Electric Vehicle Technology, Sales. Taxation and State Laws: Synthesis

Requested by
Jeff Doyle
Director, Public Private Partnerships Office
WSDOT

Prepared by
Jeff Pilcher, WSU Synthesis Editor
Kathy Lindquist, WSDOT Research Office
Michel Wendt, WSDOT Library
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Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WSDOT staff. Online and print sources may include newspaper and periodical articles, NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs and related academic and industry research. Internet hyperlinks in the TSRs are active at the time of publication, but host server changes can make them obsolete.

Request for Synthesis:

Jeff Doyle, Director, WSDOT Public/Private Partnerships, requested information about the sales and use of electric vehicles in the Pacific NW, principally Oregon and Washington. As part of the West Coast Green Highways initiative, WSDOT is considering potential partnerships for Electric Vehicle (EV) charging infrastructure. A business plan and funding request to the Department of Commerce is underway to complete the partnership financing to install EV charging at WSDOT rest areas along I-5.

Databases Searched:

- TRIS Online
- Research in Progress
- Previous Synthesis Reports
- Google
- Wisconsin DOT Transportation Synthesis Reports
- FTA website
- FHWA website

Synthesis Summary:

Categories of publications and resources are as follows:

- National Hybrid and EV Sales Figures
- State and Federal Electric Drive Laws
- EV research and data

Sources:

Costs and Emissions Associated with Plug-In Hybrid Electric Vehicle Charging in the Xcel Energy Colorado Service Territory

Authors: K. Parks, P. Denholm, and T. Markel, 2007

Introduction

The combination of high oil costs, concerns about oil security and availability, and air quality issues related to vehicle emissions are driving interest in “plug-in” hybrid electric vehicles (PHEVs). PHEVs are similar to conventional hybrid electric vehicles, but feature a larger battery and plug-in charger that allows electricity from the grid to replace a portion of the petroleum-

fueled drive energy. PHEVs may derive a substantial fraction of their miles from grid-derived electricity, but without the range restrictions of pure battery electric vehicles.

As of early 2007, production of PHEVs is essentially limited to demonstration vehicles and prototypes. However, the technology has received considerable attention from the media, national security interests, environmental organizations, and the electric power industry. In 2006, the Bush administration announced the U.S. Advanced Energy Initiative, which includes the goal of developing a PHEV capable of traveling up to 40 miles on a single electric charge. For many U.S. drivers, a PHEV-40 could reduce average gasoline consumption by 50% or more.

The economic incentive for drivers to use electricity as fuel is the comparatively low cost of fuel. Given the potential cost advantages, a study by the Electric Power Research Institute (EPRI) found a significant potential market for PHEVs, depending on vehicle cost and the future cost of petroleum. Furthermore, several researchers have noted that by adding “vehicle-to-grid” (V2G) capability, where the vehicle can discharge as well as charge, PHEV owners may also receive substantial revenue by using the stored energy in their vehicles to provide high-value electric system services such as regulation, spinning reserve, and peaking capacity.

The use of PHEVs would represent a significant potential shift in the use of electricity and the operation of electric power systems. Electrification of the transportation sector could increase generation capacity and transmission and distribution (T&D) requirements, especially if vehicles are charged during periods of high demand. Other concerns include emissions impacts including regulated emissions and currently unregulated greenhouse gas emissions. Utilities are interested in the net costs associated with this potential new load, including possible benefits of improved system utilization enabled by controlled PHEV charging.

This study is designed to evaluate several of the PHEV-charging impacts on utility system operations within the Xcel Energy Colorado service territory. The authors performed a series of simulations in which the expected electricity demand of a fleet of PHEVs was added to projected utility loads under a variety of charging scenarios. The simulations provide some basic insight into the potential grid impacts of PHEVs, focusing on the following issues:

- How do various PHEV-charging scenarios affect the total system load?
- What are the emissions associated with PHEV charging, and what are the combined emissions from both generator and vehicle? How do these emissions compare to a conventional vehicle?
- What are the marginal costs associated with PHEV charging?
- What are the quantifiable system benefits associated with controlled PHEV charging?

http://www.nrel.gov/docs/fy07osti/41410.pdf

Impacts Assessment of Plug-In Hybrid Vehicles on Electric Utilities and Regional U. S. Power Grids, Part 1: Technical Analysis

Authors: Michael Kintner-Meyer, Kevin Schneider, Robert Pratt, Pacific Northwest National Laboratory (a), November, 2007

Abstract

The U.S. electric power infrastructure is a strategic national asset that is underutilized most of the time. With the proper changes in the operational paradigm, it could generate and deliver the necessary energy to fuel the majority of the U.S. light-duty vehicle (LDV) fleet. In doing so, it would reduce greenhouse gas emissions, improve the economics of the electricity industry, and reduce the U.S. dependency on foreign oil. Two companion papers investigate the technical potential and economic impacts of using the existing idle capacity of the electric infrastructure in conjunction with the emerging plug-in hybrid electric vehicle (PHEV) technology to meet the majority of the daily energy needs of the U.S. LDV fleet.

This initial paper estimates the regional percentages of the energy requirements for the U.S. LDV stock that could potentially be supported by the existing infrastructure, based on the 12 modified North American Electric Reliability Council regions, as of 2002. For the United States as a whole,

up to 84% of U.S. cars, pickup trucks, and sport utility vehicles (SUVs) could be supported by the existing infrastructure, although the local percentages vary by region. Using the LDV fleet classification, which includes cars, pickup trucks, SUVs, and vans, the technical potential is 73%. This has an estimated gasoline displacement potential of 6.5 million barrels of oil equivalent per day, or approximately 52% of the nation's oil imports. The paper also discusses the impact on overall emissions of criteria gases and greenhouse gases as a result of shifting emissions from millions of individual vehicles to a few hundred power plants. Overall, PHEVs could reduce greenhouse gas emissions with regional variations dependent on the local generation mix. Total NOX emissions may or may not increase, dependent on the use of coal generation in the region. Any additional SO2 emissions associated with the expected increase in generation from coal power plants would need to be cleaned up to meet the existing SO2 emissions constraints. Particulate emissions would increase in 8 of the 12 regions. The emissions in urban areas are found to improve across all pollutants and regions as the emission sources shift from millions of tailpipes to a smaller number of large power plants in less-populated areas. This paper concludes with a discussion about possible grid impacts as a result of the PHEV load as well as the likely impacts on the plant and technology mix of future generation-capacity expansions.

The second paper (Part II: Economic Assessment) discusses the economics of the new PHEV load from the perspective of a load-serving entity. It discusses the potential downward pressure on rates as revenues increase in the absence of new investments for generation, transmission, and distribution.
(a) Operated for the U.S. Department of Energy by Battelle under Contract DE-AC05-76RL01830.
PDF of document available through WSDOT Library at http://www.wsdot.wa.gov/Library/

Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market
Authors: David L. Greene, Oak Ridge National Laboratory; K. G. Duleep, Energy & Environmental Analysis, Inc.; Walter McManus, J. D. Power and Associates.
Managed by UT-Battelle, LLC for the U.S. Department of Energy under contract No. DE-AC0500OR22725, August 2004.

Abstract
Diesel and hybrid technologies each have the potential to increase light-duty vehicle fuel economy by a third or more without loss of performance, yet these technologies have typically been excluded from technical assessments of fuel economy potential on the grounds that hybrids are too expensive and diesels cannot meet Tier 2 emissions standards. Recently, hybrid costs have come down and the few hybrid makes available are selling well. Diesels have made great strides in reducing particulate and nitrogen oxide emissions, and are likely though not certain to meet future standards. In light of these developments, this study takes a detailed look at the market potential of these two powertrain technologies and their possible impacts on light-duty vehicle fuel economy.

A nested multinomial logit model of vehicle choice was calibrated to 2002 model year sales of 930 makes, model, and engine-transmission configurations. Based on an assessment of the status and outlook for the two technologies, market shares were predicted for 2008, 2012 and beyond, assuming no additional increase in fuel economy standards or other new policy initiatives. Current tax incentives for hybrids are assumed to be phased out by 2008.
Given announced and likely introductions by 2008, hybrids could capture 4-7% and diesels 2-4% of the light-duty market. Based on the author's best guesses for further introductions, these shares could increase to 10-15% for hybrids and 4-7% for diesels by 2012. The resulting impacts on fleet average fuel economy would be about +2% in 2008 and +4% in 2012. If diesels and hybrids were widely available across vehicle classes, makes, and models, they could capture 40% or more of the light-duty vehicle market.
http://www-cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2004_181_HybridDiesel.pdf

Electric Powertrains: Opportunities and Challenges in the U.S. Light-Duty Vehicle Fleet
Authors: Matthew A. Kromer and John B. Heywood, Sloan Automotive Laboratory for Energy and the Environment, Massachusetts Institute of Technology, Cambridge, MA
Publication No., LFEE 2007-03 RP, Funded by Ford Motor Company through the Alliance for Global Sustainability (AGS), CONCAWE, ENI, Shell, and Environmental Defense, May 2007

Abstract
Managing impending environmental and energy challenges in the transport sector requires a dramatic reduction in both the petroleum consumption and greenhouse gas (GHG) emissions of in-use vehicles. This study quantifies the potential of electric and hybrid-electric powertrains, such as gasoline hybrid-electric vehicles (HEVs), plug-in hybrid vehicles (PHEVs), fuel-cell vehicles (FCVs), and battery-electric vehicles (BEVs), to offer such reductions.

The evolution of key enabling technologies was evaluated over a 30 year time horizon. These results were integrated with software simulations to model vehicle performance and tank-to-wheel energy consumption; the technology evaluation was also used to estimate costs. Well-to-wheel energy and GHG emissions of future vehicle technologies were estimated by integrating the vehicle technology evaluation with assessments of different fuel pathways.

While electric powertrains can reduce or eliminate the transport sector's reliance on petroleum, their GHG and energy reduction potential are constrained by continued reliance on fossil-fuels for producing electricity and hydrogen. In addition, constraints on growth of new vehicle technologies and slow rates of fleet turnover imply that these technologies take decades to effect meaningful change. As such, they do not offer a silver bullet: new technologies must be deployed in combination with other aggressive measures such as improved conventional technology, development of low-carbon fuels and fuel production pathways, and demand-side reductions.

The results do not suggest a clear winner amongst the technologies evaluated, although the hybrid vehicle is most likely to offer a dominant path through the first half of the century, based on its position as an established technology, a projection that shows continued improvement and narrowing cost relative to conventional technologies, and similar GHG reduction benefits to other technologies as long as they rely on traditional fuel pathways. The plug-in hybrid, while more costly than hybrid vehicles, offers greater opportunity to reduce GHG emissions and petroleum use, and faces lower technical risk and fewer infrastructure hurdles than fuel-cell or battery-electric vehicles. Fuel-cell vehicle technology has shown significant improvement in the last several years, but questions remain as to its technical feasibility and the relative benefit of hydrogen as a transportation fuel.
http://greisnet.com:8080/gnc/images/b/b9/MIT_ElectricDrivetrains.pdf

Escaping Lock-in: the Case of the Electric Vehicle (Technology Forecasting and Social Change)
Authors: Robin Cowan, University of Western Ontario; and Staffan Hultén, Stockholm School of Economics. (The research for this paper was supported by the Swedish Council for Planning and Coordination of Research), 1996

The Lock-in of Technologies
Many established technologies are challenged as not meeting the demands of modern society. The problem can be that they do not represent the best known technology and what makes these challenges interesting and difficult is that many of these technologies appear to be very well-entrenched in the technological system.

This paper discusses the possibility of escaping lock-in after a technology has achieved dominance in the market and has been able to enhance its comparative advantages over many decades. The case discussed is that of the secular competition between the electric vehicle and the gasoline car. The competition can be separated into 5 phases: 1) the formative years of the

automobile industry, 1885- 1905, when no technology dominated, 2) the establishment of the gasoline car as dominant 1905-1920, 3) the consolidation of the position of the gasoline car 1920-1973, 4) the questioning of the gasoline car 1973-1998, and perhaps 5) the legislated, forced introduction of large scale production of electric vehicles after 1998.

The first four phases represent the history of a technological lock-in, with the gasoline car becoming more and more firmly entrenched. The fifth phase, if it occurs, will be an example of an escape (or partial escape) from technological lockin. Concerns about noise and pollution, especially in inner cities, have raised questions about whether such an escape is possible.
http://www.cgl.uwaterloo.ca/~racowan/escape.pdf

The Alternative Fuels and Advanced Vehicles Data Center (AFDC)
Website – August 2009

Formerly known as the Alternative Fuels Data Center, the Alternative Fuels and Advanced Vehicles Data Center (AFDC) is a comprehensive clearinghouse of data, publications, tools, and information related to advanced transportation technologies.

Sponsored by the U.S. Department of Energy's Clean Cities initiative and technically administered by the National Renewable Energy Laboratory, the AFDC hosts more than 3,000 documents, interactive tools that help fleets and consumers make transportation decisions and a wealth of information to educate the public on alternative fuels and advanced vehicles.

The AFDC was originally developed in 1991 in response to the Alternative Motor Fuels Act of 1988 and the Clean Air Act Amendments of 1990. Since then, the AFDC has expanded its focus from alternative fuels to include all advanced transportation fuels, vehicles, and technologies.

The educational tools and information featured in the AFDC are geared toward helping consumers and fleets reduce petroleum consumption. Clean Cities stakeholders and fleets covered under the Energy Policy Act of 1992 share this goal and regularly use the information offered in AFDC.

To learn about how the AFDC is used in the marketplace, go to the Deploying Technologies section. If you have questions about the technologies covered in this Web site, go to the AFDC's contacts page.
http://www.afdc.energy.gov/afdc/about.html

Alternative Fuels and Advanced Vehicles Data Center: Electricity Incentives and Laws 2009 U.S.
Department of Energy link gives a comprehensive list of state and federal electric drive laws, 2009
http://www.afdc.energy.gov/afdc/fuels/electricity_laws.html

Hybrid Sales Figures/Tax Credits for Hybrids
Hybrid Vehicle Sales Information, 2009
http://electricdrive.org/index.php?ht=d/Articles/cat_id/5514/pid/2549

Electric Vehicles: 10 Predictions for 2010
Published 4Q 2009 Pike Research
Published in partnership with: Hybridcars.com by John Gartner, Senior Analyst, Clint Wheelock, Managing Director, The Transportation Revolution Starts in 2010

Introduction
During the next decade, millions of vehicles that primarily run on electric power and are plugged in to be recharged will enter roadways as the automotive industry slowly begins to wean itself

from fossil fuels. While the transition will be slower than many individuals with concerns about climate change would like, the impact on auto manufacturers, battery makers, utilities, and smart grid companies will be profound.

Despite rapid growth in the sales of plug-in hybrid electric vehicles (PHEVs) and pure battery electric vehicles (EVs), the hybrid electric vehicle (HEV) market will continue to be the largest market for the foreseeable future. This combined market for electrified vehicles will represent just a small (2.5%) portion of the total vehicle market. Yet, it will require billions of dollars in investment in charging equipment and upgrades to the power grid to manage the additional load.

In 2015, Pike Research forecasts that charging stations where drivers can plug in and recharge their vehicles will be available at more than 5.3 million locations around the globe. Lithium ion (Li-ion) battery manufacturers are gearing up for the EV age by building new manufacturing plants and expanding capacity to provide the necessary millions of cells and packs. Pike Research anticipates that this expansion will create an $8 billion industry for batteries by 2015. The EV revolution will have obvious impacts on the automotive industry and consumers. Deeper analysis reveals some trends that will influence the way vehicles are built and used. As such, Pike Research has identified 10 key trends to watch out for as the EV market takes shape.
https://www.pikeresearch.com/wp-content/uploads/2009/12/EVP-09-Pike-Research.pdf

State Statutes on Neighborhood Electric Vehicles
Prepared for Wisconsin DOT, Division of Transportation System Development Bureau of Highway Operations
Prepared by CTC & Associates LLC
WisDOT Research & Communication Services Section, November 9, 2006

Request for Report

Designed for drivers traveling short distances, Neighborhood Electric Vehicles are compact, low-speed vehicles powered by rechargeable batteries and electric motors. Some NEVs are similar in size to golf carts, but often include additional features such as windshields, headlights and taillights, turn signals, rearview mirrors, and seatbelts. NEVs have maximum speeds of around 25 mph, and typically carry one to four passengers.

Enacted earlier this year, 2005 Wisconsin Act 329 authorizes local units of government to allow NEVs to operate on roads under their jurisdiction, and several Wisconsin municipalities have enacted these ordinances. However, the state's registration law prohibits motor vehicles (including NEVs) from being operated on public roads unless they are registered under Chapter 341 of the state statutes, or are exempt from registration. NEVs are neither registered nor exempted. WisDOT expects this legislative conflict to be resolved in 2007.

Recently, the City of Sun Prairie approached Wisconsin DOT for permission to allow NEVs to operate on the portions of WIS 19 in the city that have a speed limit of 35 mph or less, especially to facilitate crossing the highway. In preparation for new legislation on NEV registration, WisDOT's Bureau of Highway Operations is seeking to develop guidance that can be applied statewide in determining when to allow NEVs to cross or operate on a state highway, and requested a scan of other states' laws in this area to inform this guidance.

Summary

In 1998, the National Highway Traffic Safety Administration officially recognized NEVs as a form of transportation. Since then, 37 states have passed legislation allowing these vehicles to be driven on roads with posted speed limits of 35 miles per hour or lower. The U.S. Department of Energy maintains a Web site on alternative fuel vehicles that includes summaries of laws governing NEV use. The Web site identifies 25 states that have "Access to Roadways" laws specifying where NEVs may operate.

The summaries of these 25 laws were compiled in this TSR from the DOE's "Incentives and Laws: State Summary" page at

http://www.eere.energy.gov/afdc/progs/all_state_summary.cgi?afdc/0 . We group each state into one of three categories:

1. States that specify a maximum speed limit with no mention of crossings (18 states) 2. States that allow NEVs to cross roadways with higher speed limits (six states) 3. States that specifically prohibit crossing roadways with higher speed limits (1 state) The Web summaries for three states (California, Colorado, and New York) include mentions of NEVs that do not fall into any of the above categories; these are detailed after the category lists.

U.S. Department of Energy, http://www.eere.energy.gov/cleancities/atv/tech/nev.htm .

In addition to the three categories mentioned, we have highlighted relevant text from state statutes that address local governments' authority to regulate NEV use, and from statutes that address registration, licensing, safety, insurance, and inspection requirements.

Some state statutes specify the types of streets or highways where NEVs are permitted; for example, South Carolina mentions "secondary highways," Utah mentions "certain highways," and Illinois prohibits operation on a "state highway, toll road or interstate highway." In addition, Rhode Island specifies that NEVs "may only be operated during the hours of 6:00 a.m. through 6:00 p.m."
http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsrelecvehicle.pdf

Electric Cars in the United States: A New Model with Forecasts to 2030
Center for Entrepreneurship & Technology, UC Berkley
Authors: Thomas A. Becker, Ikhlaq Sidhu (PI), Burghardt Tenderich – August, 2009

Introduction
While earlier generations of electric cars were plagued by poor performance, high cost, and short ranges, a new generation of affordable, high-performance electric cars is about to enter the U.S. market.

Previous versions of electric vehicles have failed to achieve any significant market share. The short- comings of these vehicles included expensive and toxic batteries with limited life spans, severely limited driving ranges, poor performance, and high overall costs. The improvements in battery technology over the past two decades, in particular the advances in Lithium-ion (Li-ion) battery technology as well as automotive technological advances ushered in by hybrid vehicles, have made it possible to design and manufacture electric vehicles with better performance than their gasoline-powered counterparts. Though the number of electric vehicles on U.S. roads is currently in the thousands, that number will soon change. Many vehicle manufacturers have indicated their intention to begin mass producing electric vehicles with Lithium-ion batteries within the next five years.

This paper forecasts the U.S. adoption rates and macroeconomic impacts of these new Lithium-ion powered electric cars through 2030, but does so for an upcoming innovation that will radically change the pricing, reliability, and driving range of these vehicles: switchable batteries with pay-per-mile service contracts. The company Better Place first proposed this vision of separating the ownership of the vehicle from the battery two years ago. It has since been endorsed by leading car manufacturers, a number of high-profile investors, countries, and U.S. states. Israel, Denmark, Australia, Hawaii, and the San Francisco Bay Area have all begun to deploy electric vehicle charging infrastructure in anticipation of the upcoming supply of electric vehicles.

The production of electric cars with switchable batteries creates the possibility for a new service-based model of electric car ownership. Under this model, electric car network operators will offer customers pay-per-mile contracts that combine the financing costs of the battery with charging and range extension services. These network operators will be able to overcome range concerns by installing and maintaining systems of battery charging and switching infrastructure that provide customers with a driving range comparable to that provided by the existing gas station network and in excess of the 200 mile range of the Tesla Roadster. A system centered on network

operators has additional advantages which are discussed in this paper, including: a lower purchase prices for these electric vehicles (EVs), an elimination of consumer uncertainty over the durability of the battery, and the centralized purchase of the charging electricity.

An analysis of vehicle adoption can look at both the initial purchase price as well as the total cost of ownership, which includes fuel, maintenance, and other costs over the life of the car. Section 1 confirms the findings of other industry reports that the total cost of ownership of Li-ion powered electric cars is lower than efficient gasoline-powered cars, but it also shows that electric cars with pay-per-mile contracts will have a lower purchase price compared to fuel-efficient gasoline vehicles It presents an economic model that forecasts the sales of electric vehicles with switchable batteries and pay-per-mile service contracts. Depending on the future price of oil and the relative purchase price of internal combustion engine vehicles, electric cars are predicted to account for 64-86% of new light-vehicle sales by 2030.

Section 2 calculates the impact of electric vehicle deployment on key macroeconomic indicators such as the trade balance, investment, employment, health, and the environment. It also summarizes the current government policies that pertain to electric car deployment and battery technology. Some of the key findings are: 1) electric vehicles will result in a substantial improvement in the U.S. trade deficit; 2) there is a net positive creation of jobs if the U.S. develops a domestic battery manufacturing industry and deploys a charging infrastructure network; 3) the health care cost savings are significant and greatly influenced by the source of electricity used to power the electric fleet; and 4) greenhouse gas emissions are reduced substantially, even compared to a scenario of improved fuel economy for internal combustion engine vehicles.
http://cet.berkeley.edu/dl/CET_Technical%20Brief_EconomicModel2030_f.pdf

Revolutionizing Transportation and Achieving Energy Security
Electrification Roadmap – Website, 2009

In November 2009, the Coalition released its Electrification Roadmap, a sweeping report outlining a vision for the deployment of a fully integrated electric drive network.

The report details the dangers of oil dependence, explains the benefits of electrification, describes the challenges facing electric cars—including battery technology and cost, infrastructure financing, regulatory requirements, electric power sector interface, and consumer acceptance issues—and provides specific and detailed policy proposals to overcome those challenges.

At this website, you may request the report digitally or printed.
http://www.electrificationcoalition.org/electrification-roadmap.php

Rocky Mountain Institute's Project Get Ready Resources
Contacts: Matt Mattila (mmattila@rmi.org) and Tripp Hyde (hhyde@rmi.org) Website, 2009

Project Get Ready is a non-profit initiative led by Rocky Mountain Institute, in conjunction with a wide array of partners and technical advisers. This website provides a wide array of tools, documents and links to help cities within the United States prepare for electric vehicle manufacturers and owners as well as business owners who might cater to them. In the words of Project Get Ready, they will:

- Create a dynamic “menu” of strategic plug-in readiness actions including the “business case” for each action.
- Provide a web database of all national (and some international) plug-in readiness activities.
- Work one-on-one with at least five cities on creating their coalitions and charters.
- Convene at least 20 cities as well as technical players regularly to discuss their lessons learned and best practices, and report these conversations on our website and materials.

- Provide a benchmark that will allow cities/regions to “prove” that they are ready for mass adoption of plug-ins.
- Document the progress made by participant cities in order to help quantify future demand and make it more transparent to industry.
- Provide helpful background and educational material on plug-in readiness.

http://projectgetready.com/category/resources

Electric Power Research Institute (website)
Environmental Assessment of Plug-In Hybrid Electric Vehicles, 2007

In the most comprehensive environmental assessment of electric transportation to date, the Electric Power Research Institute (EPRI) and the Natural Resources Defense Council (NRDC) are examining the greenhouse gas emissions and air quality impacts of plug-in hybrid electric vehicles (PHEV). The purpose of the program is to evaluate the nationwide environmental impacts of potentially large numbers of PHEVs over a time period of 2010 to 2050. The year 2010 is assumed to be the first year PHEVs would become available in the U.S. market, while 2050 would allow the technology sufficient time to fully penetrate the U.S. vehicle fleet.

The objectives of this study are the following:

- Understand the impact of widespread PHEV adoption on full fuel-cycle greenhouse gas emissions from the nationwide vehicle fleet.
- Model the impact of a high level of PHEV adoption on nationwide air quality.
- Develop a consistent analysis methodology for scientific determination of the environmental impact of future vehicle technology and electric sector scenarios.

http://my.epri.com/portal/server.pt?open=514&objID=223132&mode=2

The Electric Vehicle's Value Chain and Technology Evolution
Author: Thilo Koslowski, September 2009

The following research analyzes success factors for the development and market adoption of electric vehicles (EVs), as well as the evolution of key industry participants and their role in the emerging EV value chain.

Key Findings
• The majority of traditional automakers are taking a careful approach regarding EVs to minimize infrastructure-related risks and to maximize ROI from previous investments aimed at optimizing combustion engines.
• Onboard energy management solutions (such as charging station finders and remote battery metering) will simplify EV ownership requirements and will benefit overall market adoption.
• EV infrastructure and/or operation brokers (EV brokers) will have to expand their business models from an end-to-end solution to a flexible collaborative approach with other value chain partners (for example, offering billing and off board management support for a specific vehicle manufacturer).
http://www.gartner.com/resources/171100/171159/the_electric_vehicles_value__171159.pdf

American Council for an Energy-Efficient Economy (**ACEEE) State Energy Efficiency Policy Database on the Web, 2009**

For detailed information about energy efficiency initiatives at the state level, visit ACEEE’s State Energy Efficiency Policy Database on the Web (www.aceee.org/energy/state/index.htm). Complementing the scorecard, the site serves as another resource for information on state energy efficiency policies. The online database is searchable by state or by policy, and documents state activities in the energy efficiency policy areas covered in the scorecard. The

database includes policies and papers on energy efficient vehicles.
http://www.aceee.org/energy/state/index.htm

Additional Sources

Electric Vehicle Batteries
Lithium Ion Batteries for Plug-in Hybrid and Battery Electric Vehicles: Market Analysis and Forecasts, no date given on report

This Pike Research report outlines the critical role that governments around the globe will play in establishing the electric vehicle market, and the challenges that manufacturers face in creating an industry that will be able to stand on its own as government influence diminishes. We examine the key market drivers for the electrification of vehicles and the potential for batteries to participate in vehicle to grid services, and the impact on declining battery production costs on vehicle sales and the resale of batteries after their useful life in vehicles.
http://www.pikeresearch.com/research/electric-vehicle-batteries

Electric Vehicles on the Grid
Residential, Public, Private, and Workplace Charging Stations, EV Charging Business Models, and Vehicle to Grid Technology, no date given on report

This Pike Research report examines the many open questions surrounding business models and technology issues for electric vehicle charging infrastructure. It analyzes and forecasts the market for residential, public, private, and workplace charging stations through 2015 as well as examining operational and technological impacts of plug-in hybrid and battery electric vehicles on the grid infrastructure. Analysis includes an in-depth assessment of market drivers and barriers, along with profiles of charging infrastructure vendors, utilities, automakers, and smart grid companies.
http://www.pikeresearch.com/research/smart-energy/electric-vehicles-on-the-grid

Energy Storage Technology Markets
Advanced Battery Technologies, Pumped Hydro, Compressed Air, Flow Batteries, and Frequency Regulation for Utility-Scale Storage Applications, no date given on report

This Pike Research report analyzes the global energy storage market opportunity from several key perspectives. It includes a detailed examination of the strengths, weaknesses, technological capabilities, and economics of various energy storage technologies, including an assessment of the market prospects for each. The report also analyzes the market drivers, barriers, and regulatory/legislative issues associated with energy storage markets. In addition, it includes granular market forecasts, segmented by technology and world region, along with profiles of key market participants.
http://www.pikeresearch.com/research/energy-storage-technology-markets

Hybrid Electric Vehicles for Fleet Markets
Commercial Hybrid and Plug-in Hybrid Electric Vehicles: Cars, Light Trucks, and Medium/Heavy Duty Trucks, no date given on report

This Pike Research report provides an in-depth examination of the opportunities and challenges for HEVs and PHEVs in fleet markets around the world, including both light cars and trucks and the medium/heavy duty truck segments. The study provides a comprehensive review of key market growth drivers and business case considerations for fleet managers, along with a review of hybrid and battery technology issues. Detailed forecasts are included for the global vehicle

market, HEV and PHEV sales (total and fleet), total commercial vehicle registrations and fleet sales by segment. Key market players are also profiled including automotive OEMs, heavy-duty truck and bus manufacturers, and key suppliers including battery manufacturers.
http://www.pikeresearch.com/research/hybrid-electric-vehicles-for-fleet-markets

Plug-in Hybrid Electric Vehicles
The Global Outlook for PHEVs: Business Issues, Technology Issues, Key Players, and Market Forecasts, 2009

This Pike Research report analyzes the emerging PHEV market with a focus on business issues and demand drivers, technology issues such as the use of advanced batteries and the need for electric vehicle charging infrastructure, the effects of regulatory standards and government incentives around the world, and an in-depth assessment of major OEMs' PHEV programs. Detailed market data and forecasts include PHEV sales and registrations for world markets, sales figures for the total light vehicle and HEV markets to provide context for these numbers, and projected PHEV market shares for selected manufacturers.
http://www.pikeresearch.com/research/plug-in-hybrid-electric-vehicles

Reducing Carbon Dioxide Through Technology And Smart Growth
ScienceDaily, Feb. 13, 2009

A Georgia Tech City and Regional Planning study on climate change, published February 10 by Environmental Science and Technology, shows that "smart growth" combined with the use of hybrid vehicle technology could reduce cities' carbon dioxide (CO2) emissions – the principal driver of global warming – significantly by 2050. This study looked at 11 major metropolitan regions of the Midwestern U.S. over a 50-year period and took into account three different scenarios: the use of hybrid vehicles and two different urban growth scenarios through which population density was increased over time, a central component of smart growth planning.
http://www.sciencedaily.com/releases/2009/02/090211161854.htm