability of commercial truck EVs and quicker turnover of commercial truck vehicle fleets. Should commercial truck operators experience expected operations and maintenance savings associated with EVs, and charging infrastructure issues are addressed, it is possible that adoption could happen at a pace exceeding the high scenario presented in this report.

Because a significant portion of Iowa's RUTF motor fuel tax from commercial trucks are paid by out-of-state apportioned vehicles, the impact of commercial truck EVs must consider more than just the

[7] United States Information Administration Annual Energy Outlook 2018
[8] Bloomberg New Energy Finance Electric Vehicle Outlook 2017
[9] Energy Innovation: Policy & Technology Energy Policy Simulator

number of those vehicles registered in Iowa. Commercial truck EV impacts were calculated by forecasting the share of commercial truck mileage in Iowa that will be driven by EVs (see Figure 3). All commercial truck EV mileage was assumed to be driven by fully electric vehicles.

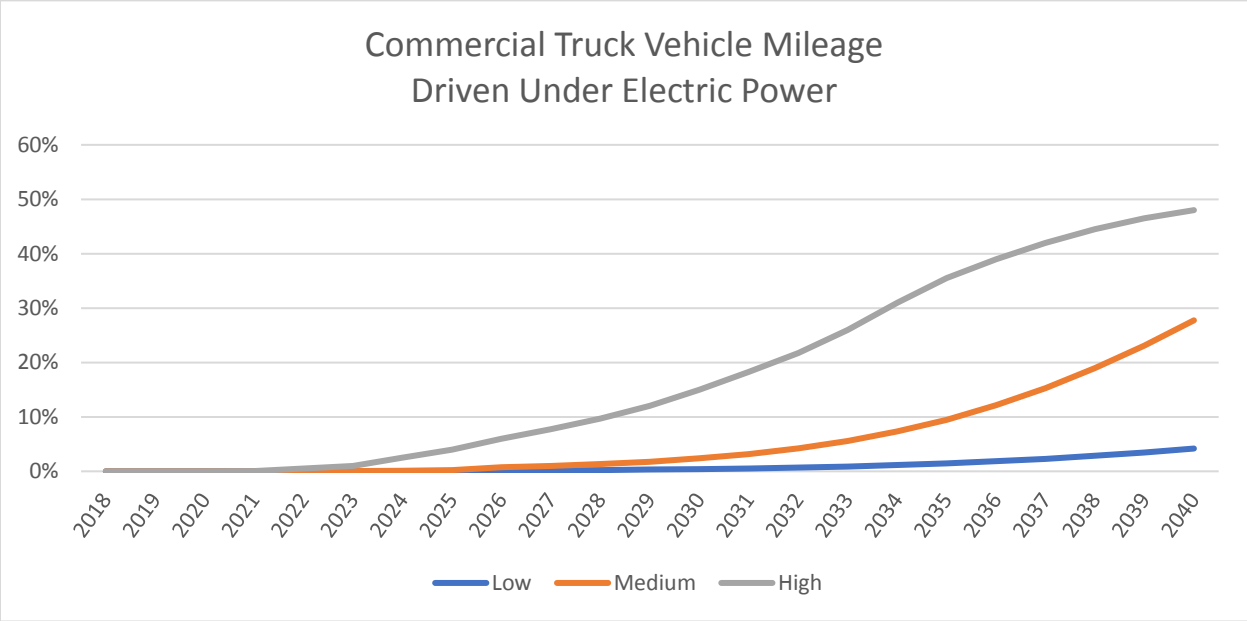

Figure 3: Forecast of commercial truck vehicle mileage driven under electric power

Forecast RUTF Impact

The passenger car and commercial truck EV forecasts were utilized to calculate revenue impacts to the RUTF. As noted earlier, passenger car revenues were calculated based on assumed values for miles driven per year, average fuel economy, fuel tax rate, and share of PHEV miles driven under electric power. It should be noted that forecast RUTF impacts resulting from passenger EVs represent only Iowa registered vehicles. In the short term, almost all passenger EV usage in Iowa will be from Iowa registered EVs due to the limited availability of high-speed charging infrastructure necessary for long-distance travel. In the longer term, as there is more accessibility to high-speed charging infrastructure, there will be more out-of-state usage of Iowa's public roadway system that is not reflected in these current forecasts.

Commercial truck EV impacts were estimated by reducing forecasted diesel fuel tax collections according to the forecasted share of mileage driven under electric power. RUTF impacts from commercial truck EVs represent both losses associated with both apportioned and non-apportioned commercial trucks.

As with the EV forecast, the RUTF impact estimates reflect a low, medium, and high scenario (see Table 1 and Figure 4). The impact is relatively minimal through 2020 but begins growing dramatically as EVs become more commonplace. In the high scenario, the RUTF impact could increase from a $564,000

reduction in RUTF in 2020 to over $11 million in 2025. That is almost a twenty-fold increase in just five years.

Reduction in RUTF due to BEV and PHEV			
Year	Low Scenario	Medium Scenario	High Scenario
2018	$317,000	$317,000	$317,000
2020	$488,000	$520,000	$564,000
2025	$1,858,000	$2,684,000	$11,117,000
2030	$7,083,000	$14,207,000	$45,221,000
2035	$19,603,000	$47,748,000	$129,260,000
2040	$39,975,000	$115,200,000	$241,316,000

Table 1: Forecast of reduced RUTF due to EVs

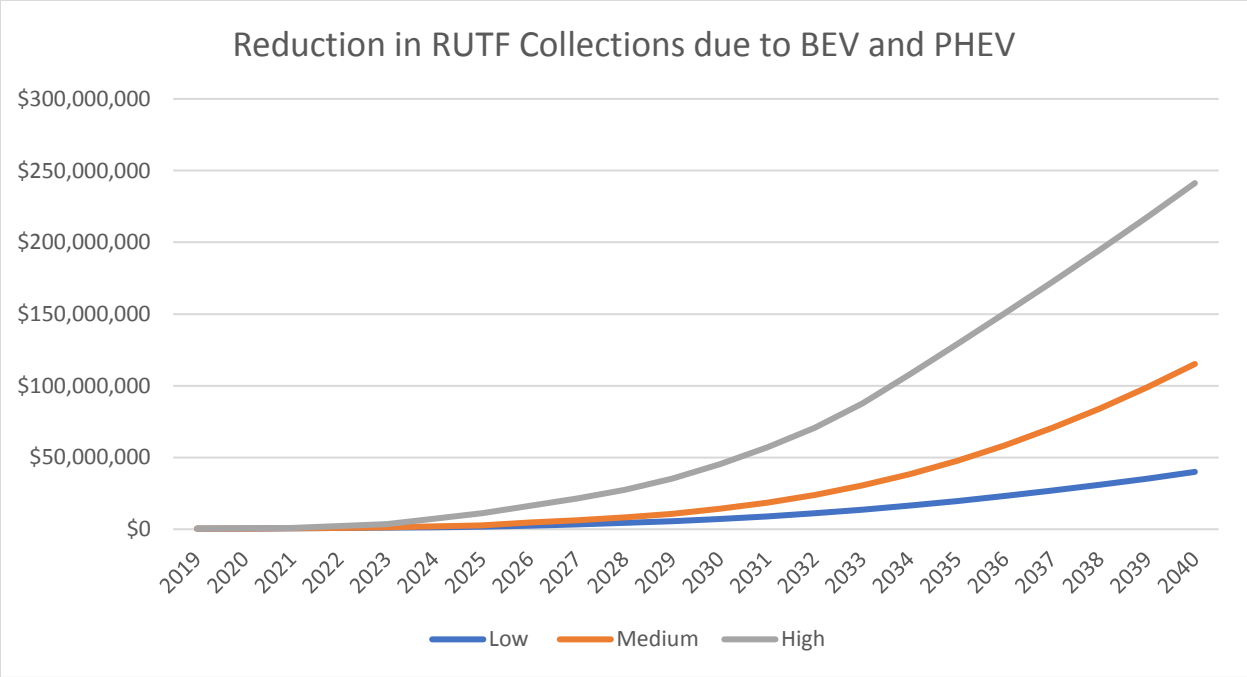

Figure 4: Forecast of reduced RUTF due to EVs

Mitigation Strategies

As noted earlier, EVs reduce collections to the RUTF by decreasing, or eliminating all together, the amount of fuel consumed for transportation. For example, HEVs utilize their electrical components in conjunction with an internal combustion engine to increase overall fuel efficiency. This reduction in the amount of fuel used reduces collections to the RUTF.

Several options exist that can mitigate the impact that EVs have on RUTF collections. Each mitigation strategy provides unique opportunities and challenges. which are detailed below.

Indexing Excise Taxes on Motor Fuels

One solution that has been implemented by several states is to index their state fuel tax rates. Tax rate adjustments are typically applied on an annual basis and are most often based on inflation rates or the wholesale price of fuel. In 2016, the state of Georgia passed legislation that tied fuel tax rate adjustments, in part, to vehicle fuel efficiency. On an annual basis, fuel tax rates are adjusted based on both the average fuel efficiency of new vehicles and the Consumer Price Index. Most states have included language that sets a baseline level to ensure revenues aren't subject to deflation or decreases in the price of fuel.

Indexing fuel tax rates, particularly if based on fuel efficiency changes, could in part mitigate losses to the RUTF resulting from some EVs. Efficiency gains across the statewide fleet from internal combustion engines and the increasing share of HEVs and PHEVs would be mitigated and result in higher motor fuel excise tax rates.

As this strategy is merely an adjustment to an existing process, it would apply to all vehicles currently using taxed motor fuels. There is an added benefit of the strategy as it would apply to in-state and out-of-state passenger vehicles and commercial trucks. Indexing fuel tax rates could also be easily implemented as the process already exists to tax motor fuel. A major limitation of this strategy is that indexing fuel tax rates would not mitigate impacts to the RUTF resulting from BEVs. BEVs utilize no motor fuel, and as such, varying excise tax rates would not mitigate their impact to the RUTF. Similarly, while driving solely under electric power, PHEVs utilize no motor fuel and indexing excise tax rates would not mitigate that loss to the RUTF.

Add a Per Kilowatt Hour (kWh) Tax on Electricity Used for Transportation

Another mitigation strategy that could be used to recoup collections to the RUTF is implementing a fee per kilowatt hour (kWh) of electricity used in EVs. Implementing a per kWh fee would be consistent with the existing process of collecting an excise tax on motor fuels. A benefit of the per kWh fee is that, like fuel taxes, it is a user fee in relation to a vehicle's use on the transportation system. However, as with existing vehicles, BEVs exhibit different efficiencies based on variables such as aerodynamics and weight. For example, a 2018 Nissan Leaf requires an estimated 30 kWh per 100 miles while a 2018 Hyundai Ioniq is estimated to only need 25 kWh to cover the same distance.

Like a fuel tax, a per kWh fee would apply to all vehicles charging within the state of Iowa, including out-of-state vehicles. The per kWh fee could also be applied to out-of-state apportioned commercial trucks traveling into and through Iowa through the International Fuel Tax Agreement (IFTA).

Enabling legislation would need to be passed allowing the per kWh fee to be implemented; however, a similar collection mechanism already exists in Iowa Code. The user fee would be collected at the point-of-sale similar to how fuel taxes are currently collected for liquified petroleum gas and liquified natural gas where they are taxed when delivered into the vehicle.

The matter of home charging complicates the feasibility of implementing a per kWh fee. While charging infrastructure will be provided at public locations, most EV owners take advantage of the ability to charge at home. According to the United States Department of Energy, more than 80 percent of EV charging currently takes place in the home. Therefore, the ability to levy and collect a per kWh fee on home charging needs to be considered. This would add thousands of additional tax collection points and would require additional infrastructure, such as separate meters dedicated solely to home charging of EVs.

Currently, multiple charging options exist for EVs. Charging at home can be accomplished via a traditional 120-volt AC plug (Level 1 charging) for slow speed charging or via a 220-volt AC plug (Level 2 charging) for fast charging. This charging flexibility could allow for easy evasion of a per kWh fee especially for 120-volt AC charging as it would be nearly impossible to ensure that all Level 1 charging is identified and taxed.

Finally, a per kWh fee would not be a means to mitigate impacts to the RUTF from hydrogen fuel cell EVs. Hydrogen fuel cell EVs don't require batteries to be charged by outside power sources but rather utilize on board hydrogen to generate electricity. As these vehicles would be charged off the grid, the per kWh fee wouldn't apply.

Add a Mileage Based User Fee

For well over a decade, the idea of collecting transportation revenues based on miles traveled has been studied extensively in the United States. This methodology, commonly called a mileage-based user fee (MBUF), would charge a tax on the number of vehicle miles traveled rather than a fixed amount of tax per gallon of fuel. By levying a tax upon the number of miles traveled, issues such as alternative fuel vehicle technology and increases in fuel economy no longer pose a risk to transportation revenues. As such, an MBUF would provide a more stable source of transportation revenue for the future. Furthermore, an MBUF would be applied to all mileage and would mitigate impacts from all types of vehicles, including hydrogen fuel cell EVs. Applying an MBUF eliminates issues such as fuel efficiency and fuel source. Therefore, it is a more equitable way of collecting transportation revenues.

At this point, were Iowa to implement an MBUF, it would only be applied to passenger vehicles registered within the state due to the lack of a national system that allocates funds for miles driven on a state-by-state basis. Mileage driven in Iowa by out-of-state passenger cars would not be mitigated through an Iowa only MBUF. However, existing taxing systems could allow an MBUF to be applied to all commercial trucks. Iowa's vehicle registration system could be utilized to identify commercial truck EVs. Once identified, a process could be put in place allowing an MBUF to be applied to non-apportioned vehicles (intrastate commercial trucks not subject to IFTA) in Iowa. IFTA, which applies to interstate commercial trucks and allows fuel taxes to be collected and netted between states based on the number of miles the vehicle traveled in a given state, could provide the necessary information to apply an MBUF to apportioned commercial trucks travelling into and through the state.

Privacy is a significant concern surrounding the implementation of an MBUF. While technology-based solutions utilizing GPS provide a means for identifying mileage driven within the state, all studies of

MBUFs note the privacy concern of location-based user fee collection to implement an MBUF. Any MBUF implementation will need to assure privacy of that data.

Non-technology-based solutions could also be implemented that would rely on odometer reporting/checks. For example, one method of non-technology-based reporting would be an annual self-reporting of mileage coupled with a reconciliation at the time of title transfer. This type of implementation would mitigate privacy concerns but could lead to significant increases in the oversight/cost of collecting the MBUF fee. Furthermore, a non-technology-based MBUF could lead to increased opportunities for tax evasion. Whether based on technology or odometer readings, implementing an MBUF would require enabling legislation to be passed at the state level.

Add a Supplemental Registration Fee on Electric Vehicles

To address their impact on transportation revenues, many states have implemented additional registrations fees on certain types of EVs. These registration fees are typically charged on an annual basis and are in addition to traditional annual vehicle registration fees. As the Iowa DOT has an annual vehicle registration system in place, adding a supplemental registration fee on EVs could be implemented with minimal administrative effort. Current Iowa Code would also ensure that these registration fees would be placed directly into the RUTF and have Iowa Constitutional protection that the funds can only be used for public road and bridge improvement and maintenance.

The registration process is understood by motorists and would not be subject to high levels of evasion. In addition, the registration fee supplement could be tailored to any level of EV including HEV, PHEV, and BEV. The fee could also be easily implemented upon hydrogen fuel cell EVs.

A supplemental registration fee could be applied to all passenger cars and commercial trucks registered in the state through Iowa's vehicle registration process. In addition, through the International Registration Plan (IRP) [10] system, a registration fee supplement could be applied to commercial trucks that are registered outside of Iowa but travel within the state of Iowa. However, mileage driven by out-of-state passenger cars would not be covered by a supplemental registration fee. In addition, a supplemental registration fee for a commercial truck would have to be very high to account for the loss in diesel fuel tax collections and it would be applied to all commercial trucks regardless of how many miles they drive in a year.

While easy to implement, a supplemental registration fee is not based on use of the highway system, as opposed to user fees such as the motor fuel tax, a per kWh tax, or an MBUF.

Add a Hydrogen Fuel Excise Tax

While not nearly as common as BEVs and PHEVs, hydrogen fuel cell EV technology continues to be developed for both passenger vehicles and commercial trucks. While likely a longer-term possibility, the development and deployment of hydrogen fuel cell commercial truck EVs has the potential to impact RUTF collections in the future. To address losses of transportation revenue an excise tax on hydrogen

[10] Like IFTA, the International Registration Plan (IRP) applies to interstate commercial trucks and allows registration fees to be collected and netted between states based on miles traveled in a given state.

used for transportation could be implemented. Implementing a hydrogen fuel excise tax is consistent with the existing process of collecting excise taxes on motor fuel and would result in a user fee that is in relation to a vehicle's use of the transportation system. The fee would apply to all vehicles fueling within the state of Iowa, including out-of-state vehicles. Through IFTA, the fee would also be applicable to out-of-state apportioned trucks traveling into and through Iowa. Currently six other states levy a fee on hydrogen vehicles through IFTA. To implement an excise tax on hydrogen, Iowa would need to pass enabling legislation. Such legislation would identify hydrogen as a motor fuel and ensure revenues have Constitutional protection for use only on public road and bridge improvement and maintenance.

What mitigation efforts have begun?

Many states have begun studying, or implementing, strategies to mitigate the impact of high efficiency vehicles on transportation revenues. While implementation has been limited, several states and multi-state coalitions are currently studying the implementation of an MBUF. As previously described, implementing an MBUF could be an effective way to mitigate transportation revenues associated with gains in vehicle efficiency.

Mileage-Based User Fees

Oregon

To date, the state of Oregon has conducted the most significant pilot efforts associated with implementing an MBUF. Oregon has advanced the idea of an MBUF from a recommendation identified in a 2001 Road User Fee Task Force report to the implementation of two user fee pilot programs which were conducted in 2007 and 2013. Following the conclusion of those efforts, the Oregon legislature passed legislation requiring the implementation of a fully functional MBUF program. The program, called OReGO, began July 1, 2015. Participants in the OReGO program are reimbursed for fuel tax paid and currently pay a rate of 1.7 cents per mile.

Oregon's OReGO program is implemented via three different vendors and allows participants to choose a GPS or non-GPS based method of collecting mileage information. Non-GPS based options are available through two of the three vendors. While these options mitigate privacy concerns, both options charge the per mile rate for all mileage traveled including mileage traveled outside the state of Oregon. Participants are then required to submit a reimbursement request to obtain credit for mileage traveled outside the state. All GPS enabled vendor options provide credits automatically for mileage traveled outside the state of Oregon and no reimbursement request is necessary. For non-GPS options, mileage is collected via a mileage reporting device that determines miles traveled without obtaining and reporting specific locations.

The Oregon legislature in 2017 passed legislation to increase transportation revenues through increased fuel tax rates. While this major transportation legislation did not include a conversion to a per mile fee, the OReGO program is still active and continues to serve as one of the most significant case studies of MBUFs in the U.S.

California

Using federal funding provided by the FAST Act Surface Transportation System Funding Alternatives (STSFA) grant program, many states and regions, in addition to Oregon, are now studying the implementation of MBUFs. For example, the state of California conducted a pilot study of 5,000 vehicles in 2016 and 2017. The study included both passenger cars and commercial trucks and offered seven unique methods to track mileage. California is building upon their original study to evaluate using pay at the pump/charging infrastructure as the means to collecting a per mile fee.

Western Road Usage Charge Consortium (RUC West)

The RUC West is an organization that brings together state transportation organizations as a forum to share best practices and research MBUFs. Of the 14 member states, six have tested or are testing MBUFs. These states include Oregon, California, Colorado, Hawaii, Washington, and Utah. The RUC West is currently completing an effort to develop and test an MBUF system that would operate across state borders. The planning for the project is being conducted by 11 member states which will define the system and develop plans for the regional system.

I-95 Corridor Coalition

Another major multi-state organization evaluating MBUFs in the U.S. is the I-95 Corridor Coalition. Like the RUC West, the I-95 Corridor Coalition provides a forum for state transportation agencies, toll authorities, and other key stakeholder organizations to address transportation management and operational issues. With funding provided through the STSFA, the I-95 Corridor Coalition is conducting a multi-year study evaluating the feasibility of replacing fuel taxes with MBUFs. The first phase of the study includes a 2018 pilot project focused within the state of Delaware. The pilot study included 150 participants.

Others

Many other states are also conducting studies of MBUFs. Study scopes vary but include efforts to evaluate MBUFs based on several different variables.

Supplemental Registration Fees

While MBUFs have not been implemented on a large scale, many states have passed legislation implementing supplemental registration fees on EVs. A total of 19 states have passed legislation to collect an additional fee from EVs to mitigate losses in fuel tax collections. Collections have begun with fees varying on a state-by-state basis. A summary of supplemental registration fees is shown in Table 2 on the next page.

State	Vehicle Types	Fee	Year Effective
California [1]	BEV / Zero Emissions	$100	2020
Colorado	BEV / PHEV	$50	2014
Georgia [2]	BEV / PHEV / Zero Emissions	$200	2015
Idaho	BEV / PHEV / Zero Emissions	$140 / $75 / $140	2017
Indiana [3]	BEV/ PHEV / HEV / Zero Emissions	$150 / $50 / $50 / $150	2018
Michigan [4]	BEV / PHEV / HEV / Zero Emissions	$100 / $30 / $30 / $100	2017
Minnesota	Electric and Zero Emissions	$75	2018
Missouri	BEV / PHEV / Zero Emissions	$75 / $37.50 / $75	2014
Nebraska	BEV / Zero Emissions	$75	2011
North Carolina	BEV	$100	2014
Oregon	BEV	$110	2020
South Carolina [5]	BEV / PHEV / HEV / Zero Emissions	$120 / $60 / $60 / $120	2018
Tennessee	BEV / Zero Emissions	$100	2017
Utah [6]	BEV / PHEV / HEV / Zero Emissions	$120 / $52 / $20 / $120	2019
Virginia	BEV / Zero Emissions	$64	2014
Washington [7]	BEV / PHEV	$150	2016
West Virginia	BEV / PHEV / Zero Emissions	$200 / $100 / $200	2017
Wisconsin [8]	BEV / Zero Emissions	$100	2018
Wyoming	BEV	$50	2016

[1] Fees will be adjusted for inflation annually beginning in 2021

[2] Commercial vehicle fee is $300. Fees adjusted annually based on vehicle efficiency data published in US DOE Fuel Economy Guide

[3] Fees will be adjusted for inflation every fifth year beginning in 2023

[4] Fees are higher on vehicles with an empty weight of greater than 8,000 pounds.

[5] Fees are paid every other year

[6] Fees begin at half the rate shown and increase annually from 2019 through 2021

[7] Fee applies to vehicles capable of traveling at least thirty miles using only battery power. Fee increased from $100 to $150 in 2016

[8] Fee applies to vehicle up to 8,000 pounds gross weight

Table 2: Summary of supplemental registration fees for EVs by state

As shown, fees range from $20 to $300 based on EV type and state. While all 19 states will levy the fee on BEV, it is important to note the applicability of the fee to PHEV and HEV varies widely. Approximately half of the states apply a fee on PHEVs, although in many instances the fee is less than the BEV fee. In addition, some states apply a fee to HEV. In those few states, the HEV is equal to or lower than the fee applied on PHEV.

Since implementing a supplemental registration fee, multiple states have made changes to their original fee structure. Some states, like Washington and North Carolina, have increased the fee amount levied upon BEV. The states of Virginia and Idaho changed legislative language to exclude HEVs from being subject to a supplemental fee.

Fee amounts are typically set to replace the fuel tax revenue that is generated by the average vehicle. For example, Tennessee passed legislation in 2017 that created a $100 registration fee on BEVs. The

comptrollers summary[11] noted that, based on the state's fuel tax rate of $0.26 per gallon, the $100 registration fee was equal to the tax that would have been collected on 385 gallons of gas. Using the 2015 average fuel economy per gallon for light vehicles of 23.9 the $100 fee is equivalent to the revenue that would have been generated by driving 9,200 miles. That 9,200-mile figure is less than the average Tennessee driver's 11,600 miles and as such the $100 fee is lower than the fuel tax collected from the average Tennessee vehicle.

Conclusion and Recommendations

The issue of EVs and the potential impact on the RUTF is one that has been under review by the Iowa DOT for several years. In both the 2011 and 2016 RUTF studies, Iowa DOT identified this as an emerging challenge that needed to be continuously monitored and evaluated.

EV growth in Iowa continues at a significant pace with the number of BEVs doubling between the years of 2017 and 2018. While total registrations remain low at this point, all forecasts indicate that growth in EVs will continue to occur at a rapid pace over the next 10 to 30-year period.

Based on 2018 data, Iowa's fleet of BEVs and PHEVs were found to have resulted in lost RUTF collections of approximately $317,000. As noted earlier, losses to the RUTF are forecast to increase substantially over the coming decades and could total $40 million to $240 million by 2040 depending on growth of the EV market. Based on recent growth, current registrations, and forecasted growth, the Iowa DOT recommends the legislature consider the following actions to mitigate the loss of transportation revenue due to these vehicles.

Mitigation Recommendations

Iowa DOT recommends implementing three fees to mitigate current and future losses to the RUTF resulting from BEVs, PHEVs, and hydrogen fuel EVs. Multiple fees are necessary to account for differences in how passenger EVs and commercial truck EVs are expected to be used and charged. Multiple fees also ensure that fees are collected from out-of-state and hydrogen EV users of Iowa's public roadway system. In making these recommendations, Iowa DOT took care to recommend solutions and fees that will be subject to the constitutional protection offered by Article VII, section 8 of the Iowa Constitution, "Motor vehicle fees and fuel taxes," which requires that "[a]ll motor vehicle registration fees and all licenses and excise taxes on motor vehicle fuel, except cost of administration, shall be used exclusively for the construction, maintenance and supervision of the public highways exclusively within the state . . . ."

Recommendation 1: Implement a per kWh excise tax on electricity used for transportation for all non-residential charging. Adding a per kWh excise tax mimics the current excise taxes levied upon motor fuels and reflects a user fee based on how much the vehicle uses the transportation system. A per kWh fee would capture all vehicles charging in Iowa including out-of-state passenger vehicles. A per kWh fee

[11] Tennessee Comptroller of the Treasury information regarding the state's 2017 Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy Act (IMPROVE Act).
http://www.comptroller.tn.gov/Repository/RE/OREA%20IMPROVE%20Act_July%202017.pdf

would also be able to be applied to out-of-state apportioned commercial truck EVs traveling into and through Iowa.

To avoid the burden and cost of collecting this user fee at homes, Iowa DOT recommends the per kWh fee be applied only to non-residential charging locations. Chargers subject to the per kWh excise tax would include both dealer and user-charging infrastructure. Dealer locations include retail locations such as existing fueling stations and user locations include businesses who have on-site charging infrastructure to charge their commercial truck fleets. This methodology is modeled after Iowa's LNG and LPG process and would allow the per kWh fee to be implemented at the point-of-sale.

Because electricity in Iowa is currently subject to the Iowa sales tax, Iowa DOT recommends the sale of electricity for use in charging locations be exempted from Iowa's sales tax. This process of obtaining a sales tax exemption and implementing an excise tax is like the implementation of Iowa's new Water Service Excise Tax, which was passed in 2018 as part of SF 512. Owners of charging infrastructure would collect the per kWh excise tax from customers and remit the tax to the Iowa Department of Revenue. Both owners and users of the charging infrastructure would be exempt from paying sales tax on that electricity. Implementation of the per kWh fee and exemption from sales tax ensures that electricity used for vehicle charging is subject to only a single Iowa tax.

Because electricity is used to power and propel EVs, a per kWh fee is equivalent to a motor fuel tax and is thus subject to the Iowa Constitutional requirement that the revenue derived from a per kWh fee must be used for the improvement and maintenance of Iowa's public roadway system.

Most large commercial trucks are currently powered by diesel engines and pay a fuel tax rate of $0.325 per gallon. Currently, Class 8 trucks (for example a semi-truck and trailer) achieve an average fuel economy of approximately six miles per gallon. Class 8 EV trucks are estimated to be able to travel approximately 20 miles on the same amount of energy as is contained in a gallon of diesel fuel; an increase of over three times the average Class 8 diesel truck. As such, a diesel gallon equivalent of electricity needs to be taxed at three times the existing diesel rate to fully mitigate losses to the RUTF. Iowa DOT recommends a per kWh fee of $0.026 be implemented to mitigate these losses to the RUTF.

The per kWh fee would also be applied to passenger EV charging performed at non-residential locations. Passenger BEVs achieve even greater efficiency gains than do commercial truck EVs. A review of a wide variety of BEVs shows these vehicles are over five times as efficient as the average passenger vehicle. Based on those efficiencies, a per kWh fee of $.044 would be necessary to fully mitigate losses to the RUTF. However, the primary goal of the per kWh fee is to mitigate losses associated with commercial truck EVs; therefore, the $0.026 per kWh fee is preferable. Were the $0.044 per kWh rate applied, commercial truck EVs would be paying significantly more than their diesel powered equivalent. Based on the $0.026 per kWh fee, passenger EV losses will only be partially mitigated when charging at non-residential locations. In addition, given that 80 percent or more of passenger EV charging occurs at home, non-residential charging will only minimally offset losses associated with in-state passenger EVs. Therefore, another user fee is necessary to mitigate the impacts to the RUTF from in-state passenger EVs.

Recommendation 2: Implement a supplemental registration fee for electric vehicles. To mitigate losses to the RUTF resulting from in-state passenger EVs, Iowa DOT recommends a supplemental registration fee be implemented. The supplemental registration fee would be applied to electric

motorcycles along with EVs. This supplemental registration fee is intended to mitigate lost RUTF revenue due to at-home charging of EVs. Because Iowa already has a vehicle registration system in place, adding a supplemental registration fee on these vehicles would be easily administered. Furthermore, as described earlier, as a vehicle registration fee, the revenue is subject to the Iowa Constitutional requirement that it must be used for the improvement and maintenance of Iowa's public roadway system.

Iowa DOT recommends the supplemental registration fee be levied on all EVs to which section 321.109 of the Iowa Code applies. Vehicles covered under that section are generally described as passenger cars, pickup trucks, sport utility vehicles, and crossovers with an unladen weight of less than 10,000 pounds. In addition, while it is a negligible part of the RUTF revenue stream, from an equity perspective the supplemental registration fee should be levied upon electric motorcycles.

As noted earlier the average passenger vehicle in Iowa is assumed to generate approximately $150 in fuel taxes per year. Most states with a supplemental registration fee have set their fee to equal the average excise tax lost per vehicle. Were Iowa to take the same approach, rates of $150 for BEVs, $75 for PHEVs, and $10 for motorcycles would be recommended. However, it is important that supplemental registration fees account for passenger EV charging that is likely to occur at non-residential locations and is thus subject to the per kWh fee. Therefore, to account for excise fees collected on non-residential electricity, supplemental registration fees are recommended in the amount of $130 for BEVs, $65 for PHEVs, and $9 for motorcycles. These fees, when combined with anticipated excise tax collections on electricity collected at non-residential locations (assumed to be 15 percent of all passenger EV charging), replace the lost excise taxes on motor fuel paid by the average motorist.

Recommendation 3: Implement a hydrogen fuel excise tax. Adding a hydrogen fuel excise tax assures a user fee is in place once hydrogen fuel cell EVs start using Iowa's public roadway system. At this time, the use of hydrogen fuel cell EVs is not expected to be widespread; however, there is potential for commercial truck hydrogen fuel cell EVs to start entering the system in late 2020. Like the implementation of a per kWh fee, the implementation of a hydrogen fuel excise tax assures users of Iowa's public road system, including out-of-state vehicles, pay a user fee to the RUTF. In addition, this excise tax would be defined as a motor fuel tax and thus be subject to the Iowa Constitutional requirement that the revenue derived from a hydrogen fuel excise tax must be used for the improvement and maintenance of Iowa's public roadway system.

The recommended rate for a hydrogen fuel excise tax was derived using the same methodology as used to recommend a per kWh rate. Currently, Class 8 trucks (for example a semi-truck and trailer) achieve an average fuel economy of approximately six miles per gallon. Class 8 hydrogen fuel cell commercial truck EVs are estimated to be able to travel approximately 13 miles on the same amount of energy as is contained in a gallon of diesel fuel; an increase of just over two times the average Class 8 diesel truck. As such, a diesel gallon equivalent of hydrogen needs to be taxed at two times the existing diesel rate ($.325 per gallon) to fully mitigate losses to the RUTF. Iowa DOT recommends a hydrogen fuel excise tax rate of $.65 per diesel gallon equivalent (2.49 pounds of hydrogen).

This same rate would apply to passenger fuel cell hydrogen EVs. While this rate level would not fully mitigate the impact on the RUTF of passenger hydrogen fuel cell EVs due to their efficiency, the impact is negligible.

Implementation

It is important to note the specific recommendations are intended to be a 10 to 20-year solution to this issue. These recommendations will mitigate losses to the RUTF but aren't as equitable as a mileage-based user fee. As noted earlier, MBUFs present the best opportunity to address the many equity concerns surrounding transportation funding but the implementation of such fees at a national level is still likely a long-term prospect. A national implementation of an MBUF is the only viable approach to successful implementation; therefore, Iowa DOT does not recommend an MBUF at this time. Until a national MBUF system is put into effect, the recommendations in this report will protect Iowa's existing transportation revenue as it relates to the expansion of EVs and other alternative fueled vehicles in the fleet.

To have time to make the necessary modifications to the vehicle registration system and motor fuel excise tax collection mechanisms, it is recommended the supplemental registration fee for EVs and the hydrogen fuel excise tax take effect on January 1, 2020.

Because charging infrastructure already exists in Iowa that may need to be modified to track usage, the per kWh excise tax is recommended to take effect on July 1, 2020.

The implementation of a per kWh fee, a supplemental registration fee, and an excise tax on hydrogen fuel will serve to mitigate loses to the RUTF. The mitigation solutions recommended may need to be adjusted in the future based on the development of the EV and hydrogen fuel cell EV market but at this time are the most equitable way to mitigate losses to Iowa's RUTF.