

# CENTER FOR THE COMMERCIALIZATION OF ELECTRIC TECHNOLOGIES



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## Volume 1 Texas Triangle Plug-in Electric Vehicle Readiness Plan

Summary and Recommendations



Driving on Texas Highways

Prepared by the Center for the Commercialization  
of Electric Technologies under a grant from the  
U.S. Department of Energy's Clean Cities



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## **Executive Summary**

This is Volume 1, Summary and Recommendations of the three-volume Texas Triangle PEV Readiness Plan. The Plan addresses barriers to readiness and PEV acceptance in the triangle formed by the Texas metro areas of Dallas/Ft. Worth, Houston, and Austin-San Antonio with a focus on the small and mid size cities in between. The Plan benefits the stakeholders and general public by laying out the issues and providing a set of recommendations to address these issues.

## About the Authors

The Texas Triangle Plug-In Electric Vehicle Readiness Plan of the Center for the Commercialization of Electric Technologies was a collaboration between five planning teams: Plug-in Texas (state legislation and agency initiatives); Frontier Associates (electric utility issues and PEV grid interface); Southwestern Economics and CCET (local best practices to promote readiness); ECotality North America (PEV charging infrastructure along the triangle corridors); and Dave Tuttle Consulting (consumer information program). In addition, a Technical Advisory Committee including Clean Cities coalition staff, electric utility representatives, and cognizant state agencies provided review of the work products. Finally, Southwest Research Institute provided key technical review and valuable insights into the implications of the economic change from a petroleum-based to an electricity-based transportation system.

## Acknowledgements and Disclaimers

Opinions expressed in this report, as well as any errors or omissions, are the authors' alone. The examples, facts, results, and recommendations summarized in this report represent our interpretations. Nothing herein is intended to provide a legal opinion. The recommendations are voluntary except to the extent that governing bodies may decide to enact them in the form of legislation or ordinance. The plan may not be copied, reproduced, modified, distributed, sold, broadcast, stored or otherwise used without the express permission of CCET or the original copyright holder or the authors.

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*Electric vehicles first made their entry into the transportation systems early in the last century only to disappear under the market pressure of the internal combustion engine and Henry Ford. But in my life time the electric vehicle "ride" has been for not-so-energetic golfers and two-wheeled scooter enthusiasts. But that's about to change. Modern electric vehicles offer all the comfort, safety and convenience of their gasoline counterparts, save one thing--range limitations. Our Texas efforts will provide leadership to the nation in developing the needed infrastructure to support electric vehicle travel among our major cities, and we'll clean up smog along the way.*

*Milton Holloway, President & COO of CCET*

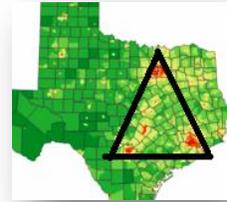
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## 1. Scope of the Plan

The Center for the Commercialization of Electric Technologies (CCET), with funding from the U.S. Department of Energy’s (DOE) Clean Cities initiative, has prepared this Texas Triangle Plug-in Electric Vehicle (PEV) Readiness Plan. The geographic scope of this Plan is primarily the triangle created by Houston, Dallas-Ft. Worth and San Antonio linked by Interstates 45, 10, and 35, and including the City of Austin. The topical focus of this Plan is recommending actions at the State and local level to reduce barriers to PEV market penetration—particularly in the small and mid-size cities outside of the large metro areas.



There is also a strong focus on the interplay between the grid and PEVs because of CCET’s mission of promoting “smart grid” technologies within the State’s self-contained electricity grid—the Electric Reliability Council of Texas (ERCOT). CCET is not a government agency nor is it a lobbying organization. Therefore, the actions that make up this Plan are limited to recommendations that various groups—including ERCOT, the Texas Legislature, municipal governments, State agencies, electric utilities, and other groups—may want to consider to promote PEV “readiness.”

## 2. Background: What is PEV “Readiness” and Why is it Important?

Previous efforts in the 1990s to introduce electric vehicles—primarily to address air quality standards, but also to address fuel economy standards and concerns over the high costs of imported oil—were not successful for a variety of reasons. One of these was that the public and state and local government institutions were perceived as not prepared for the introduction of this new technology—hence the desire to ensure that this most recent wave of PEVs into the market will not fail again because of the lack of readiness on the part of consumers and public institutions.

The Federal government through the American Recovery and Reinvestment Act (known popularly as “the Stimulus”) invested several billion dollars in PEV incentives to purchasers, battery technology research and development, and programs to promote PEVs. In addition some 20 states and the District of Columbia offer additional subsidies for the purchase of PEVs.<sup>i</sup> If the introduction of the gasoline internal combustion engine (ICE), which displaced horse and buggies (along with the first introduction of electric vehicles) at the turn of the last century, did not need government assistance or readiness programs, why do PEVs require them now?

Advocates for PEVs cite three major reasons as a rationale for promoting PEVs through public expenditures: (1) air quality, including the belief by many that carbon emissions will have catastrophic effects on global climate, (2) the need to reduce dependence on foreign sources of oil (much of this from countries that are unfriendly to the US), and (3), the belief that with mass production and continued improvements in battery technology the lifetime costs of the PEVs will be less than that of conventional ICE vehicles, thus providing consumer benefits in terms of reduced transportation costs.

This Plan does not examine this rationale for public policy, but rather accepts the fact that PEVs are being introduced into the marketplace in large numbers. As shown in Figure S1 below, even the reduced expectations of sales of PEVs indicate a significant rate of growth—one that exceeds the market penetration of hybrid vehicles a decade earlier.<sup>ii</sup>

Beginning in 2011, PEVs are now being marketed by half a dozen car manufacturers with the all-electric or battery electric vehicle (BEV) Nissan Leaf and the plug in hybrid (PHEV) Chevrolet Volt.<sup>iii</sup> Several other manufacturers are now (or soon will be) offering PEVs.

The third point in the case for PEVs cited above is as yet unrealized for most drivers in most parts of the country—lower overall cost of ownership vis-à-vis conventional (ICE) vehicles. In general, the *fuel and operating costs* of PEVs are anywhere from half to one third that of gasoline powered vehicles. However, the *front end costs* are significantly higher for PEVs, resulting in payback periods of several years when buying a PEV over a similarly equipped internal combustion engine vehicle.<sup>iv</sup>

Current sales of PEVs are mostly to those who either want a hedge against further gasoline price spikes or shortages, are motivated by environmental concerns, and/or are an early adopter interested in the technology and performance of electric vehicles.

The current marginal economic case for PEVs is expected to change as PEV battery prices go down. Battery costs were \$650 per kWh in 2009 and have been steadily declining to \$450 by late 2011 and a projected \$250 by 2020.<sup>v</sup> Battery costs are the reason PEVs are now more expensive than similarly equipped conventional gasoline powered vehicles. If these projections are realized, the payback periods will drop and PEVs will achieve significant market penetration. Figure S-1 shows the recent past sales of PEVs and a recently developed projection of future sales by PEV model and year. The 2015 sales projections are below the earlier DOE estimates (and Administration goal) of 1 million PEVs. These current projections are from EPRI<sup>vi</sup>

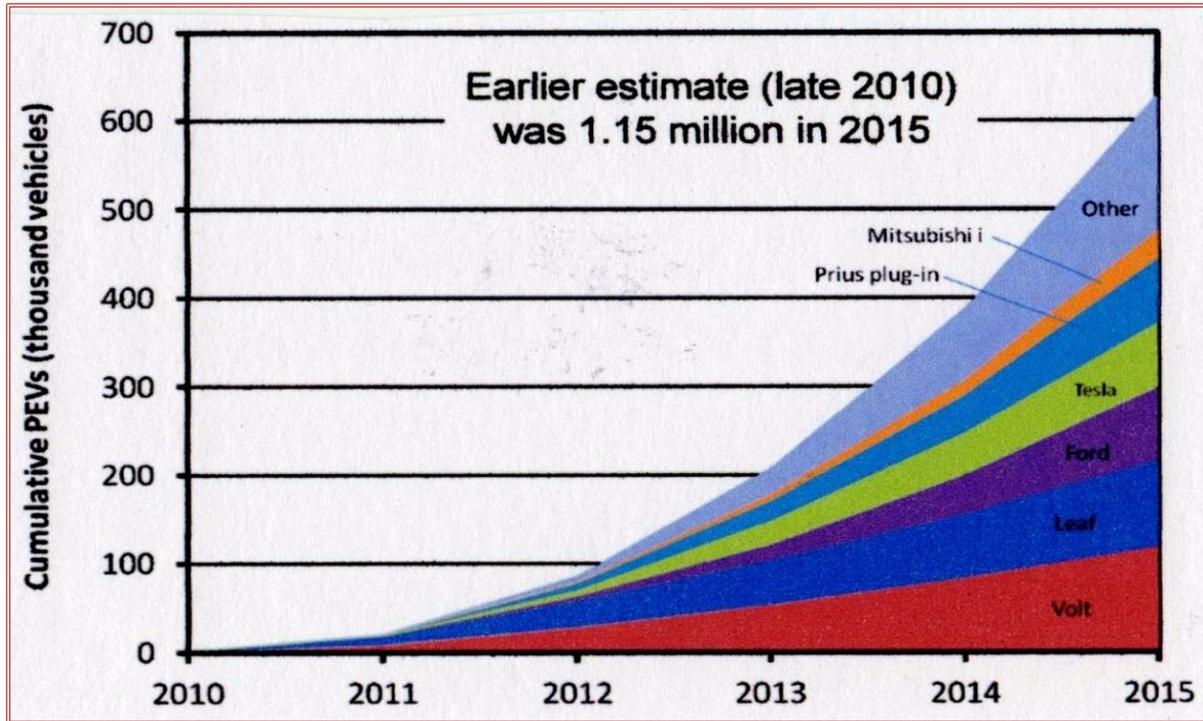


Figure S1-Actual and Projected Sales of PEVs in US through 2015  
Source: ERPI, 2012

Also of note, the current (mid 2012) sales of PEVs are dominated by Chevy Volts and Nissan Leafs. By 2015, the projected sales of these two models will continue to increase, but will be only about one third the total volume of PEV sales as a number of new models are introduced. The total sales volume of PEVs for 2011 was less than 20,000 vehicles of the more than 12.8 million light duty vehicles sold.<sup>vii</sup> Nevertheless, when compared to the growth of hybrid electric vehicles in their first years of availability, the sales of PEVs are higher.

### 3. Rationale behind the Texas Triangle PEV Readiness Plan (Plan)

There were two guiding premises behind the CCET grant application. One was that each of the large metropolitan areas in the triangle had made considerable progress in developing PEV promotion and readiness programs, but that the small and mid-size cities lacked a similar level of PEV awareness and readiness.

A second premise was that there are issues related to PEV readiness that could be better handled from a statewide perspective. As with the other 15 awardees of the planning grants<sup>viii</sup>, CCET was asked to identify barriers to PEV market penetration and recommend measures to overcome these barriers, thus achieving “PEV readiness.”

## 4. Organization of the Plan

With CCET as the grant recipient, several individuals and firms were contracted to develop individual elements of the Plan based on identified barriers to PEV readiness. The Plan elements are presented in individual chapters in Volume II and include analyses of:

- State of Texas PEV, and alternative fuels, legislation over the past six years as well as State agency actions, (Chapter 2 of the Plan),
- Barriers to PEV readiness in small and mid-size cities in the Texas Triangle (Chapter 3) ,
- Electric power industry and grid related PEV issues (Chapter 4),
- Feasibility of connecting the urban areas in the Texas Triangle with PEV charging infrastructure (Chapter 5),
- How to provide a state-focused noncommercial and reliable source of PEV information, (Chapter 6), and
- Issues associated with the long term (Beyond Readiness, Chapter 7).

Volume III consists of appendices with more detailed information in the Plan.

Following are some of the key points from the various chapters and then a presentation of recommendations from the Plan.

## 5. Key Points from the Six Plan Elements

### 5.1. Texas Legislative and Regulatory Setting

With its reluctance to spend taxpayer monies on PEV subsidies and its aversion to having government “pick winners” in technological developments, the State Legislature has not joined 15 other states in enacting significant incentives to PEV market penetration. Most of the activity in the State has been local metropolitan planning organizations and large cities using federal funds to institute programs.

Nevertheless, as *Chapter 2* indicates, numerous bills have been introduced and there has been some action at the state agency level. This Plan suggests others, including the use of front-end subsidies for PEVs in ozone non-attainment areas using an existing program managed by the Texas Commission on Environmental Quality (TCEQ). Other topics discussed include a tax on PEVs to offset the reduced purchases of gasoline that currently fund highway maintenance.

## 5.2. Local Best Practices

*Chapter 3* and the more detailed supporting appendices propose a statewide program that would provide mostly non-monetary incentives to local communities to address some 11 initiatives that would overcome barriers to adoption and an easier transition from purely petroleum based transportation to electrified transportation. The 11 options represent both barriers that prevent PEVs from competing fairly with their ICE counterparts (such as unnecessary delays and permitting fees associated with vehicle charging equipment and lack of knowledge leading to irrational decision making) to actual promotion of PEVs (such as allowing PEVs to use high occupancy vehicle lanes and a subsidy for PEV purchases in areas where there would be demonstrable air quality improvement).

The *Texas PEV-Friendly Community* program would recognize municipalities throughout the entire state that meet a certain level of achievement based on which options are selected and the degree of success of accomplishing them. The program would need a state level entity to sponsor it and would be most efficiently operated in conjunction with a statewide consumer information program with a dedicated website as its centerpiece (*Chapter 6*). A general listing of the 11 elements of the Texas PEV-Friendly Community program is provided in the recommendations section of this volume.

## 5.3. Electric Utilities and PEV Readiness

Because Texas has its own grid (the rest of the U.S. and Canada is served by a separate interconnected interstate electric grid) regulated by a single set of Texas entities and is now restructured in a largely competitive market, we are in a position to innovate and move relatively quickly to resolve issues and take advantage of opportunities in what is known as smart grid technology. As PEVs become more numerous, they represent both a challenge and an opportunity to operate the grid more efficiently. The great majority of charging will occur in the evening and overnight and at home (or for fleets at a central location or garage). Slight modifications in the exact timing of the charging can mean the difference between exacerbating the stress on the grid (particularly between 5 and 7 pm on summer days) and taking economic advantage of the large volume of West Texas wind generation which is most plentiful at night.

At the micro or neighborhood level, if several households sharing a common transformer each begin charging their PEVs at the same time and the distribution utility is not aware of this possibility, then local transformers and circuits can be overloaded and fail. *Chapter 4* discussion and recommendations deal with these types of issues and how they can be addressed in the short term.

#### 5.4. Intercity PEV Travel

For drivers of battery electric vehicles (BEVs operate solely on stored electric power in the battery), it is currently very difficult to travel from one major metro area in the Texas Triangle to another. Running out of electric charge creates what is known as “range anxiety” and, thereby, is a barrier to the adoption of the all-electric or BEV segment of the PEV market.



**Figure S-2 Corridor Segments Analyzed in Chapter 5**

Over the next five years, there will be inadequate “organic growth” of private sector and local government charging stations particularly on the northern portion of I-45 and the western portion of I-10 to deal with range anxiety for Battery Electric Vehicle Drivers.

However, a \$1 million per year subsidy over a five-year period beginning in 2013 could provide a minimal, but adequate, mix of fast charge and Level 2 charging.

As indicated in *Chapter 5*, the corridors connecting the metropolitan areas of the state’s largest cities will eventually be served by PEV charging through organic growth of charging infrastructure in communities and at businesses along the corridor without government funding. However, it is expected that for the next five years such growth will be inadequate to ensure that drivers of BEVs will be able to comfortably make intercity trips. This is especially true along I-10 connecting Houston and San Antonio and to a lesser extent between Houston and Dallas on I-45.

There are several policy options. One is to do nothing and simply wait for the battery technology improvements to extend range and for local businesses along the interstates to install charging equipment to attract customers. As local communities develop charging stations to serve their own populations (either fee-based or free), the range anxiety issue will work itself out through

market mechanisms. This “organic growth” of PEV charging stations is considered the business-as-usual (BAU) scenario in *Chapter 5* that examines this issue.

A second approach that does not require waiting for technology improvements and organic growth of charging along the connecting roadways is simply to recognize the limitations of BEVs for long trips. Under this approach, a two-car family might have a BEV for in-town travel and a conventional internal combustion engine (ICE) vehicle or a PHEV for long trips. A single-car family, or an individual, could simply purchase a PHEV and switch to gasoline or diesel power when the charge on the battery is depleted. This would also be a BAU approach and would be enhanced by a good consumer information program (as in *Chapter 6*).

At the time that the federal *planning* funds for this Plan were made available, it appeared that significant levels of *implementation* funding would follow. Therefore, a part of this Texas Triangle PEV Readiness Plan (*Chapter 5*) looked at the infrastructure requirements for a federal or federal/state construction program of charging stations to connect the metropolitan areas using a variety of business models and technologies. The Chapter 5 analysis indicates that for a subsidy of \$1 million per year for the period 2013-2017 a minimal, but adequate, series of Level 2 and DC Fast Charging stations could be established along the connecting corridors in the Texas Triangle (including Hwy 71 from Austin to Columbus). This is an option to consider if federal funding becomes available.<sup>ix</sup>

## 5.5. Consumer Information

*Chapter 6* of this Plan addresses what most observers believe is the single most important “need” to remove barriers to PEV market penetration. This is the provision and ready availability of solid, unbiased, easy-to-understand, current information upon which a prospective PEV purchase can base purchasing decisions. This information is not just necessary for the prospective individual customer, but also for those who provide services, fleet owners, and public officials. Please go here (<https://sites.google.com/site/texastriangleev2/>) to see the prototype of a website.

While this prototype is not intended to be the final website with full hosting and maintenance support, webmaster, videos, and more aesthetically attractive design, we are making it available for viewing given it has many useful links and content. To provide credibility, independence, and continuity to this Texas based PEV consumer information program we are recommending that it be operated by the same statewide entity that runs the Texas PEV-Friendly Community as illustrated in Figure S-2 below.

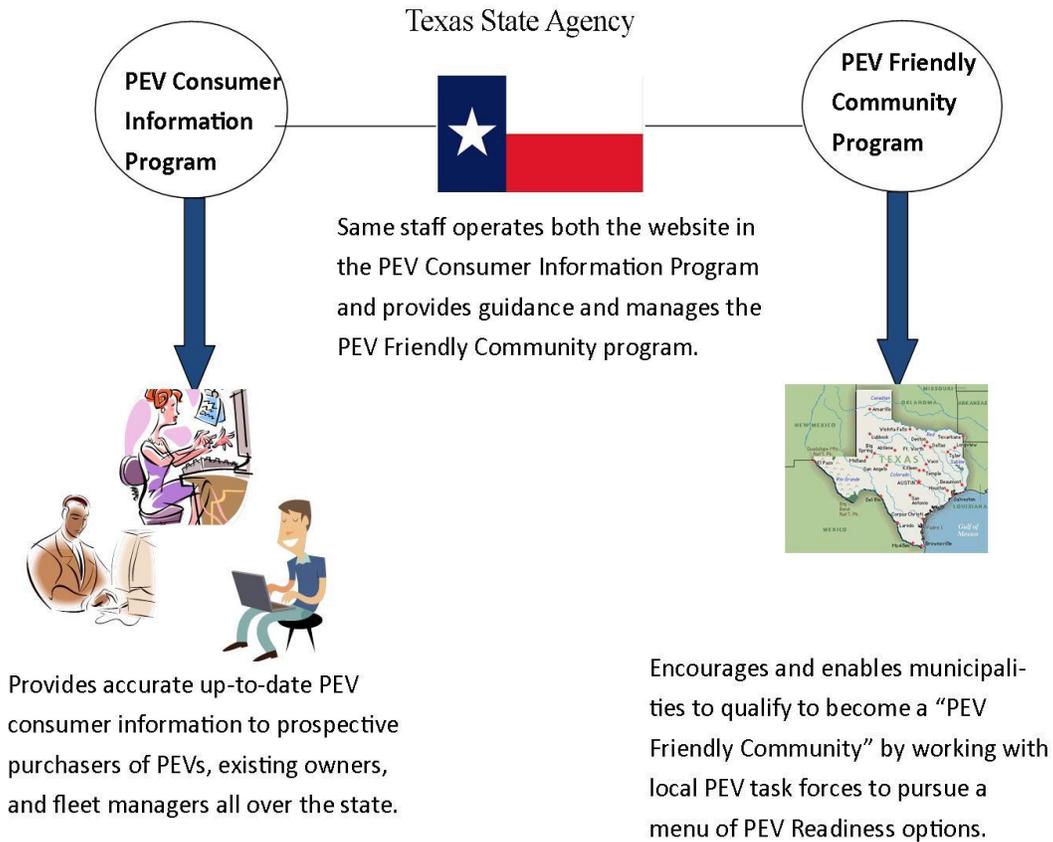


Figure S-2. Recommended organization to implement PEV Consumer Information and Texas PEV-Friendly Community programs under a proposed Interagency Council for Transportation Fuels to be appointed by the Governor or a state agency

### 5.6. Longer Term Planning for Electrification of Transportation – Beyond Readiness

*Chapter 7* of this Plan looks beyond the three-to-five year planning horizon implied by “readiness” to suggest initiatives that should be started soon to be ready to adapt to what could be an eventual shift to the electrification of transportation. Much of the discussion in this chapter has a national flavor and, as such, is intended to inform a larger audience. Also, topically the issues addressed pick up and overlap the electric utility/PEV interface discussed in *Chapter 4*.

## **6. List of recommendations from the Texas Triangle PEV Plan**

The process for developing the recommendations that comprise this Plan began with drafts developed by the individual chapter authors (subcontractors to CCET, See Appendix 1B). These were refined through two separate review loops and meetings of the Technical Advisory Group for this project (See Appendix 1C). Finally, the recommendations were discussed and revised by the CCET Board of Directors. Some of the issues were not resolved and lend themselves to the type of policy discussions envisioned by the proposed Interagency Transportation Fuels Council recommended below to deal with the future role of electric power and natural gas as an alternative to refined crude oil.

There are 35 recommendations in the table that follows. They are presented by category. The seven categories are: general, electric power industry, PEV consumer education, intercity charging to address range anxiety from drivers of battery electric vehicles, local best practices for communities to adopt, direct incentives for new PEV purchasers, and recommendations for the longer term (beyond readiness). The table provides a brief description of the barrier that is being addressed, the actual recommendation, and, in the third column, some additional comments.

## RECOMENDATIONS

<b>A. Category: General</b>			
<b>No.</b>	<b>Problem, Barrier or Opportunity to Promote PEVs</b>	<b>Recommendation</b>	<b>Comments</b>
G-1	The road fuel sales tax is not adequate to fund new highway transportation needs. PEVs use state highways, but pay little or no (in the case of BEVs) taxes for the use of the roads. This exacerbates the current highway funding program. However, because the level of PEV market penetration is low, and likely to remain so for a few years, and because other fuel efficient vehicles (e.g., the hybrid) are also exacerbating the problem, careful consideration needs to be given to this issue.	<b>Either an interim legislative study committee or the Interagency Transportation Fuels Council (recommended below) should have a recommendation ready for enactment in the 2015 session of the Texas Legislature.</b>	<b>The recommendation should take into account the relatively lower impact of the lighter fuel efficient vehicles on roadways as well as the need for all vehicle types to share in resolving this problem.</b>
G-2	Given the opportunities and challenges posed by the electrification of transportation for Texas, at issue is how to pursue the various recommendations for PEV readiness and promotion listed below by category. Absent any new approach, the future will look something like the immediate past: regional activities funded largely by federal grants, ad hoc efforts, and commercial and non-profit partnerships. Many of the issues below are best pursued at the state level—either through state agency actions, legislation, and information sources. No single state agency has a clear purview of the various issues, but several have key roles. (See comments at far right)	<p><b>Establish through executive order a four-year statewide Transportation Alternative Fuels Interagency Council to implement programs and coordinate policies, contingent upon no incremental funding from the State.</b></p> <p>State authorities (e.g., gubernatorial executive order or legislation) could establish an interagency council on alternative transportation fuels that would include both transportation electrification and use of natural gas in those vehicles best suited for LNG or CNG.</p> <p>The Council would include representatives from each of the agencies listed at right, plus a nonvoting member each from the environmental community, the metropolitan planning organizations, the natural gas marketing community, vehicle manufacturing,</p>	<p>To avoid the appearance (as well as the actuality) of setting up yet another bureaucracy, the Interagency Council would be strictly limited to a four-year lifetime, with any residual responsibilities assigned to one or more state agencies at the end of this time. (The Council would rely on Federal or other outside funding.)</p> <p>The Council could start with the PEV activities and work with the natural gas and automotive industries to include LNG and CNG vehicles and policies.</p> <p>Agencies with current PEV (and natural gas) related purview include:</p> <ul style="list-style-type: none"> <li>• Public Utility Commission of Texas</li> <li>• ERCOT</li> <li>• Texas Commission on Environmental</li> </ul>

		<p>and the electric power industry. The various programs recommended below, specifically the Texas PEV Friendly Community program and the statewide consumer information website would be run by Council staff.</p>	<p>Quality</p> <ul style="list-style-type: none"> <li>• State Energy Conservation Office</li> <li>• Texas Department of Transportation</li> <li>• Texas Railroad Commission</li> <li>• Department of Motor Vehicles</li> <li>• University research groups at state supported colleges</li> </ul> <p>The Clean Cities Coalition includes several dedicated professionals who have been working in this subject area for many years in Texas. They could be contracted as a temporary staff to provide immediate and cost effective expertise, especially if federal funding could be obtained for their services.</p>
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**B. Category: Electric Power Industry (EPI)**

No.	Problem, Barrier or Opportunity to Promote PEVs	Recommendation	Comments
EPI-1	<p>Distribution utilities need a reliable means of understanding where PEV charging may be taking place in order to anticipate where their transformers and circuits may be stressed. This would permit them to upgrade the equipment before damage and an outage occurs.</p>	<p><b>DMV notification of PEV Registration to distribution utilities.</b></p> <p>The unique vehicle identification number or VIN assigned to each vehicle reveals the model of the vehicle being registered. If the DMV were to routinely provide notification including the addresses of the owners of models known to be PEVs to the utilities, preemptive action could be taken to avoid circuit and transformer overloading.</p>	<p>Temporary measures are currently in place with select vehicle manufacturers. A more reliable and permanent solution is preferred to encompass all PEVs in both the primary and secondary market.</p> <p>Preferably, this recommendation could be accomplished through executive action rather than requiring legislation.</p>
EPI-2	<p>Currently, under the Texas Public Utilities Regulatory Act (PURA), within the boundaries of a public power entity service territory, no other entity is allowed to resell or provide electricity for a fee other than the public entity. If a public power entity (i.e. a municipally-</p>	<p><b>No recommendation.</b></p> <p>Although discussed at length, the CCET Board elected to make no recommendation on the need for clarification as to the rights and roles of public power electric utilities with respect to their ability</p>	<p>This issue could be one that the proposed interagency council for transportation fuels could consider in the future.</p>

	owned utility or, in some cases, a co-operatively owned utility) allows another entity to provide such service, the utility may be forced into the competitive market. Some public power entities would like the ability to allow/regulate third party PEV charging, but are concerned that by doing so, they will jeopardize their status.	to regulate PEV charging by third parties.	
EPI-3	In the deregulated portion of the Texas market, only registered retail electric providers (REPs) can sell electricity to customers. Given that PEV charging may be construed to be a sale of electricity, a prospective owner of PEV charging equipment who wanted to recoup his investment by charging customers for the use of the EVSE, would be required to register with the PUC of Texas and pay fees. This burden could be a barrier to public charging.	<b>Exempt public fee-based PEV charging stations from regulation as REPs, so long as the power has been sold once at the retail level to the charging station owner.</b>  Owners of PEV charging stations to be exempted from the requirement to register and be regulated as a REP in the regulated portion of the Texas market.	<u>Would likely require legislation.</u>  Rationale: Currently, owners of recreational vehicle parks are exempt from registering as a REP when they sell electricity to RV owners as part of their fee for use of the parking spot. EP3 would be analogous since the EVSE amortization is large compared to the value of the kWh sold.
EPI-4	Until managed charging to optimize PEV charging to respond to grid resources is available, a time of use (TOU) rate for PEV charging in the late night through early morning hours can help reduce peak demand and take advantage of the less expensive and more abundant wind energy resource from West Texas. At present, some REPs, such as TXU and Reliant offer such rates.	<b>REPs and public power entities are encouraged to voluntarily continue to offer time-of-use rate plans to promote off-peak charging by PEV owners until managed charging programs are developed to optimize PEV charging.</b>	TOU rates would NOT apply uniquely to PEV charging, but would help demand response peak-shifting in general. The PUCT’s <i>Power to Choose</i> website could encourage REPs, for example, by simply designating such plans as “PEV Friendly.”
EPI-5	The large Transmission and Distribution Utilities (TDUs), municipally owned utilities (Muni’s) and several REPs in Texas are well along the path of educating their customers and employees to the benefits, challenges, and technical aspects posed by PEVs. Our survey revealed that this is not the case for the smaller utilities.	<b>Utility management and staff preparation for PEV Readiness</b>  Develop periodic utility “roundtable discussions” for sharing best practices.	This could be part of an overall CCET PEV Initiative in conjunction with the Texas Rural Electric Cooperative, the PUCT, and smaller public power groups.
EPI-6	The best way to familiarize staff and customers (e.g., Co-op members) is first hand familiarity	<b>Encourage Electric Co-op and Muni Internal PEV Promotion through PEV purchase and</b>	The PEV owned and operated by the Co-op or Muni could be made available for drive-and-ride

	with PEVs and EVSE, and actually experience driving a PEV.	<b>charging station installation.</b>  The PEV would be available for employee use and could be demonstrated in annual Co-op membership meetings, for example.	events discussed under Consumer Education below.
EPI-7	Fleet owners and operators are emerging as a break-through segment of PEV purchasers and users as they make use of cost-effective electrification of transportation. Electric utilities could serve as examples to the commercial and governmental fleet managers by converting their fleets to PEVs for those vehicle types that prove to be cost effective and are most appropriate for electrification. This could be justified in part as a transportation measure to achieve attainment of air quality standards in non-attainment areas.	<b>Encourage larger electric utilities to demonstrate use of PEVs including large bucket trucks and vehicle pool employee use vehicles.</b>	This could be assisted through use of Texas Emission Reduction Program (TERP) funding to offset front end costs where emission reduction benefits are demonstrated. This could be part of a CCET PEV Initiative.
EPI-8	A fleet with the capability of managing its charging rate affecting 100kW of capacity is theoretically able to participate in the ERCOT ancillary service market. The aggregation of PEV EVSE and managed charging could eventually become an important part of demand side management and grid performance.	<b>ERCOT should further explore the market potential for the managed charging of PEVs.</b>  With the cooperation of a Qualified Scheduling Entity and ERCOT staff, one or more fleets would demonstrate through a pilot program how PEV charging could participate in the ancillary service market.	Note: This is one of three parts of a program proposed by CCET to DOE <sup>x</sup> . Whether or not this application is awarded, this could also be part of a CCET PEV Initiative.
EPI-9	In addition to participating in the ancillary service market (see EPI-7 above), PEV charging can be folded into an existing demand response program including direct load control—in exchange for benefits such as the installation of a Level 2 charger, bonus payments, rate relief, etc.	<b>Once it has been determined that the benefits exceed the costs, public power and REPs are encouraged to voluntarily create innovative cooperative and synergistic demand response programs for their PEV customers to mitigate against peak loads.</b>  Two options are discussed at right.	Two options: An ancillary market participant can offer the customer rebates for installation of Level-2 residential charging equipment, with the agreement that they can interrupt charging if necessary. Another version of this agreement includes the caveat that the ancillary market participant can interrupt charging provided that the vehicle will be fully charged by a certain time set by the customer.

**C. Category: Consumer Education (CE)**

No.	Barrier or Opportunity to Promote PEVs	Recommendation	Comments
CE-1	PEVs are viewed by much of the public as strictly utilitarian modes of clean transportation. An emerging consensus among those promoting PEVs is that the best overall consumer education technique is for prospective consumers to actually experience PEVs through driving the vehicle. The driving experience dispels the notion of PEVs as a weak sister to the internal combustion engine.	<b>Encourage ride-and-drive programs with cooperation from auto dealers, local utility and local PEV enthusiasts.</b>	This technique is part of the local best practices section below with its portfolio of 11 optional initiatives. See LBB1 through 11 below.  This could also be part of a CCET PEV Initiative.
CE-2	Conflicting information about PEV safety, economy, and performance is an inherent barrier to increasing the market share of PEVs. Environmental groups and auto manufacturers tout PEVs for their own ends. Likewise, political push back against PEVs plays upon safety incidents and government subsidies. The consumer, interested primarily in the total cost of transportation, often does not know who to trust.	<b>Encourage the creation of a statewide website that is commercially neutral, strictly objective, and focuses on Texas related PEV issues. This program would one of the functions of the Council recommended above and therefore, its funding would be contingent upon the receipt of outside (e.g., Federal) funds.</b>	This is one of the seven elements in the Texas Triangle PEV Readiness Plan. It is treated in detail in Chapter 6 of the Plan.

**D. Category: Intercity Charging to Address Battery Electric Vehicle (BEV) Range Anxiety (ICC)**

No.	Barrier or Opportunity to Promote PEVs	Recommendation	Comments
ICC-1	The corridors connecting the metropolitan areas of the state’s largest cities will eventually be served by PEV charging through “organic growth of charging infrastructure” in communities and businesses along the corridor without government funding. However, it is expected that for the next five years such growth will be inadequate to ensure that drivers of battery electric vehicles (BEVs) will	<b>Approach Intercity Charging as an Economic Development Opportunity</b> Organic growth of PEV charging can be accelerated without government funding through public charging (Level 2) to serve PEVs in the local community. Where these stations are located near amenities (restaurants, historic downtowns, museums, parks, etc.) out of town BEV drivers will likely spend money shopping and	This approach is part of the Texas PEV-Friendly Community program.

	<p>be able to comfortably make intercity trips, which is important for encouraging BEV adoption. This is especially true along I-10 connecting Houston and San Antonio and to a lesser extent between Houston and Dallas on I-45. The first link to avoid range anxiety under a Business as Usual Scenario (no additional government funding for charging stations) will be I-35 between Austin/San Antonio and Dallas/Ft. Worth.</p>	<p>eating thus creating an economic development incentive for local communities to create convenient, well-marked, and well- advertised charging along the corridor.</p>	
ICC-2	Ditto	<p><b>Inform the Public of Alternatives to Accommodate Intercity Travel and PEV Use Over the Short Term</b></p> <p>PEV market penetration in Texas is not critically dependent upon establishing a charging infrastructure along the Texas Triangle corridors. Two interim solutions are (1) encouraging purchase of PHEVs<sup>xi</sup> to avoid entirely the issue of range anxiety, or (2) encouraging two-car families to purchase a BEV or NEV<sup>xii</sup>, where price and driving patterns are appropriate, in addition to their internal combustion engine “trip car.”</p>	<p>Realization of the opportunities available to take advantage of PEVs is dependent upon a good consumer information program.</p>
ICC-3	Ditto	<p><b>TxDOT Use of Strategically Located Rest Areas to Provide PEV Charging</b></p> <p>The Texas Department of Transportation (TxDOT) operates several strategically located rest areas along I-10 and I-45. If TxDOT were permitted by legislation to bid out a portion of these locations to EVSE vendors for both Level 2 and DC Fast Charge, the gaps along these corridors could be closed.</p>	<p>The bid could be designed such that TxDOT eventually generates positive revenue. The chargers could be accompanied by a kiosk that informs the public of PEVs in general and charging locations along the corridor specifically.</p>
ICC-4	Ditto	<p><b>Use of federal funds, if made available for the State, for Level 2 Network along interstate corridors to minimize delays and avoid range anxiety for BEV owners</b></p> <p>As noted previously, analysis done for this Plan indicates that for a subsidy of \$1 million per year for the</p>	<p>DC Fast Charging is considerably more expensive to build and operate than Level 2, but it most nearly recreates the experience of refilling the tank at a service station entailing a 30 minute “delay.” DCFC in adequate numbers is a response to long distance travel in</p>

		<p>period 2013-2017 a minimal but adequate series of Level 2 and DC Fast Charging stations could be established along the connecting corridors in the Texas Triangle (including Hwy 71 from Austin to Columbus). This is an option to consider if federal funding becomes available.</p>	<p>BEVs. The build out assumes private sector participation through organic growth in addition to the subsidized stations. However, it should be noted that results indicate little organic growth can be expected during the initial years, since it would be difficult to compete with subsidized infrastructure. Nevertheless, within the next five years it would still be expected that organic growth would start to occur in high-demand locations, such as in the cities along I-35.</p>
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**E. Category: Local Best Practices to Remove Readiness Barriers and Promote PEVs (LBP)**

<b>No.</b>	<b>Barrier or Opportunity to Promote PEVs</b>	<b>Recommendation Options</b>	<b>Comments</b>
LBP-0	<p>The impetus for the Texas Triangle PEV Readiness Plan was to extend the planning and readiness activities occurring in the metropolitan regions at the corners of the Texas Triangle to the many communities along and inside the corridor. Because of the variety of towns ranging from bedroom communities to farm and ranch centers, a flexible means of adopting the various readiness measures to a community profile is important.</p>	<p><b>Establish the Texas PEV-Friendly Community program with publically recognized communities that achieve this designation, contingent upon outside funding (e.g., Federal) to support the staff required to administer it. This program would be administered by the Council recommended in G-2 above.</b></p>	<p>The program is voluntary with participating communities electing various options which would collectively achieve a point total that would make them eligible for the designation <i>PEV Friendly</i>. The program would be open to all communities throughout the state and would be promoted and administered by the interagency council staff recommended above.</p>
LBP-1	<p>The overwhelming consensus of those who have attempted to work at the community level to remove barriers to PEV readiness is that no single authority can accomplish the task. Instead, a group of PEV enthusiasts working as a core team is essential to success.</p>	<p><b>Using “Ride and Drive” events as a kickoff, a PEV core team ideally including at least the mayor, city council member, city manager, or a city department manager serving as chair would be organized to coordinate the remaining ten initiatives.</b></p>	<p>Other members of this core team should include a member of the local electric utility, an electrical contractor, automobile dealer, and an environmental community representative.</p>

LBP-2	Need for fleets to consider PEV economic benefits and move to purchase PEVs when the total cost of ownership favors PEVs.	<b>The municipality would purchase at least one PEV and have a program in place to determine when PEV replacements are cost effective</b>	This action will serve as an example and as an ideal learning process for the municipality and other fleet operators.
LBP-3	In addition to a statewide website with a Texas focus there needs to be at least one local PEV expert	<b>Designate a knowledgeable, local PEV expert who is available to provide advice in an unbiased manner.</b>	The expert should have a very good grasp on where to go for answers and knowledge of the statewide websites and its links.
LBP-4	Local building and electrical codes may not be up to date with respect to changes made at the national level to accommodate safe PEV charging. Moreover, permitting for individuals who want to add a Level 2 charger in their home or business may be overly time consuming and expensive thus creating a barrier to PEV charging.	<b>Institute local code revisions by ordinance and streamline permitting activities for installation of electric vehicle supply equipment (EVSE). Provide overall training for local code enforcement and permitting authorities on PEVs.</b>	The training for local code enforcement personnel and electrical contractors will remove uncertainties and address concerns that would otherwise result in delays and high costs.
LBP-5	Local public power utility representatives or Retail Electric Providers in the deregulated market can provide rate plans that encourage night time rather than peak time PEV charging.	<b>Engage local public power utilities or REPs to ensure that rates that encourage nocturnal and off peak charging are considered as an offering to the public.</b>	
LBP-6	The largest single barrier to PEV market penetration is the front end cost. For many people in small towns and especially planned communities, street legal neighborhood electric vehicles can accomplish the clean air and petroleum reduction goals of PEVs at one third the front end cost of full service PEVs.	<b>Publicize the geographic extent of the community that can be accessed through neighborhood electric vehicles and avoid unnecessarily excluding NEVs as a transportation option for short distance and slow speed urban and suburban travel.</b>	NEVs can also serve as an entry level vehicle for those who cannot yet afford a full service PEV.
LBP-7	Publically available PEV charging, either free or fee based, will soon be an important service for community residents who drive a PEV. In addition, a publically available local PEV charging can reduce range anxiety for drivers of battery electric vehicles passing through the community.	<b>Establish at least one PEV charging station in a prominent and easily accessed location and encourage private commercial parking lot owners and retailers to consider PEV charging locations.</b>	The charging station can play an important symbolic role. It will be important that a variety of guidelines discussed in Chapter 3 be followed for this to be a success.
LBP-8	Home charging is proving to be the overwhelmingly predominant place that PEVs are charged. However, considerable obstacles arise where the PEV owner is a resident of an	<b>Engage local apartment owners and property managers to plan for and adopt one of several solutions to the problems of PEV charging at</b>	There are drawbacks to the various solutions to the multifamily housing PEV charging problem, but working constructively with the core team,

	apartment complex or other multifamily arrangements. There are a variety of business models that have been developed to deal with these issues.	<b>multifamily housing properties.</b>	solutions can be developed that meet community specific circumstances.
LBP-9	The second most desired location for PEV charging is the work place. Many high profile PR-conscious “green” employers have developed elaborate and expensive employee PEV charging. These are not likely to find traction with most Texas based small businesses.	<b>Encourage work place charging through a low cost, a low tech, and simple approach to “get the ball rolling” in this sector by allowing employee access to 120V outlets. This could involve fee-based Level 1 charging.</b>	A simple approach as a first step is provided in Chapter 3 of the Plan. More sophisticated ( and currently more costly approaches are also available,
LBP-10	PEVs pose some high voltage electrical risks for those responding to accident scenes.	<b>First responder training for police, fire, and emergency medical personnel is important. Programs are already available to provide this training.</b>	Any consideration of risk should take into account that internal combustion engines with their gasoline fuel also pose serious risks that are absent in BEVs.
LBP-11	The Federal Highway Administration has recently developed signage specifically for PEVs. It is important for those PEV travelers passing through the towns to have uniform signage directing them to PEV charging stations.	<b>Establish uniform signage in the community for PEV charging stations open to the public.</b>	

**F. Category: Direct Incentives to Purchasers to Increase PEV Market Penetration (DIP)**

No.	Barrier or Opportunity to Promote PEVs	Recommendation	Comments
DIP-1	Even with the federal \$7500 tax rebate, the upfront cost of a PEV is still a barrier for those who consider total cost of ownership. An additional state level direct incentive would improve the payback period and thus the incentive to buy a PEV.	<b>Use of up to \$2.5 million in TERP funds to provide direct subsidies of \$2500 to the first 1000 purchasers of PEVs in air quality non-attainment areas after the effective date of the legislation. The program could also be limited to two years.</b>	Ten other states have some form of state rebate or refund. This recommendation has the added advantage of helping to attain ozone air quality standard. Would probably require state legislation.
DIP-2	A direct incentive to accelerate purchases of PEVs in other states, notably CA, has been to allow PEVs access to high occupancy lanes on freeways.	<b>Allow PEVs access to high occupancy vehicle (HOV) lanes on expressways</b>	This would probably require state legislation.

**G. Category: Beyond Readiness**

No.	Barrier or Opportunity to Promote PEVs	Recommendation	Comments
BR-1	<p>For the electric grid, the specific time a PEV is charged could have an impact on peak demand. In order for PEVs to be broadly adopted in the market, the issue of when vehicles are charged will need to be addressed. At this point, the technology for broad control of when a PEV is charged does not exist.</p>	<p><b>PEV Charge Control</b></p> <p><b>Develop a technical program containing the following elements:</b></p> <ul style="list-style-type: none"> <li>• <b>Explore/characterize technical solutions for time of day charging control</b></li> <li>• <b>Voluntary/mandatory/rate incentive strategies</b></li> <li>• <b>Grid impact for each strategy</b></li> <li>• <b>Consider strategies unique for the Texas Triangle area</b></li> <li>• <b>Implementation of one or more strategies on vehicle(s) and capture the result</b></li> </ul>	<p>This could be part of an overall CCET PEV Initiative, in the form of a technology development program. It could be in conjunction with ERCOT, the DOE, or other state and federal funding agencies. An initial feasibility study to ascertain cost effectiveness should be completed first.</p>
BR-2	<p>The idea of PEVs participating in the energy services market, specifically in the area of providing one or more ancillary services has been discussed broadly. In some cases, staged demonstrations have been conducted showing that the controlled charging of PEVs can be tied to providing ancillary services. Technology development is needed to bridge the gap between a staged demonstration and robust technical solution for reliability participating in the energy market.</p>	<p><b>Individual Vehicle Ancillary Services</b></p> <p><b>This technical program would include the development and demonstration of an individual PEV providing ancillary service. The program would include the following components:</b></p> <ul style="list-style-type: none"> <li>• <b>Communications development</b></li> <li>• <b>Control strategies response to ISO signals (ERCOT and other ISOs)</b></li> <li>• <b>On/off or charge rate control</b></li> <li>• <b>Grid impact</b></li> <li>• <b>Cost considerations/revenue recovery</b></li> <li>• <b>Response rates/timing</b></li> <li>• <b>Actual energy/regulation availability</b></li> <li>• <b>Consider impact of V2G on vehicle</b></li> </ul>	<p>This could be part of an overall CCET PEV Initiative, in the form of a technology development program. It could be in conjunction with ERCOT, the DOE, or other state and federal funding agencies.</p>
BR-3	<p>Many players in the PEV industry, including automotive OEMs, EVSE suppliers, and utilities</p>	<p><b>Vehicle Communications Protocols/standards</b></p> <p><b>This technical program would include the</b></p>	<p>This program could be conducted in conjunction with existing efforts in</p>

	<p>are working in the development of SAE standards surrounding managed charging. While this is a start, before wide spread adoption, there needs to be a migration path defined from the existing OEM unique strategies to a single solution.</p>	<p><b>investigation and characterization of the developing communications technologies and protocols and, where standards are not being developed yet, actively participate in the development of those standards. The program would include the following components:</b></p> <ul style="list-style-type: none"> <li>• Investigate and characterize the current OEM and other vehicle communication strategies (cell phone, Onstar, internet, other)</li> <li>• Investigate and characterize the developing utility to EVSE strategies</li> <li>• Investigate and characterize the developing SAE EVSE to Vehicle communication standards (actively participate in the standards development)</li> <li>• Evaluate the cyber security aspects with the utility to EVSE as well as the EVSE to Vehicle communications</li> <li>• Develop a communications laboratory where the different communication strategies and protocols can be developed and tested.</li> <li>• Demonstrate working laboratory level communications on a vehicle platform</li> </ul>	<p>national laboratories or as a standalone effort in an independent R&amp;D facility. The results will be critical to establishing the basis for more advanced PEV control strategies required for a much larger adoption of PEVs.</p>
BR-4	<p>Similar to the previously discuss EPI-7 and EPI-8; this effort would develop the technology for a PEV fleet to be aggregated. The program would utilize results developed in BR-3 or similar program as basis for expansion beyond a single vehicle to a fleet.</p> <p>The technology for PEV fleet aggregation including communications and control strategies does not currently exist.</p>	<p><b>Fleet Ancillary Services</b></p> <p><b>This program would include the technology development and demonstration of a fleet of vehicles providing ancillary services. The program would include the following components:</b></p> <ul style="list-style-type: none"> <li>• Fleet of PEVs from a single location or company</li> <li>• Commutations management (single controller/individual EVSE aggregation)</li> <li>• Charge management/on-off control</li> <li>• Determination of limits of aggregation (vehicle</li> </ul>	<p>This could be part of an overall CCET PEV Initiative, in the form of a technology development program. It could be in conjunction with ERCOT, the DOE, or other state and federal funding agencies.</p>

		<p><b>availability/connection/battery energy level based on use)</b></p> <ul style="list-style-type: none"><li>• <b>Determination of the limits of what ancillary services a fleet can provide.</b></li><li>• <b>V2G impact and viability</b></li></ul>	
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## ENDNOTES

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<sup>i</sup> [http://en.wikipedia.org/wiki/Government\\_incentives\\_for\\_plug-in\\_electric\\_vehicles](http://en.wikipedia.org/wiki/Government_incentives_for_plug-in_electric_vehicles)

<sup>ii</sup> Davis-Schurhoff (Electric Power Research Institute, EPRI) presentation at Plug In 2012 in San Antonio, July 2012.

<sup>iii</sup> GM calls the Volt a “range extended electric vehicle” or EREV. In this Plan we will refer to those electric vehicles capable of using electricity plus another fuel a PHEV to avoid confusion. It is important to understand that a PHEV avoids the problem of range anxiety by switching to gasoline when the more efficient battery is approaching depletion and therefore requires a charge.

<sup>iv</sup> Edison Electric Institute (EEI)’s Load Forecasting Growth, Nov. 14, 2011 citing JDPower claims that as long as gasoline prices remain below \$4 per gallon PEV demand will not be significant. Presentation ( )claims that Nissan Leaf payback period is now 6 to 10 years or 150,000 miles—twice the length of the battery guarantee.

<sup>v</sup> Ibid.

<sup>vi</sup> Davis-Schurhoff, presentation at Plug In 2012, San Antonio, July 2012.

<sup>vii</sup> John Broder, The Electric Car Unplugged, March 2102.

<sup>viii</sup> Austin Energy was another of the 16 national winners of the grant funds from DOE. The AE planning effort has as its focus PEV readiness in Austin and San Antonio and the communities in between on I-35 all of which are municipally owned utilities.

<sup>ix</sup> DC Fast Charging is considerably more expensive to build and operate than Level 2, but it most nearly recreates the experience of refilling the tank at a service station entailing a 15 minute “delay.” DCFC in adequate numbers is the ultimate response to the challenge of facilitating long distance travel in BEVs. The \$1 million per year build out accounts for private sector participation through organic growth in addition to a series of strategically placed subsidized stations.

<sup>x</sup> In response to DOE Financial Opportunity Announcement (FOA) 708, CCET submitted a proposal on June 14, 2012. CCET would manage the two year program, with the majority of the work being performed by Texas based Clean City Coalition staff. In addition to this fleet ancillary service pilot, the program, if funded, would help implement two other components of the Texas Triangle PEV Readiness Plan: the Texas PEV Friendly Community program and a statewide website for consumer information.

<sup>xi</sup> For this Plan, the term PHEV includes extended range electric vehicles (EREVs) such as the Chevy Volt.

<sup>xiii</sup> NEVs (neighborhood electric vehicles) are street legal, frequently one third the price of BEVs, and achieve the same clean air and fuel savings benefits of BEVs, where owners are willing to live with the range, speed, and comfort limitations of these vehicles.