ELECTRIC VEHICLE MARKET PENETRATION:
An examination of industry literature

Issues in brief    # 2011-01

Prepared by

The Texas Transportation Institute,
Strategic Solutions Center
**Summary**

It is difficult at this time to quantify the number of electric vehicles currently registered in the State of Texas or to project the number of vehicles that will be registered in the long term. The state currently lacks the necessary record-keeping procedures to quickly and accurately assess the current number of registered electric vehicles. Furthermore, various market factors inhibit the ability to project electric vehicle market penetration at the state level with any confidence. Lack of supporting infrastructure for the charging of these vehicles and their high cost relative to traditional gasoline and diesel-based vehicles make long-term market projections problematic. Until electric vehicles from major auto manufacturers, such as the Nissan Leaf, are actually available for purchase by consumers, it will not be possible with current data to make reliable projections of electric vehicle market penetration in Texas. However, the limited data sources available provide estimates for the total number of electric vehicles sold annually in the Texas region by 2020 that range between 4,000 and 57,700.

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**Why is this important to Texas?**

Electric vehicles that do not run on fossil fuels will not pay fuel taxes, one of the two major sources for building and maintaining the state’s roadways. Knowing how many of these types vehicles are currently on the road and how many are expected in the future is of critical importance to funding state infrastructure upkeep and development in the long term.
The Electric Vehicle Market
When discussing the market for electric vehicles, particularly with regard to its future impact on infrastructure funding, it is important to first identify the type of vehicles that are being discussed.

*Hybrid Electric Vehicles* — Hybrid electric vehicles (HEV) are among the most popular electric motor-based vehicles on the road. They differ from traditional vehicles in that in addition to an internal combustion engine (ICE), HEVs also rely on an electric motor for vehicle propulsion. The ICE generally acts as either a charger for the electrical drive’s batteries or as a secondary means of propulsion if the batteries lack the adequate charge. One of the most common HEVs on the roadway is the Toyota Prius (pictured).

*Plug-in Hybrid Electric Vehicles* — A plug-in hybrid electric vehicle (PHEV) operates in a manner similar to a standard hybrid vehicle, in that its primary means of propulsion is a battery supported electric motor with a petroleum-based ICE serving as a secondary means of propulsion and/or battery charging. However, the major difference between a PHEV and an HEV is that a PHEV may be charged through a connection with an external electrical power supply. There are very few PHEVs currently on the road. However, the Chevrolet Volt (pictured) is expected to be among the most popular once it is released on a full scale basis.

*Electric Vehicles* — Pure electric vehicles (EV) do not have an ICE. They rely solely on their electrical motor for propulsion. As with PHEVs, there are not many pure EVs on the road today, as most vehicles utilizing electrical motors for propulsion are either an HEV or a PHEV. However, the soon to be released Nissan Leaf (pictured) will be among the first pure EVs released by a major automobile manufacturer. In this memorandum, the term electric vehicles and “EV” will be used to refer to these types of vehicles: vehicles that utilize electrical motors as their primary means of propulsion and completely lack a traditional internal combustion engine (ICE).
While there are currently a number of electric vehicles on the domestic automotive market, as a vehicle class they are not expected to constitute a significant presence on U.S. roadways until models from major automotive makers become widely available for purchase in 2011. Expectations for large-scale adoption by the driving public are very low in the near term; but in the long term, the rate of their adoption will pose significant challenges for funding roadway upkeep and expansion. Many models, such as pure plug-in electric vehicles, will not pay any fuel taxes while those that utilize an internal combustion element in conjunction with their electric motors (such as HEVs and PHEVs) will likely pay very little in fuel taxes relative to traditional fuel vehicles. As such, the rate at which the general public adopts these vehicles could significantly impact transportation funding sources. These funding sources, and specifically fuel taxes, are already facing long term shortfalls thanks in part to the ever increasing fuel efficiency of the domestic passenger vehicle fleet. Researchers at the Texas Transportation Institute therefore conducted a survey of automotive market literature and various data sources to identify potential trends in terms of long-term market penetration for EVs.

From the initial analysis conducted, the only conclusion that can be reasonably drawn is that the future is unknown. Projections of EV market penetration are available from a variety of sources, but there is little consistency in the numbers presented. Estimates for the number of EVs that will be sold in the Texas region in 2020, for example, appear to range from several thousand to almost 58,000. The level of uncertainty surrounding the EV market can be at least partially attributable to two factors: vehicle cost and supporting infrastructure.

Cost

The expected purchase price (not including incentives) of these types of vehicles, $41,000 for the Chevrolet Volt (PHEV) and $33,000 for the Nissan Leaf (EV), means that they are less likely to be utilized by a broad swath of the motoring public and will likely be only attractive to “young, very-high income” individuals. According to Deloitte Consulting, this small number of potential consumers will not be enough to spur mass adoption. While the federal government is offering a $7,500 tax credit for the purchase of an EV, about $2,000 of which can be applied to the purchase and installation of home charging stations, it is unknown as to how long these incentives will ultimately be offered.

A significant portion of the estimated cost of a new EV is related to the battery. In some cases, it can account for up to two-thirds of the overall purchase price, if not more. In an attempt to spur the domestic battery manufacturing industry, the Obama administration has offered about $24 billion in various incentives for the EV industry. There is also $2.4 billion in American Recovery and Reconstruction Act (ARRA) money available for EV component makers. The Energy Department is also loaning significant funds to Nissan, Ford, GM, Tesla and Fisker. These funds are being made available because the administration believes that by increasing production of these vehicles’ most expensive components, namely the battery, that price will eventually drop due to economies of scale as mass
production increases. The Obama administration expects that battery costs alone will drop by 70 percent in the coming years. Boston Consulting Group predicts a 60 to 65 percent drop by 2020. However, some analysts, such as those at Roland Berger Strategy Consultants, are predicting a possible “battery bubble” within five years as production of these components will outpace demand. If such a bubble were to develop, many of the companies currently working to develop EV battery technology might not survive.

**Infrastructure**

A big issue that will affect the purchase of EVs domestically is the presence of infrastructure for the support of these vehicles. Drivers of gasoline vehicles generally do not have to worry about the availability of gas stations as long as their vehicle does not run low on a particular trip. However, EVs do not currently have as extensive a support structure as gasoline vehicles have, and it is unknown to what extent drivers will be willing to purchase these vehicles without it. The penetration of fuel cell technologies will be similarly limited by the availability of hydrogen refueling stations. However, it is expected that fuel cell vehicles will require substantially less time to refuel than EVs.

“Range anxiety” refers to a general concern expressed by potential users of EVs regarding their ability to keep their vehicle charged on any given trip. It has been routinely speculated that range anxiety will result in the appeal of EVs being mostly limited to urban drivers or will result in EVs serving as a secondary or tertiary vehicle for households using traditionally fueled vehicles.

There are several methods for potentially addressing range anxiety. EVs are generally envisioned as being charged at home when demands on electricity grids, and hence electricity prices, are lower. Charging stations for home use are expected to run about $2,500 which includes installation costs. In terms of charging cost, it is estimated that the electricity required to fully charge a Nissan Leaf overnight will be about $3.00.

Numerous entities, both public and private, are working to develop stations that would allow for vehicles to be charged outside of the home. In Texas, TXU Energy will be installing at least a dozen electric vehicle charging stations on city property within Fort Worth and Dallas as a means of encouraging EV purchase. For the first year, TXU will pay for all of the electricity for these stations and

1 Lane, C. (2010, August 14). Rich man’s ride; Electric cars likely to remain green status symbols, affordable only by households making $200,000 a year. *National Post*.

2 Roland Berger Consultants, (Presentation dated February, 2010). Powertrain 2020: Li-ion batteries — the next bubble ahead?

will allow for free charging of city employee vehicles in the second and third years. 4 Half Price Books claims to have installed North Texas’ first EV charging station at a location on the Northwest Highway that will allow drivers to charge their vehicles for free until September 2011. The station features two charging spots and was developed by Coulomb Technologies, Inc. at a cost of $10,000. 5 Coulomb Technologies is a California-based firm whose system directs drivers to the nearest available charging station. The company is part of ChargePoint America, a $37 million program funded with $15 million in ARRA grants from the DOE that is aiming to install 4,600 to 5,000 of these devices in nine American cities. It is currently donating charging stations to businesses in an attempt to “jump start” the market. The State of Washington is using $1.5 million in federal money to kick start a program that will turn the section of I-5 from Canada to Oregon into an “electric highway.” The estimated cost of the project is $250 million and will install charging stations capable of filling a lithium-ion battery to within 80 percent of capacity within 30 minutes. 6

Another method of addressing range anxiety might be to develop “battery swap” stations, where vehicles can have their depleted batteries swapped for freshly charged batteries. This approach has the advantage of being much faster than a typical vehicle charging at home. However, EV batteries are not currently standardized. Better Place, a California-based firm, is currently testing battery swapping stations in Japan and is planning tests in Israel. 7

Electric Vehicles in Texas

Hard, reliable data on the expected number of EVs in the State of Texas is difficult to obtain. A survey of available data sources related to state and national vehicle fleets has revealed several possible reasons for this:

- The uncertainty surrounding the EV industry, in terms of when certain models will be available for purchase, has made long-term projections difficult.
- EVs are not currently categorized as a separate vehicle class by state vehicle registration entities, to the extent that they could be analyzed from vehicle registration records.
- EVs are not taxed at the state and/or federal level, something that would allow for analysis of current revenues or projection of future revenues from these vehicles.

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7 Reed, J. (2010, September 17). Electric Cars are all the rage in Israel. Financial Times.
State Data
In examining available vehicle registration records, researchers discovered a lack of information that would allow for a quick and accurate determination of the number of EVs registered in the State of Texas. While vehicle registration records contain a great deal of information, in their current form they are not suitable for this type of analysis.

Vehicle Class
The Texas Department of Motor Vehicles and the counties responsible for administering vehicle registrations use the Vehicle class, a two-digit number, to classify various types of vehicles. Most vehicles registered for personal use in the State of Texas fall under one of four vehicle classes:

- Class 25: Passenger Vehicle less than or equivalent to 6,000 lbs.
- Class 26: Passenger Vehicle greater than 6,000 lbs.
- Class 35: Truck less than of equivalent to 1 ton.
- Class 36: Truck greater than 1 ton.

EVs are likely to be classified as Class 25 vehicles, and there are no other categories that differentiate engine type. Thus, an analysis of EV use in Texas cannot occur based on vehicle classification.

Vehicle Identification Number (VIN)
VINs are typically 17 digits and contain a great deal of data pertaining to the specific vehicle. This information includes:

- Make, model and year.
- Location of manufacture.
- Special vehicle features.
- Order of manufacture relative to other models from the same plant.

The “special features” series of digits in the VIN carry the most hope for identifying electric vehicles. However, this series of numbers varies in terms of the information contained depending on the initial three digits (make, model and manufacturer). For example, the information contained in the “special features” identifiers is different for vehicles manufactured in Japan, the United States and Europe. As such, they are not uniform across all vehicle makes and models. Thus, identifying electric vehicles from VIN numbers recorded in vehicle registrations will be problematic, given that:

- A complete catalogue of all “special feature” identifiers for all makes and models would need to be compiled.
- All statewide vehicle registrations would need to be run through an algorithm capable of reading these numbers and identifying the vehicle as being electric.
United States Department of Energy

The Department of Energy (DOE) and the Energy Information Administration compile vehicle records as they pertain to energy consumption. As such, these entities are currently monitoring (and in some cases, facilitating through research programs) the development of EVs. As part of the DOE’s 2011 Energy Outlook Report, projections of EV purchases were developed. While these projections were not specific to Texas, Texas is included in the West South Central Region (WSCR) along with Louisiana, Arkansas, and Oklahoma.

For the WSCR, DOE projects that electric vehicle sales in 2011 will be about 1,250, 2,590 in 2012, and 4,155 in 2020 (Figure 1). Average yearly growth rate in EVs is expected to be 12.2 percent from 2012 through 2035. By 2035, the DOE predicts that annual EV sales will top 13,800 in the WSCR.

![Figure 1: Annual Hybrid, Electric Vehicle, and Hybrid-Electric Vehicle Sales (2011 - 2035)](image-url)

While the EV market is projected to continue growing through 2035, as Figure 2 shows, traditional petroleum–based automotive technologies will continue to dominate the roadway. But while traditional petroleum fuel vehicles will continue to account for the largest percentage of new vehicle sales, that share will steadily decline. In 2010, traditional petroleum-based vehicles accounted for about 86.1 percent of new auto sales in the WSCR, and by 2035 they will account for 73.1 percent. Ethanol and flex fuel-based vehicles will constitute the most popular alternative fuel technologies, accounting for just fewer than 20 percent of regional sales by 2035. Hybrids will account for 6.6 percent of regional auto sales while EVs will account for less than 1 percent.

![Figure 2: Composition of Annual New Vehicle Sales by Vehicle Technology](image)


**Other Resources**

Figure 3 show various projections of national EV sales for the year 2020. J.D. Power Automotive Forecasting has predicted that annual sales of electric vehicles will approach 2 million in 2020. HSBC has
projected annual sales by that time to reach about 9 million. Deloitte Consulting predicts that annual sales of EVs by 2020 will be no more than 465,000, and IBM forecasts EV sales in 2020 to be just over 1.3 million. IBM further projects that by 2020, there will be almost a quarter of a million EVs in the State of Texas.

<table>
<thead>
<tr>
<th>Source</th>
<th>Annual EV Sales in 2020</th>
<th>for Texas (6.9%)</th>
<th>Cumulative</th>
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<tbody>
<tr>
<td>J.D. Power</td>
<td>2,000,000</td>
<td>138,000</td>
<td>759,000</td>
</tr>
<tr>
<td>HSBC</td>
<td>9,000,000</td>
<td>621,000</td>
<td>3,415,500</td>
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<tr>
<td>Deloitte</td>
<td>465,000</td>
<td>32,085</td>
<td>176,468</td>
</tr>
<tr>
<td>IBM</td>
<td>1,321,200</td>
<td>57,708</td>
<td>248,485</td>
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</tbody>
</table>

Figure 3: Estimated 2020 EV sales nationally

<table>
<thead>
<tr>
<th>Year</th>
<th>Est. Plug-In New Vehicles Registration</th>
<th>Cumulative Plug-In Totals</th>
<th>Est New Vehicle Registration in Texas</th>
<th>Est. Cumulative PEV in Texas</th>
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<tbody>
<tr>
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<td>65,000</td>
<td>65,000</td>
<td>2,839</td>
<td>2,839</td>
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<tr>
<td>2012</td>
<td>102,200</td>
<td>167,200</td>
<td>4,464</td>
<td>7,303</td>
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<td>2013</td>
<td>220,800</td>
<td>388,000</td>
<td>9,644</td>
<td>16,947</td>
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<tr>
<td>2014</td>
<td>320,400</td>
<td>708,400</td>
<td>13,994</td>
<td>30,942</td>
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<tr>
<td>2015</td>
<td>460,800</td>
<td>1,169,200</td>
<td>20,127</td>
<td>51,069</td>
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<tr>
<td>2016</td>
<td>531,000</td>
<td>1,700,200</td>
<td>23,193</td>
<td>74,262</td>
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<td>2017</td>
<td>680,400</td>
<td>2,380,600</td>
<td>29,719</td>
<td>103,980</td>
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<td>2018</td>
<td>885,600</td>
<td>3,266,200</td>
<td>38,681</td>
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<td>2019</td>
<td>1,101,600</td>
<td>4,367,800</td>
<td>48,116</td>
<td>190,777</td>
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<tr>
<td>2020</td>
<td>1,321,200</td>
<td>5,689,000</td>
<td>57,708</td>
<td>248,485</td>
</tr>
</tbody>
</table>

Figure 4: National EV registrations, IBM

For additional information, please contact:

Richard T. Baker, Associate Transportation Researcher
Texas Transportation Institute, Austin Office
Texas A&M University System
1106 Clayton Lane, Suite 300E
Austin, TX 78723
(512) 467-0946 Office
r-baker@ttimail.tamu.edu


9 Lane, C. (2010, August 14). Rich man’s ride: Electric cars likely to remain green status symbols, affordable only by households making $200,000 a year. National Post.