
# Electric Vehicle Policy For the Midwest – A Scoping Document

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December 2009

Prepared for the RE-AMP Network
www.reamp.org

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# Acknowledgments

We appreciate the support of RE-AMP's Global Warming Strategic Action Fund for allowing us to prepare this report. We also thank Clean Wisconsin for its support for this project. We're very grateful to the many members of RE-AMP's Transportation, Clean Energy and Global Warming Solutions working groups for their input and insights.

Among the other organizations and individuals (in no particular order) that offered ideas for this report: Project Get Ready (Rocky Mountain Institute), Sentech Inc., Chelsea Sexton (Lightning Rod Foundation), CalCars, Plug-In America, General Motors, University of Minnesota's Center for Transportation Studies, University of Delaware, Argonne National Laboratory, Electric Power Research Institute, The Brookings Institution, Center for Neighborhood Technology, Electric Drive Transportation Association, Pacific Gas & Electric, Southern California Edison, Center on Wisconsin Strategy, The Ecology Center, Fresh Energy, Plains Justice, Xcel Energy, Sierra Club, Jim Motovalli, Jim Peterson (Seeking Alpha), Southern Municipal Power Agency, Coulomb Technologies, The Brattle Group, Ford Motor Co., Minnesota Pollution Control Agency, National Wildlife Federation, Iowa Environmental Council, Intertribal Council On Utility Policy, Clean Fuels Ohio, Environmental Law and Policy Center of the Midwest, Center for Automotive Research (Ohio State Univ.), American Council for an Energy Efficient Economy, Citizen's Utility Board of Wisconsin, Great Plains Institute, Natural Resources Defense Council, City of Minneapolis, Bright Automotive, Oregon Department of Transportation, Neighborhood Energy Connection.

We thank our colleagues at the Institute for Local Self-Reliance for their input and comments on drafts of this report. We also thank our intern Simon Kassel for his work in pulling together background data and charts/graphs. All shortcomings and errors, of course, are the responsibility of the authors.

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# BACKGROUND FOR THIS REPORT

In January 2009, at a meeting of all Midwestern Governors Association (MGA) Advisory Groups involved in the Midwestern Greenhouse Gas Accord process, 30 people convened to discuss the implications of electrified vehicles on the electrical system in the Midwest. A sub-group subsequently prepared a 10-page document, *Implications of Plug-in Hybrids and Electric Cars on the Electric Energy System: A Report to the Midwestern Governor's Association Greenhouse Gas Accord.*

That paper expressed optimism that electrified vehicles (PHEVs and BEVs) could "offer exciting contributions to a low-carbon future" but cautioned that EVs are not a silver bullet and MGA states should seek a comprehensive approach to reducing emissions from the transportation sector.

This new scoping report significantly expands on and updates that earlier MGA guidance document. We offer an overview of current private and public efforts to expand the use of electrified vehicles with a specific focus on activities in the eight RE-AMP states (Illinois, Iowa, Michigan, Minnesota, North Dakota, Ohio, South Dakota and Wisconsin). We examine in more detail the GHG implications of expanded use of EVs and compare that to other transportation-related GHG reduction strategies. We identify the most relevant policies either in practice or proposed. Finally, we recommend a set of near term initiatives. This report is targeted at policy makers, foundations and organizations in the RE-AMP states but we hope it will prove useful to organizations around the country.

## Common Abbreviations

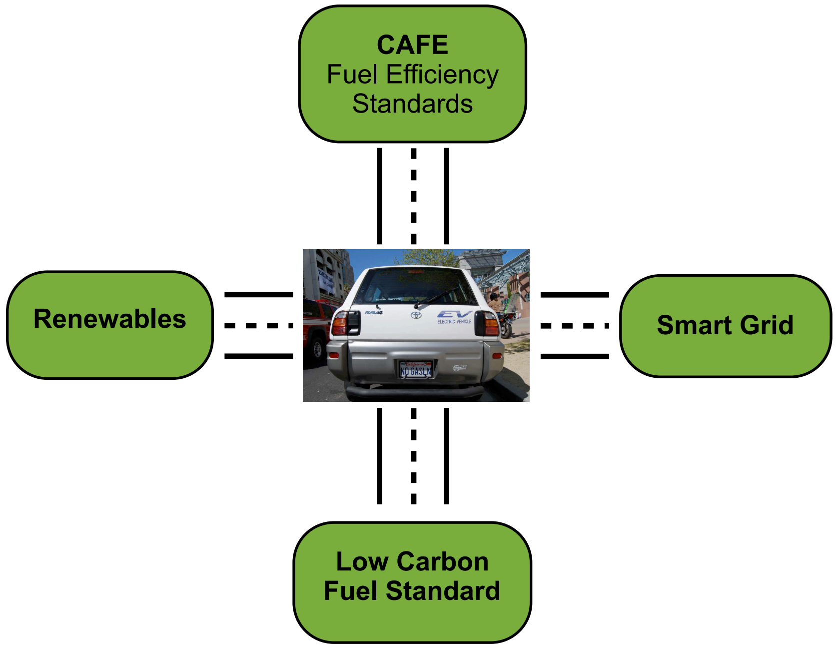
BEV - Battery Electric Vehicle
CV – Conventional Vehicle – internal combustion engine
DoD - Depth of Discharge
EREV - Extended Range Electric Vehicle
EV - Electric Vehicle (these are plug-ins, typically includes BEV, EREV, NEV, PEV and PHEV)
FFVs - Flexible-Fueled Vehicles
HEV - Hybrid Electric Vehicle
ICE - Internal Combustion Engine
kWh – Kilowatt-hour
Li-Ion – Lithium Ion
LEV – Low Emission Vehicle
LSEV – Low Speed Electric Vehicle
MPG – Miles per Gallon
NEV - Neighborhood Electric Vehicle
NiMH - Nickel Metal Hydride
PbA - Lead Acid
PEV – Plug-in Electric Vehicle (includes both EVs and PHEVs)
PHEV – Plug-in Hybrid Electric Vehicle
PHEV20 (PEV20) – Plug-in Hybrid (Electric Vehicle) with 20-mile electric-only range
ULEV - Ultra Low Emission Vehicle
V2G – Vehicle to Grid
ZEV - Zero Emission-Vehicle

## NOTE:

Throughout this report, for simplicity the abbreviation "EV" is used to denote electric vehicles that are plugged in for recharging. In almost every case, our reference to EVs would include both plug-in hybrids and plug-in battery electric vehicles. If not, we have tried to make it clear if there is a distinction specific to PHEVs or BEVs.

# EXECUTIVE SUMMARY

**Many Roads Lead To and From Electric Vehicles**




In the last three years the transportation sector has witnessed a revolutionary upheaval. Car sales plummeted, with the most dramatic declines occurring in light truck sales. Two of the three big U.S. car companies declared bankruptcy. The federal government and California imposed significant efficiency standards and for the first time required reductions in greenhouse gas (GHG) emissions from cars. Car companies that had spurned electrification suddenly embraced it. Utilities began aggressively pursuing smart grids, with EVs as a key catalyst. EVs have gone mainstream, a featured commodity. A dozen car companies have said they will be introducing electrified car models in the 2010-2011 time frame. Several cities and regional coalitions have begun to elaborate public charging networks.

According to the National Conference of State Legislatures (NCSL), 68 bills from 25 different states were introduced in 2009 that involved electric vehicles (about a dozen have been enacted). There has been limited efforts in the RE-AMP states to push EV policies. The most aggressive efforts have been in the state of Michigan which has what appears to be an effective strategy for attracting both EV and advanced battery research and manufacturing.

The RE-AMP network's core goal is to enable dramatic reductions in GHG emissions. Therefore this report focuses on the impact of EVs on these emissions, beginning with a comparison of EVs with other key strategies like improving fuel efficiency and lowering the carbon intensity of fuels.

Potentially, a low carbon fuel standard (LCFS) could have the biggest impact on GHG reductions by 2020 because once in place it will apply to all vehicles while fuel efficiency (CAFE) standards will apply only to new vehicles. However, CAFE standards are already in place nationally while no RE-AMP state has yet to enact a LCFS.

The short term impacts on GHG emissions of expanding EVs will be very small because the vehicles will not enter into the market in large numbers until manufacturing ramps up and they will slowly replace the types of new cars being made by automakers. In the next decade the introduction of EVs in the RE-AMP states will reduce transportation sector GHG emissions by significantly less than 1 percent, compared to 10 to 20 times greater reductions from either CAFE or a future LCFS.

**Impacts on GHG Emissions of LCFS and CAFE Policy in the RE-AMP Region**

| | 2005 GHG Emissions Transportation (MMtCO2e) | 2020 LCFS GHG Reductions % of 2005 Transportation GHG | 2020 CAFE GHG Reductions % of 2005 Transportation GHG | 2020 LCFS and CAFE Combined Reductions % of 2005 Transportation GHG - |
|---|---|---|---|---|
| **Illinois** | 78 | 8.5% | 6.2% | 14.7% |
| **Iowa** | 21 | 8.5% | 6.6% | 15.1% |
| **Michigan** | 58 | 8.5% | 8.1% | 16.6% |
| **Minnesota** | 37 | 8.5% | 6.9% | 15.4% |
| **North Dakota** | 6 | 8.5% | 5.3% | 13.8% |
| **Ohio** | 73 | 8.5% | 6.8% | 15.3% |
| **South Dakota** | 6 | 8.5% | 6.1% | 14.6% |
| **Wisconsin** | 31 | 8.5% | 8.6% | 17.1% |
| **TOTAL (REAMP States)** | 310 | 8.5% | 7.1% | 15.6% |

Like any GHG reduction strategy, EVs cannot be viewed as a stand alone solution. Fortunately, electrified vehicles will have a catalyzing and symbiotic relationship to many other GHG reduction strategies. For example, because federal policy gives EVs a very high fuel efficiency rating, they will play a role in car companies meeting the new CAFE standards. EVs are also poised to play a key role in transportation fuel supplier's efforts in meeting low carbon fuel standards. Moreover, because of their energy storage capability, EVs also can play an increasingly important role in the expansion of renewable energy. And EVs already are playing an important role in the discussions about the future elaboration of a smart grid.

Thus any comprehensive and coherent GHG reduction plan, either at the state or regional level, should encourage a steady expansion of electrified vehicles and related industrial development. This report discusses dozens of policies proposed to achieve this goal, and selects eight of these as near term efforts key to a successful transportation electrification initiative. The recommendations include:

- Create a RE-AMP Electric Vehicle Readiness (RE-AMP-EVR) Adhoc Group
- Enact Legislation That Opens a Regulatory Proceeding Covering Electric Utility Related EV Issues
- Require a Performance Standard for New Construction to be EV and Renewable Energy Ready or Capable
- Allow Municipal Energy Financing to Cover Level 2 EV Charging Systems
- Fast Track and Simplify Permitting and Installation of EV Charging Systems
- Initiate Government Fleet Conversions to EVs
- Begin Smart Grid Deployments
- Allow Utilities Cost Recovery Authority for Any Distribution System Upgrades Needed to Facilitate Growing Numbers of EVs

# CHAPTER 1. A BRIEF RECENT HISTORY OF ELECTRIFIED VEHICLES: FROM RECEDING TIDE TO TSUNAMI

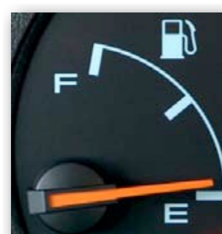
Perhaps the most useful way to describe the last 20 years of electrified vehicle development is with the metaphor of the tides. From 1990 to about 2000 the EV tide came in, catalyzed by policy developments. From 2000 to 2005 the EV tide went out, largely a result of policy changes resulting from opposition from the U.S. auto industry. From 2005 to 2007 the tide began to rise again, spurred this time by grassroots initiatives and rising oil prices. Since 2008, an unprecedented confluence of economic, technological and political forces has transformed the rising tide into a tsunami of increasingly rapid developments that promise to make electrified vehicles a centerpiece of U.S. transportation policy.

## 1990 to 2000: the EV tide comes in

- In 1990, the introduction by GM of its concept electric car, the Impact, inspires the California Air Resources Board (CARB) to mandate that two percent of all new vehicles for sale in California in 1998 and ten percent by 2003 be all-electrics. At its peak, California's Zero Emissions Vehicle (ZEV) regulations bring some 5,500 electric vehicles onto California's roads, including Ford's small Think car, Toyota's small SUV, the RAV4, Ford's light pickup truck, the Ranger and GM's EV-1. The RAV4EV has an all-electric driving range of 130 miles.

- The first Gulf War breaks out in 1990, forcefully reminding the public and policymakers of the dangers of our increasing dependence on imported oil.
- In 1993, the U.S. government launches its Partnership for a New Generation of Vehicles (PNGV), a 7-year $1 billion effort to encourage U.S. car companies to build vehicles that could achieve 80 mpg. Recipients of PNGV funds agree to unveil a concept car by 2000, a preproduction prototype by 2004 and be in full production by 2010. Japan launches a similar program one year later

## 2000 to 2005: the EV tide goes out




- The unprecedented sales of SUVs and trucks generate enormous profits for U.S. car manufacturers. Ford's profit reaches $6.5 billion in 1998 and in 1999 rises to a record $7.2 billion. A *Bloomberg News* headline declares, "The Hottest Dow Stock of 1999? That Old Plodder, GM".
- In early 2000, Ford, GM and Daimler Chrysler meet the first deadline of the PNGV, unveiling mostly hybrid concept cars.
- After introducing their prototype high efficiency vehicles in 2000, American car companies halt further commercialization. In 2001, the PNGV program is cancelled at the request of the automakers.
- In 1999, the Honda Insight becomes the first hybrid electric vehicle (HEV) sold into the U.S.
- In 2001, Toyota introduces its hybrid Prius in the U.S. market
- In 2001, CARB again changes the ZEV regulation. Auto companies sue and in 2003, CARB all but abandons its electric vehicle mandate. Most car companies end their EV programs
- In 2003, GM announces it will not renew leases for its EV1 cars and will reclaim them by the end of 2004. Ford and Toyota follow suit.

## 2005 to 2007: the EV waters rise again.

- In April 2006, the movie *Who Killed the Electric Car?*, is released to wide distribution. It tells the story of the California ZEV mandate and ends in a cemetery with a funeral for GM's EV1. But even as the movie generates widespread outrage and debate, the tide is turning on EVs.

- Grassroots activists try to stop car companies from crushing the electric vehicles leased under California's ZEV program. Those who have leased the cars demand the right to purchase them outright. GM refuses but in 2005 Ford and Toyota agree. When the protests end more than 800 electric vehicles are still on California's highways and become the foundation for a renewed effort to promote electric vehicles.

- In September 2003, Toyota introduces its second generation Prius with same sales price as the original but 15 percent more interior space and 50 percent better mileage than its comparable American model. Toyota outfits the Prius with a device that allows Japanese drivers to put the car into an all-electric driving mode for 1-2 miles. The device is invisible to U.S. customers. But American engineers quickly learn how to modify the Prius sold in the U.S. so that it too can travel only on electricity, adding sufficient battery capacity for it to travel for 10 miles or more before the gas engine is needed.

- By 2005 several Priuses have been converted into plug-in hybrid electric vehicles with an all-electric driving range up to 20 miles. Car industry reporters begin to write stories about the PHEV grassroots effort. In the spring of 2006, Felix Kramer, founder of CalCars, spends $15,000 to transport his own converted Prius PHEV to Washington, D.C. to allow several U.S. Senators and leading policymakers and opinion leaders to literally kick the tires [1]. Several small companies begin to offer plug-in hybrid conversions.

- The price of oil begins to climb, from $25 per barrel in 2003 to $40 in 2004, $60 in 2005, $75 in 2006 and $90 in 2007. Americans began buying small and more fuel-efficient cars. Hybrid sales soar. By the end of 2007, Prius sales worldwide reach 1 million. More and more car manufacturers announce the introduction of hybrid models.

- In 2007, Toyota, which for the first six years of Prius sales had used the advertising tag line, "You Never Have to Plug It In," announces that in 2010 it will begin leasing plug-in Priuses to Japanese fleet owners.

Nissan Leaf

Chevy Volt

## 2007 to 2009: the EV tsunami hits

- In mid 2007, Google issues a $10 million solicitation for the commercialization of electrified vehicles.

- The price of oil peaks at $140 per barrel in July 2008. By the end of 2008, U.S. car sales have dropped by 50 percent from 1999 levels. In December 2008 GM and Chrysler receive $17 billion in federal bailout funds. In April 2009 Chrysler goes into bankruptcy. In June GM follows.

- In December 2008, Congress appropriates $25 billion to help car companies achieve new fuel efficiency levels. Part of the appropriations will go to develop electrified vehicles and new batteries.

- By early 2009, a dozen car manufacturers, from major companies like GM, Ford, Toyota and Nissan, and new car companies like BYD Auto, Fisker, Tesla and Th!nk, announce they will begin selling EVs or PHEVs in the U.S. in 2010 or 2011.

- In 2009, the Environmental Protection Agency (EPA) issues draft revised fuel efficiency (CAFE) standards that match California's proposed "clean cars" standards that has been held up awaiting a waiver from the EPA. These new CAFE standards will be adopted in early 2010.

- In 2009, in the latest revision of its ZEV standards, California all but mandates the introduction of more than 50,000 PHEVs in the 2012-2014 timeframe.[2]

- California Air Resources Board (CARB) directs its staff to begin developing new rules known as "ZEV 2.0" that will likely return the ZEV program to its original focus of pushing the envelope on pure EV technology expansion. California has about 20 percent of the U.S. automobile market. Ten other states have adopted California's ZEV rules.

- In February 2009 the American Recovery and Reinvestment Act of 2009 (ARRA) is enacted. It includes handsome tax credits for Plug-in EVs including for conversion kits (see link in endnote for descriptions).[3]

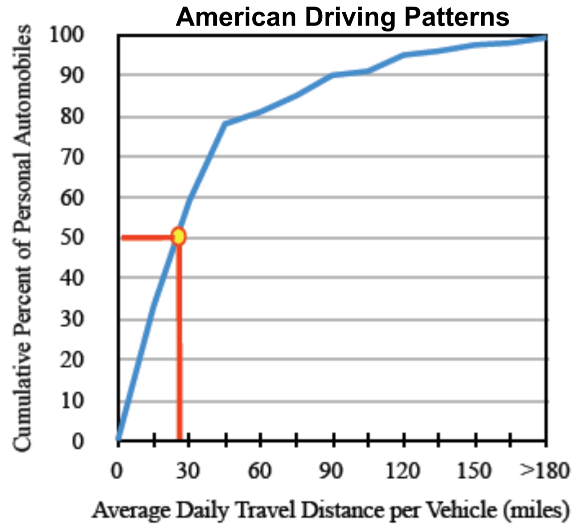
- A 2009 poll by Pike Research found that 48% of respondents said that they would be "extremely" or "very" interested in purchasing a PHEV with a 40-mile range on a single charge.[4] In addition, 85% of consumers stated that improved fuel efficiency would be an important factor when choosing their next vehicle and 65% of those interested in PHEVs expressed a willingness to pay up to 12 percent more.

- In August 2009, DOE announces[5] grants to 48 new advanced battery and electric drive projects that will receive $2.4 billion in ARRA funding. More than half of the funding went to companies in the state of Michigan.

- In mid-September 2009, DOE announces a $5.9 billion Advanced Technology Vehicles Manufacturing (ATVM) program loan to Ford Motor Company to transform factories across Illinois, Kentucky, Michigan, Missouri, and Ohio to produce more fuel-efficient models. Part of the loan proceeds will be used by Ford to develop their future plug-in electric vehicles.

**Can EVs Get Us Where We Want to Go?**

The range of EVs and the time needed to recharge is often pointed to as a barrier to consumer acceptance. Some say that unless the vehicle has a 250-mile range and can be recharged in the same timeframe as putting gas in your vehicle, EVs will never become acceptable to Americans. This fact may be true for some consumers but driving patterns indicate that many household vehicles could be EVs and not put a dent in anyone's convenience factor. As the chart below shows, nearly 80% of vehicles travel less than 50 miles per day and 50 percent of us travel less than 25 miles per day. Our vehicles are parked for much more time than they are moving and could be recharged during that time.




Manufacturers are conscious of consumer's "range anxiety" and are dealing with it in several ways. Some will simply market their EVs to consumers that don't need their vehicle for long trips. Nissan's forthcoming Leaf, a plug-in all electric vehicle with a 100-mile range, will initially be targeted at the commuter market but the company is also spending a lot of effort to get cities and states to build out public charging networks. GM's Chevy Volt, a 40-mile all electric range plug-in EV, is being marketed as an "extended range" EV since it will also have a gasoline-fueled generator under the hood that can charge the batteries on the fly allowing for a 200-mile range before it needs more gas or electricity.

- DOE offers a conditional loan of $528.7 million to manufacturer Fisker Automotive for the development of two versions of PHEVs. Vehicles will roll off assembly lines in the U.S. beginning in late 2012.

- DOE has offers conditional loans of $1.6 billion to Nissan North America, Inc. and $465 million to Tesla Motors.

- In October 2009, Ford a creates a new position "Director of Global Electrification".

- In October 2009, France announces in October 2009 it will commit $2.2 billion to put 2 million electric cars on the road by 2020.

- China's government all but mandates EVs and offers handsome incentives to build up the EV and battery manufacturing sectors and charging infrastructure. China plans to raise its annual production capacity to 500,000 hybrid or all-electric cars and buses by the end of 2011, up from 2,100 in 2008.

- Pike Research's EV market assessment report for 2015 predicts that China will be the world leader in charging stations, selling nearly half of the global total of 1.5 million units that could be sold in 2015.[6]

- In November 2009, a group of high-powered executives from the automotive, EV charging, energy storage and investment sectors known as the Electrification Coalition released their *Electrification Roadmap* outlining steps needed to reach 13 million EVs on the road by 2020, and have EVs comprise 90 percent of all light duty vehicle sales by 2030 – years ahead of current projections.

- Director Chris Paine begins production of a new documentary movie, "Revenge of the Electric Car!"

# CHAPTER 2. ELECTRIC VEHICLE POLICY AND RELATED ACTIVITIES IN RE-AMP STATES

According to the National Conference of State Legislatures (NCSL), 68 bills involving electric vehicles in 25 different states have been introduced in 2009. About a dozen have been enacted.[7] The eight RE-AMP states have seen relatively little EV-related activity, with the major exception of Michigan. While somewhat related and certainly important, we're not covering energy efficiency and biofuels policies nor policies promoting HEVs. Michigan has the most active and comprehensive set of EV and related policies so we provide a more detailed description of their activities below. Details on the other RE-AMP states and their EV initiatives can be found in Appendix A.

## Summary of Activities in RE-AMP States

**TABLE 1: RE-AMP State-By-State Existing Electric Vehicle Related Policies**

| | Policy Summary | Time Period | Link |
|---|---|---|---|
| **Illinois** | Alternate Fuels Rebate Program: Rebates of up to $4,000 or 80% of the cost of vehicle conversion to electric power. | Enacted 1997 | Link to policy |
| | Smart Grid Initiatives: Major stakeholders develop a strategic plan for the deployment of smart grid in Illinois. Also, increases funding for ComEd to deploy smart meters beginning in 2010. | To be Completed October 2010 | Link to policy |
| | NEV Roadway Access Limits: Limits the use of Neighborhood Electric Vehicles to roads with a speed limit of 35 mph or less. | Effective January 2006 | Link to policy |
| **Iowa** | Electric Vehicle Registration Fee: Establishes a $25 registration fee for electric vehicles or $15 if the car is five or more years old. | Effective 2000 | Link to policy |
| | NEV Roadway Access Limits: Limits the use of Neighborhood Electric Vehicles to roads with a speed limit of 35 mph or less. | Enacted March 1999 | Link to policy |
| **Michigan** | Michigan Impact Studies of PHEVs: The Michigan Energy Efficiency Grant Program includes the allocation of money for automakers and research institutes to study the impact of PHEVs in Michigan. | April 2008 | Link to policy<br><br>Link to policy |
| | Smart Grid Initiatives: The Michigan Public Service Commission is studying issues surrounding the integration of PHEVs into the electric grid. | March 2008 | Link to policy |
| | Michigan Next Energy Authority Act: Provides nonrefundable tax credits for researchers, developers and manufacturers of electric and other alternative fuel vehicles (AFV). Alternate fuel vehicles are any that run on fuel other than petroleum. | Enacted January 2008 | Link to policy |

| | | | |
|---|---|---|---|
| **Michigan (cont.)** | Alternative Fuel Development Property Tax Exemption: This law included a provision that created a tax credit for the industrial property making electric, hybrid or alternative fuel vehicles and their components, provided that they maintain certain levels of jobs and capital investments. | April 1995 | Link to policy |
| | Michigan Business Tax Act: Provides tax credits for manufacturers of high-power batteries for PHEVs. Tax credit quantities are determined by the kWh capacity of each battery as well as the number produced. This act also provides additional tax credits for battery manufacturers who create a target number of new jobs. | Enacted January 2009 | Link to policy |
| | Tax Credits for Battery Research and Development: The state of Michigan has pledged $555 million dollars in tax credits for manufacturers and developers of electric vehicle batteries in Michigan. | Enacted January 2009 | Link to policy |
| | Alternative Fuel Vehicle Emissions Inspection Exemption: This law includes Alternative Fuel Vehicles in the list of vehicles that are exempt from emissions inspection requirements. | Enacted May 1995 | Link to policy |
| | Advanced Vehicle Acquisition and Alternative Fuel Use Requirement: The State must use hybrid electric vehicles in its fleet as long as they are deemed cost-effective and capable of doing their necessary jobs. Similarly, the state's fleet must use alternative fuel when possible. | Executive Directive November 2007 | Link to policy |
| | NEV Requirements and Roadway Access Limits: Electric mobility devices must drive as far to the right of the side of the road as possible. They may not exceed a speed of 25 mph or go on any roads with a speed limit of 35 mph or higher. | August 2006 | Link to policy |
| | Michigan Academy for Green Mobility: As part of the Michigan Green Jobs Initiative, the Michigan Department of Energy, Labor and Economic Growth is partnering with two universities to provide training of automotive engineers for advanced vehicles. | Started August 2009 | Link to policy |
| **Minnesota** | PHEV Task Force: In 2006, the State established a task force to study the barriers to wide-spread adoption of PHEVs in Minnesota. | Enacted May 2006 | Link to policy |
| | PHEV Infrastructure and Study of EV impacts on Transportation Funding: Any electric vehicle infrastructure installed in the state must be compatible with Society of Automotive Engineers standards and be capable of providing bidirectional charging, once electrical utilities achieve a cost-effective capability to draw electricity from electric vehicles connected to the utility grid. Also the Dept. of Transportation (MnDOT) completed a study in December 2009 that addressed, in part, the impact that EVs might have on the current funding mechanisms for the state's roadways and provided suggestions on how to mitigate any impacts. | Enacted May 2009 | Link to policy<br><br>Link to MnDOT report |

| | | | |
|---|---|---|---|
| **Minnesota (cont.)** | Great River Energy Off-Peak Charging Program: This program from Great River Energy provides rebates to charging stations that provide off-peak (11pm-7am) electric vehicle charging. | August 2009 | Link to policy |
| | PHEV and NEV Purchasing Requirement: The State must begin purchasing PHEVs and neighborhood electric vehicles (NEV) as soon as they become commercially available and within 10% of the cost of comparable gas-powered vehicles. Neighborhood electric vehicles are powered fully by electricity but only travel up to 25 mph. | Enacted May 2006<br><br>Amended May 2009 | Link to policy<br><br>Link to policy |
| | NEV Definition and Roadway Access Limits: NEVs are defined as 4-wheeled electric vehicles that can go between 20 and 25 mph. They may not be operated on a street with a speed limit higher than 35 mph. | Enacted 2009 | Link to policy |
| | State Agency Energy Plan and Vehicle Acquisition Priorities: Government agencies must reduce gasoline use by 50% by 2015 and state vehicles must become more gasoline efficient in that same time period. | Executive Order September 2004 | Link to policy |
| | Smart Grid Collaborative: The Minnesota Department of Commerce and the University of Minnesota are collaborating to engage stakeholders on issues related to Smart Grid development in Minnesota. | Started 2009 | Link to policy |
| **North Dakota** | State Conversion of Two Cars to Plug-In Hybrid: The state partnered with Basin Electric, A123 Systems and Hymotion to convert two Ford Escapes to plug-in hybrid vehicles. | May 2007 | Link to policy |
| | NEV Roadway Access Limits: NEVs are defined as electric vehicles that can go between 20 and 25 mph. They may not be operated on a street with a speed limit higher than 35 mph. | Enacted 2009 | Link to policy |
| **Ohio** | Research Partnerships for Electric Vehicles: The Ohio Third Frontier program is 10 year, $1.6 billion State-sponsored initiative allocated for a broad range of technological innovation. In 2009, $3 million of this money was granted to the Center For Automotive Research (CAR) at The Ohio State University to develop electric vehicle technology. | Granted July 2009 | Link to policy<br><br>Link to policy<br><br>Link to policy |
| **South Dakota** | NEV Roadway Access Limits: Neighborhood electric vehicles are permitted from going on streets with a speed limit of 35 mph or more. | Enacted 2008 | Link to policy |
| **Wisconsin** | Vehicle Battery and Engine Research Tax Credits: Provides automobile developers with a tax credit equal to 10% of electric vehicle research costs. | Enacted June 2007 | Link to policy |
| | NEV Roadway Access Limits: NEVs are defined as 4-wheeled electric vehicles that can go between 20 and 25 mph. They may not be operated on a street with a speed limit higher than 35 mph. | Enacted December 2007 | Link to policy |

Various sources including: DOE, EPA, NCSL, Individual State legislatures

## Michigan's EV Activities in Detail

Of all the RE-AMP states, Michigan is the most active in terms of its efforts to expand EVs and related industries using legislative, regulatory and incentive-based approaches. Back in April 2009, Michigan's Governor, Jennifer M. Granholm, announced the successful efforts to expand advanced vehicle and battery manufacturing in the state. "Today marks a defining moment for Michigan's future as we see a new industry begin to take root and grow new jobs," Granholm said. "Thanks to the most aggressive economic strategy of any state in the country, Michigan, the global center of automotive research and development, is positioned to lessen the nation's dependence on foreign oil and become the advanced battery capital of the world."

With existing and sometimes empty infrastructure geared toward the old auto industry and high unemployment with skilled workers looking for jobs it makes perfect sense for Michigan to rebuild its industrial economy on the basis of electric vehicles and advanced batteries. The State's initiatives have proven to be very effective and helped the state secure over half of the $2.5 billion in Federal economic stimulus funding for advanced EV battery manufacturing. The state is poised to gain thousands of new jobs in this emerging economic sector in the U.S. Below are descriptions of Michigan's EV programs.

### Research

**Michigan Impact Studies of PHEVs[8]**
As part of a $5-million Michigan Energy Efficiency Grant Program, General Motors, Pacific Northwest Laboratory, DTE Energy, Michigan Transportation Research Institute (UMTRI) and others will study the impact of PHEVs in Michigan. The research is expected to be completed in 2010.

**Smart Grid Initiatives**
The Michigan Public Service Commission (MPSC) established a smart grid collaborative in 2007. In 2008 the MPSC ordered the smart grid collaborative to begin studying various aspects of PHEVs including[9]:

- Using actual vehicles, some of which incorporate V2G systems, if and when available;
- Analyzing the environmental effects in Michigan of PHEVs at low, medium and high levels of adoption, with and without V2G capability;
- Analyzing the effect of PHEVs on Michigan utility and regional electric system load duration curves and the effect of PHEV market penetration on generation mix and capacity requirements;
- Analyzing the technical issues related to the participation of V2G in the Midwest Independent Transmission System Operators' ancillary services market; and
- Analyzing meter and time-based pricing policies for electricity used to charge electric vehicles.

### Financial Incentives

**Alternative Fuel and Vehicle Research, Development, and Manufacturing Tax Credits[10]**
Effective January 1, 2008, taxpayers certified by the Michigan NextEnergy Authority (MNEA) may claim a nonrefundable credit for tax liability attributable to research, development, or manufacturing of qualified alternative fuel vehicles (AFVs) and renewable fuel. For the purpose of this incentive AFVs include fuel cell, electric, hybrid electric, natural gas, E85, liquefied petroleum gas, and hydrogen vehicles. Renewable fuels include biodiesel blends of at least 20%. (Reference Michigan Compiled Laws 207.821-207.827 and 208.1429)

**Alternative Fuel Development Property Tax Exemption**
A tax exemption may apply to industrial property that is used for high-technology activities including those related to advanced vehicle technologies such as electric, hybrid, or alternative fuel vehicles and their components. (Reference Michigan Compiled Laws 207.552 and 207.803)

**Michigan Business Tax Act (Act 36 of 2007)**[11]
This law allows the Michigan economic growth authority to enter into agreements to provide tax credits to stimulate the domestic commercialization and affordability of high-power energy batteries.

For tax years that begin on or after January 1, 2010 and end before January 1, 2015, a taxpayers manufacturing plug-in traction battery packs in Michigan may claim a credit against their tax (up to $10 million/year). The Michigan economic growth authority may enter into more than 1 agreement under this section and at least one agreement shall require capital investments of not less than $200 million not later than December 31, 2012.

**Tax Credits for Battery Research and Development**
In January 2009, a new law provided up to $335 million in refundable tax credits to encourage companies to develop and manufacture advanced batteries and commercialize advanced-battery technologies in Michigan. The law was later amended to add $220 million in tax credits bringing total incentives to $555 million. The initiative is targeted for:

- the research, development, and manufacture of battery packs used in hybrid plug-in vehicles;
- vehicle engineering that supports battery integration;
- advanced automotive battery technology engineering; and
- the construction of integrated battery cell manufacturing facilities.

## Non-Financial Incentives

**Alternative Fuel Vehicle (AFV) Emissions Inspection Exemption**[12]
Dedicated AFVs powered by electricity (among other alternative fuels) are exempt from emissions inspection requirements. (Reference Michigan Compiled Laws 324.6311 and 324.6512)

**Advanced Vehicle Acquisition and Alternative Fuel Use Requirement**[13]
The Department of Management and Budget (DMB) must include hybrid electric vehicles within the state's fleet if the vehicles are determined to be cost effective and capable of meeting the state's transportation needs. In addition, as the state's public alternative fuel fueling infrastructure continues to develop, the state's alternative fuel vehicle fleet is required to fuel with alternative fuels to the extent possible. (Reference Executive Directive 22, 2007)

**NEV Requirements and Roadway Access Limits**
Unique to other state's typical rules, NEV's in Michigan must be driven as near to the right side of the roadway as practicable. NEVs can travel at a speed of not to exceed 25 miles per hour and shall not be operated on a highway or street with a speed limit of more than 35 miles per hour except for the purpose of crossing that highway or street. (Reference Michigan Compiled Laws 257.660)

**Michigan Academy for Green Mobility**
In August 2009, Governor Jennifer Granholm announced the launch of the Michigan Academy for Green Mobility (MAGM). The Michigan Department of Energy, Labor & Economic Growth is partnering with Michigan Technological University and Wayne State University to offer MAGM's first round of training that prepares automotive engineers for renewable energy jobs. The courses will be focused on developing engineering skills that apply to next-generation hybrid and electric vehicles with an emphasis on battery design and hands-on learning.

**Recent EV and Battery Manufacturing Developments in Michigan**[14]

Ford Motor Company will turn a now-vacant Michigan Truck Plant into the new home of the automaker's new fuel efficient, global vehicle. The plant will be renamed the Michigan Assembly Plant and will produce the first redesigned Ford Focus cars. The plant will also build a new battery-electric version of the Focus for the North American market, which is expected to debut in 2011. An estimated 3,200 jobs will be created in Michigan because of the plant conversion

In March 2009, Daimler AG won approval today of a state tax break to build a $10 million research center in Washtenaw County to develop hybrid vehicle technology. The Michigan Economic Growth Authority (MEGA)[15] board approved a $7.5 million tax credit for the 65,000-square-foot research and development center at an undetermined site near Ann Arbor that will employ 223 workers, mostly engineers and technicians, according to a Michigan Economic Development Corp. memo. Work at the facility would focus on developing alternative propulsion systems.

In April 2009 Michigan's aggressive effort to develop a homegrown advanced-battery industry resulted in four companies (Johnson Controls-Saft Advanced Power Solutions, LG Chem-Compact Power, KD Advanced Battery Group and A123 Systems) announcing plans to invest more than $1.7 billion in advanced-battery manufacturing facilities in Michigan. The projects would create 6,683 new jobs in Michigan and were awarded state refundable tax credits that will help the companies in their quest for some of the $2 billion in federal grants for advanced-battery research and development.

In August 2009, the following 12 Michigan projects were awarded more than $1.35 billion in grants from the U.S. Department of Energy to support advanced battery and electric vehicle manufacturing and development under the American Recovery and Reinvestment Act.

**Cell, Battery and Materials Manufacturing Facilities**

- Johnson Controls — $299.2 million awarded for production of nickel-cobalt-metal battery cells and packs, as well as production of battery separators for hybrid and electric vehicles.
- A123 Systems — $249.1 million awarded for manufacturing nano-iron phosphate cathode powder and electrode coatings, fabrication of battery cells and modules, and assembly of complete battery pack systems for hybrid and electric vehicles.
- KD Advanced Battery Group — $161 million awarded for production of manganese oxide cathode/graphite lithium-ion batteries for hybrid and electric vehicles.
- Compact Power (on behalf of LG Chem) — $151.4 million awarded for production of lithium-ion polymer battery cells for the GM Volt.
- General Motors — $105.9 million awarded for production of high-volume battery packs for the GM Volt.

**Electric Drive Component Manufacturing Facilities**

- General Motors — $105 million awarded for construction of U.S. manufacturing capabilities to produce the second-generation GM global rear-wheel electric drive system.
- Ford Motor Company — $62.7 million awarded to produce a Ford electric drive transaxle with integrated power electronics in an existing Ford transmission facility.
- Magna E-Car Systems of America — $40 million awarded to increase production capacity of advanced automotive electric drive system component manufacturing plants located in the United States.

**Advanced Vehicle Electrification**

- Chrysler — $70 million awarded to develop, validate, and deploy 220 advanced plug-in hybrid electric pickups and minivans.
- South Coast Air Quality Management District — $45.4 million awarded to develop a fully-integrated, production plug-in hybrid system for Class 2-5 vehicles.

**Advanced Vehicle Electrification and Transportation Sector Electrification**

- General Motors — $30.5 million awarded to develop, analyze, and demonstrate hundreds of Chevrolet Volt Extended Range Electric Vehicles.
- Ford Motor Company — $30 million to accelerate the launch and commercialization of PHEVs and EVs by partnering with 15 of America's leading utilities.

## Federal EV and Related Programs in RE-AMP States

**Energy Frontier Research Centers**

In April and August 2009, DOE made announcements on investments of $777 million in "Energy Frontier Research Centers" (EFRC) over the next five years. Forty-six new multi-million-dollar EFRCs will be located at universities, national laboratories, nonprofit organizations, and private firms across the nation. Several awards were made in RE-AMP states.[16]

**Clean Cities Program**

In August 2009, DOE announced the recipients of $300 million in Clean Cities program funding. These projects aim to speed the transformation of the nation's vehicle fleet, putting more than 9,000 alternative fuel, electrified and energy efficient vehicles on the road, establishing 542 refueling locations across the country and displacing approximately 38 million gallons of petroleum per year. A summary of the grants made to coalitions in the RE-AMP states includes[17]:

- **Clean Fuels Ohio's Ohio Advanced Transportation Partnership (OATP).** The project will include the purchase and conversion of 283 alternative fuel vehicles for numerous fleets including taxis, cities, schools, and delivery vehicles. In addition, 15 alternative fueling and service stations will be constructed.
- **Clean Energy Coalition's CEC Michigan Green Fleets Initiative.** The project will increase the use of natural gas, electric and hybrid electric vehicles in 13 sites throughout Michigan. A total of 271 alternative fuel vehicles and 19 alternative fueling sites will be added throughout the state.
- **City of Chicago, Department of Environment's Chicago Area Alternative Fuels Deployment Project.** The project will deploy 554 alternative fuel and hybrid electric vehicles and install 153 alternative fueling and electric vehicle charging stations throughout the Chicago region. The initiative also includes 63 electric vehicle charging stations.
- **State of Wisconsin's Wisconsin Clean Transportation Program.** The project will deploy 502 alternative fuel and advanced technology vehicles through 119 public and private fleets throughout the state. The program includes the installation of 10 alternative fuel refueling sites.
- **Metropolitan Energy Information Center's Midwest Region Alternative Fuels Project.** The project will include 27 alternative fuel stations (16 CNG, 7 B20/E85, one B20, three Electric Charging) and deploy 373 alternative fuel and advance technology vehicles (235 CNG, 58 HEV, two LPG, two EV).

# CHAPTER 3. THE IMPACT OF ELECTRIC VEHICLES AND OTHER TRANSPORTATION INITIATIVES ON GHG EMISSIONS

## Background

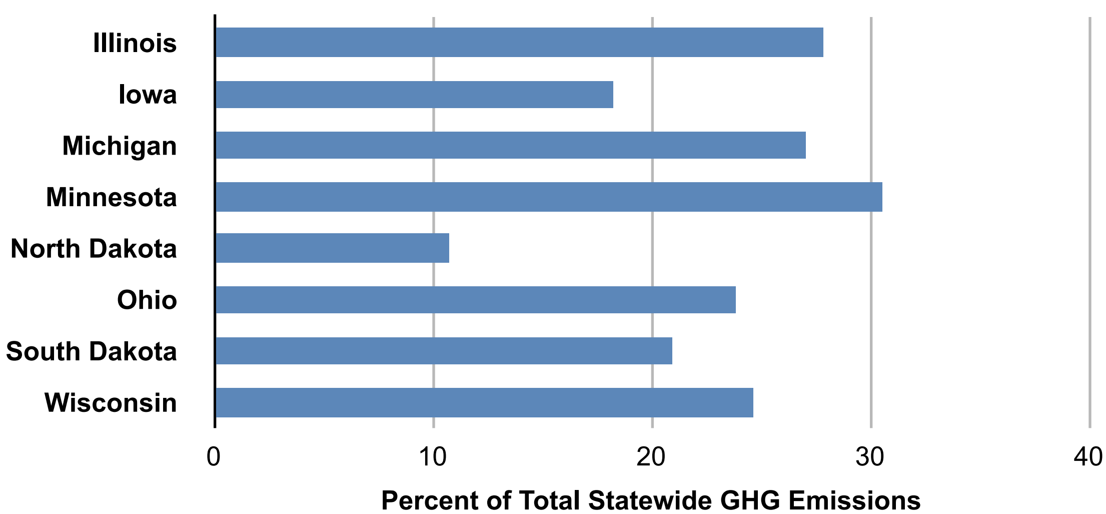
The U.S. transportation sector is responsible for nearly 1.9 billion metric tons/year, about 30 percent of our overall net GHG emissions. Transportation accounted for 47% of the net increase in total U.S. greenhouse gas emissions from 1990-2006.[18] Personal and commercial vehicles (e.g. light duty) make up about half of the estimated GHG emissions from the transportation sector. There are more than 43 million such vehicles throughout the RE-AMP states. Transportation fuel consumption by light duty vehicles is projected to decline while that of heavy trucks is expected to increase modestly over the next 20 years.

In the RE-AMP states, transportation emissions comprise about 25 percent of total emissions, ranging from a low of about 11 percent in North Dakota to a high of about 30 percent in Minnesota. As we would expect, the more rural RE-AMP states have greater transportation-related GHG emissions on a per capita basis than more urbanized states. The disparity is a reminder that each state offers its own context for designing GHG reduction strategies. For example, targeting transportation emissions sources in Minnesota may take a higher priority than in North Dakota.

There are many strategies used to reduce transportation-related greenhouse gas emissions: improving vehicle efficiency; increasing the use of low carbon fuels; reducing the number of miles driven; electrifying vehicles.

In this chapter we estimate the GHG reductions that will result from the federal government's vehicle fuel efficiency standards (CAFE) and compare that to reductions from a low carbon fuel standard, accelerated electrified vehicles, and reductions in vehicle miles traveled (VMT).

**Chart 1: GHG Emissions from Transportation Sector in 2005 by RE-AMP State**




Source: Climate Analysis Indicators Tool (CAIT US) Version 3.0. (Washington, DC: World Resources Institute, 2009).

**Table 2: Total Number Of Registered Vehicles in RE-AMP States**

| | 2007 | 2003 | 1999 | 1995 |
|---|---|---|---|---|
| **Illinois** | 9,757,004 | 9,250,014 | 9,355,260 | 8,973,009 |
| **Iowa** | 3,360,196 | 3,368,915 | 3,049,967 | 2,814,018 |
| **Michigan** | 8,191,748 | 8,540,325 | 8,289,644 | 7,674,090 |
| **Minnesota** | 4,755,753 | 4,525,140 | 4,009,717 | 3,881,829 |
| **North Dakota** | 710,537 | 694,241 | 704,412 | 694,675 |
| **Ohio** | 10,848,476 | 10,536,372 | 10,235,603 | 9,810,270 |
| **South Dakota** | 864,838 | 826,944 | 781,961 | 708,613 |
| **Wisconsin** | 5,017,895 | 4,647,150 | 4,265,772 | 3,993,328 |
| **TOTAL (RE-AMP States)** | **43,506,477** | **42,389,101** | **40,692,336** | **38,549,832** |

**Table 3: 2007 Registered Vehicles By Category in RE-AMP States**

| | Cars | Buses | Trucks | Privately Owed | Publicly Owned |
|---|---|---|---|---|---|
| **Illinois** | 5,814,178 | 18,310 | 3,924,516 | 9,667,025 | 89,979 |
| **Iowa** | 1,727,177 | 7,375 | 1,625,644 | 3,311,377 | 48,819 |
| **Michigan** | 4,972,114 | 26,290 | 3,193,344 | 8,043,143 | 148,605 |
| **Minnesota** | 2,552,023 | 18,122 | 2,185,608 | 4,701,060 | 54,693 |
| **North Dakota** | 344,258 | 2,512 | 363,767 | 695,827 | 14,710 |
| **Ohio** | 6,362,791 | 45,953 | 4,439,732 | 10,671,336 | 177,140 |
| **South Dakota** | 372,633 | 2,736 | 489,469 | 843,808 | 21,030 |
| **Wisconsin** | 2,645,181 | 14,962 | 2,357,752 | 4,945,207 | 72,688 |
| **TOTAL (RE-AMP States)** | **24,790,355** | **136,260** | **18,579,832** | **42,878,783** | **627,664** |

Source: Federal Highway Administration (FHWA), http://www.fhwa.dot.gov/

## Reducing GHG Emissions by Improving Vehicle Efficiency Standards

First enacted by Congress in 1975, Corporate Average Fuel Economy (CAFE) standards reduce energy consumption by increasing the fuel economy of cars and light trucks. Regulating CAFE standards is the responsibility of National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA).

In September 2009, the Obama Administration announced a joint proposal by NHTSA and EPA to raise the fleet-wide fuel economy of new vehicles sold in the United States to 34.1 mpg by model year 2016 (from the current 27.5 mpg)[19]. The standards, if fully implemented, would also establish the first national tailpipe carbon dioxide standard for vehicles on a fleetwide basis, 250 grams per mile, nearly 30 percent less than the emissions produced by today's average new vehicle.[20] Passenger cars will have to emit less than 224 g/mile of CO2 by 2016 (for a quick comparison, the European Union (EU) is setting new car fleet emissions targets of about 152 g/mile of CO2 by 2020.)

The new CAFE and CO2 emissions standards are expected to be finalized by April 2010. Using authority granted under the Clean Air Act, California and other states that adopt California's air quality regulations will be allowed to establish even stronger standards in the future.

**Table 4: Average Required Fuel Economy (mpg) under New CAFE Proposed Standards**[21]

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **Passenger Cars** | 33.6 | 34.4 | 35.2 | 36.4 | 38.0 |
| **Light Trucks** | 25.0 | 25.6 | 26.2 | 27.1 | 28.3 |
| **Combined** | 29.8 | 30.6 | 31.4 | 32.6 | 34.1 |

Source: NHTSA

**Table 5: Projected Fleet-Wide Emissions Compliance Levels under the Proposed Footprint-Based CO2 Standards (g/mi)**

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| **Passenger Cars** | 261 | 253 | 246 | 235 | 224 |
| **Light Trucks** | 352 | 341 | 332 | 317 | 302 |
| **Combined** | 295 | 286 | 276 | 263 | 250 |

Source: NHTSA, EPA

Since the CAFE standards only affect new vehicles, the impact of the higher standard will be felt only as the current fleet turns over. If we assume by 2020 that 30 percent of vehicle miles traveled would be compliant with new CAFE requirements of 250 g/mi (down from 400 g/mi) and also adopt a generous assumption that VMT in 2020 will be the same as 2005 across the RE-AMP states, the CAFE standard might reduce transportation sector emissions by about 7.1 percent across the region. (Note: Estimates on vehicle miles traveled combined with the level that light duty vehicles play in overall transportation sector emissions lead to the differences noted below between states of the impact of CAFE standards.)

**Table 6: Potential GHG Emissions Reductions from CAFE in RE-AMP States-2020**

| | 2005 GHG Transportation Emissions (MMtC02e) | 2020 CAFE GHG Reductions as % of 2005 Transportation GHG Emissions | 2020 CAFE GHG Reductions (MMtC02e) |
|---|---|---|---|
| **Illinois** | 78 | 6.2% | 4.8 |
| **Iowa** | 21 | 6.6% | 1.4 |
| **Michigan** | 58 | 8.1% | 4.7 |
| **Minnesota** | 37 | 6.9% | 2.6 |
| **North Dakota** | 6 | 5.3% | 0.3 |
| **Ohio** | 73 | 6.8% | 5.0 |
| **South Dakota** | 6 | 6.1% | 0.4 |
| **Wisconsin** | 31 | 8.6% | 2.7 |
| **Total (REAMP states)** | 310 | 7.1% | 21.9 |

## Reducing GHG Emissions Through A Low Carbon Fuels Standard (LCFS)

A Low Carbon Fuel Standard (LCFS) requires fuel providers to ensure that the mix of fuel they sell meets a declining standard for carbon intensity over time.


Photo credit: Pearson Fuels

The MGA Energy Security and Climate Stewardship Platform, endorsed by Midwestern governors and the Premier of Manitoba in November 2007, embraces the creation of "a uniform, regional low-carbon fuels policy – implemented at the state or provincial level as a standard, objective or incentive…".

The MGA formed a partnership with the North Central Bioeconomy Consortium to staff a multi-stakeholder working group to study low carbon fuel standards. In January 2009 the stakeholder groups recommended that state level governments adopt LCFS rules to reduce by 10 percent the carbon intensity of liquid fuels over 10 years, using 2005 as the baseline year. The LCFS would apply to providers of liquid and non-liquid ground transportation fuels. States are directed to join a Regional Coordinating Body (RCB) established to assist jurisdictions in the development, implementation and operation of LCFS. The RCB would also handle the distribution and potential trading of LCFS allowances.

Most LCFS proposals allow many pathways to meet the standard. These include:

- Increase use of biofuels with reduced CO2 emissions.
- Increase refinery efficiency.
- Use refinery feed stocks that have lower life cycle emissions.
- Purchase credits, including credits from utilities that sell electricity for EVs/PHEVs.

When fully implemented LCFS, unlike the CAFE standards, will have a fleet-wide impact rather than just on the emissions by new cars and light trucks. The LCFS will be implemented in the Midwest gradually so the full impact will not occur until after 2020 at the earliest. Prior to 2020, as the policy is ramping up, the impact on emissions would be small.

A LCFS would also have a wider impact than the CAFE standards because they will apply to more transportation subsectors. We estimate that about 85 percent of total transportation sector emission sources including liquid fuels for rail and truck transport will presumably be covered.

As noted, if one is implemented, a LCFS will also have a greater GHG reduction impact in the short term than the current CAFE because it will apply to all vehicles and not just new vehicles. However, as the vehicle fleet turns over, CAFE standards will begin to have a greater impact unless the 10 percent LCFS is increased.

**Table 7: Impacts on GHG Emissions of LCFS and CAFE Policy in the RE-AMP Region**

| | 2005 GHG Emissions Transportation (MMtCO2e) | 2020 LCFS GHG Reductions % of 2005 Transportation GHG | 2020 CAFE GHG Reductions % of 2005 Transportation GHG | 2020 LCFS and CAFE Combined Reductions % of 2005 Transportation GHG - |
|---|---|---|---|---|
| Illinois | 78 | 8.5% | 6.2% | 14.7% |
| Iowa | 21 | 8.5% | 6.6% | 15.1% |
| Michigan | 58 | 8.5% | 8.1% | 16.6% |
| Minnesota | 37 | 8.5% | 6.9% | 15.4% |
| North Dakota | 6 | 8.5% | 5.3% | 13.8% |
| Ohio | 73 | 8.5% | 6.8% | 15.3% |
| South Dakota | 6 | 8.5% | 6.1% | 14.6% |
| Wisconsin | 31 | 8.5% | 8.6% | 17.1% |
| TOTAL (REAMP States) | 310 | 8.5% | 7.1% | 15.6% |

We can see that based on the current CAFE and LCFS standards, by 2020 the LCFS potentially will result in a slightly greater GHG emissions reduction in the transportation sector. There is a significant caveat to this discussion, however. No RE-AMP state has yet enacted an LCFS. Therefore an LCFS will go into effect in RE-AMP states several years after it does in California and will not likely be enacted in all RE-AMP states. Thus while the estimates regarding CAFE can be considered realistic, those regarding LCFS must be considered theoretical.

The last column in the table above shows the combined impact on transportation GHG emissions of the LCFS and the CAFE in 2020 compared to emissions in 2005.

## Reducing GHG Emissions by Reducing Vehicle Miles Traveled

The last major GHG reduction strategy we'll look at is a reduction in the number of vehicle miles traveled (VMT). Simply put, getting people to drive less, to use car sharing services or transit, and/or get to where they want to go using non-motorized transport. As the charts below indicate, vehicle miles traveled on a per capita basis vary significantly between the RE-AMP states but growth is relatively flat or slow over the last 10 years. Not surprising, residents in rural states tend to drive more than residents in states with larger urban centers (eg. Chicago).

**Chart 2: Annual Vehicle Miles Traveled (million miles) - RE-AMP**

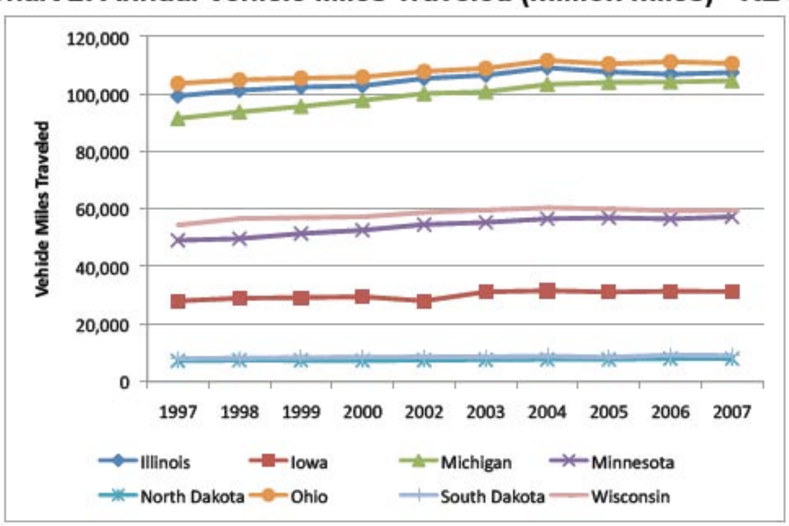
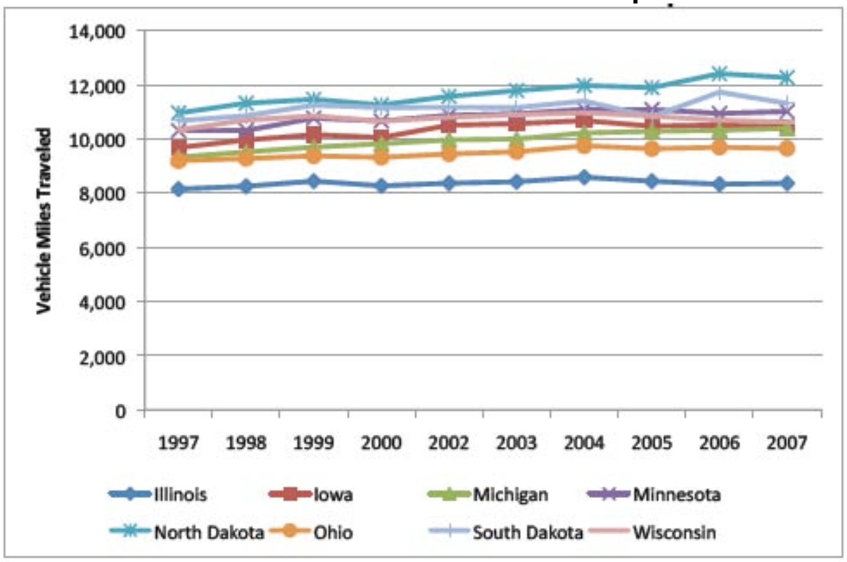


**Chart 3: Annual Vehicle Miles Traveled Per Capita - RE-AMP**




Source: United States Research and Innovative Technology Administration Bureau of Transportation Statistics

In general, reducing VMT as a GHG reduction strategy is seen as a longer-term approach but efforts must start now. There will be little GHG reductions by 2020 from VMT strategies but there will be a growing benefit by 2030, assuming that states, counties and cities are willing to enact land use policies that increase density or invest heavily in mass transit systems. More and better transit systems could play a larger role particularly in urban centers in reducing emissions but the time needed to build-out the infrastructure will push any substantive GHG savings beyond the 2020 timeframe. Efforts to adopt land use strategies that result in more compact community designs lend themselves to reduced driving as well as being attractive areas for EVs with shorter all-electric ranges.

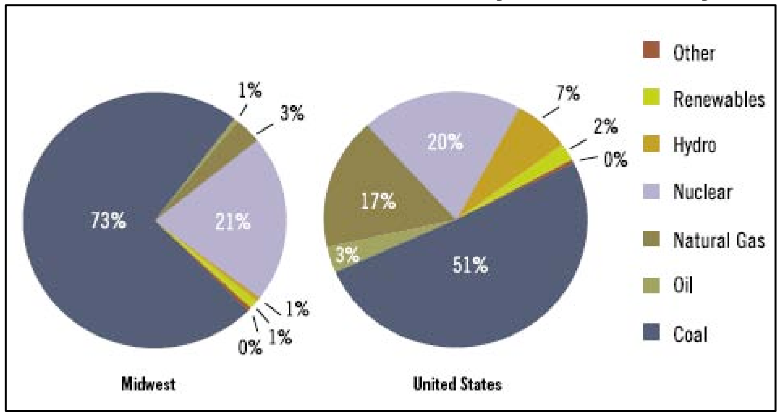
In a recent study[22] from the Urban Land Institute (ULI), *Moving Cooler*, it notes, "The analysis demonstrates that over time, changes in land use and investments in improved transit and transportation options can improve the efficiency and quality of travel, reduce trip lengths, and reduce GHG emissions. The notable reductions for these strategies are realized in the outer decades of this analysis, in 2030 and beyond." ULI concludes that by 2050, actions leading to VMT reductions could lead to 9-15 percent reductions in transportation sector GHG emissions. Despite the longer term focus, actions need to begin today and the longer the delay, the longer it will be to realize the full potential of GHG reductions from VMT strategies.

One particular wildcard in discussions of reducing VMT is the future of gasoline prices and policies to raise the cost of driving (e.g. pay as you drive insurance). The quick rise of gas prices that took place in the years prior to the recent economic collapse seemed to be having an influence on consumer behavior and statistics were showing increased transit use and VMT started trending down. Gasoline prices were averaging over $4.00 per gallon in many locations during that time while today they are about $2.60. If gas prices were to rise again, the interest in transit might grow and people might begin driving less.

## Reducing GHG Emissions By Electrifying Vehicles

The impact of electrified vehicles on GHG emissions depends on at least two factors; the GHG impact of individual vehicles and the speed at which EVs enter and replace the current fleet of vehicles.

**Chart 4: Midwest, and U.S. Electricity Generation by Source**




Source: World Resources Institute, EIA

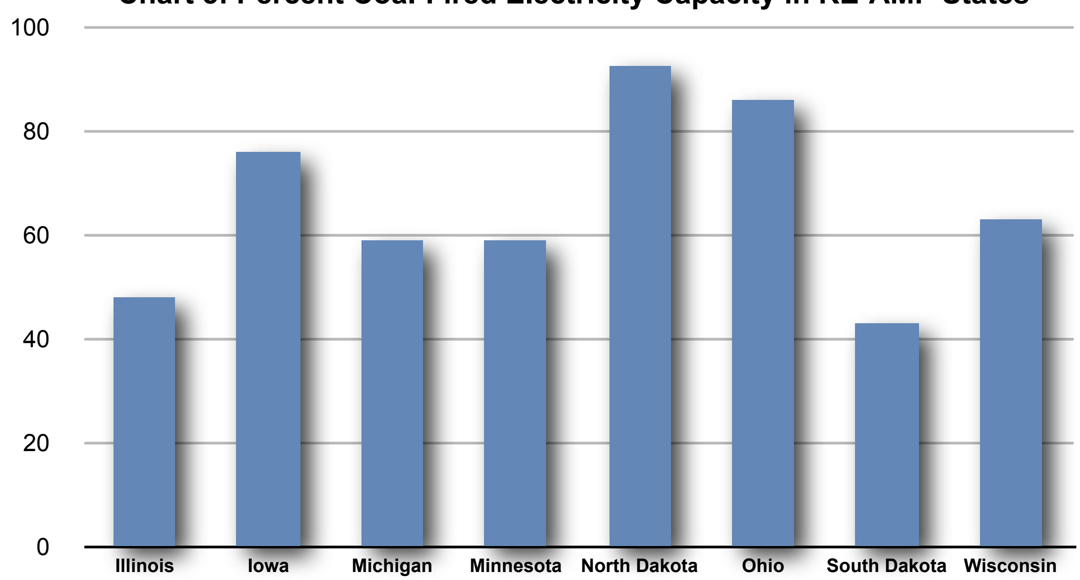
With regard to the GHG impact on individual vehicles, we surveyed many studies. Sherry Boschert of the San Francisco Electric Vehicle Association and author of the 2006 book, *Plug-in Hybrids: The Cars that will Recharge America*, has amassed the most extensive tracking of these studies that we found. The DOE's Alternative Fuels & Advance Vehicles Data Center also tracks a range of EV studies[23].

Boschert's survey of 49 studies found that plug-in vehicles released 24 percent to 65 percent less carbon than hybrids, when the electricity sources they used was taken into account.[24] That is a very wide range, to be sure, but all studies estimate a significant reduction.

The Midwest region has a much more carbon-intensive electricity sector than the nation. The region relies on coal to generate 73 percent of its electricity compared to 51 percent for the nation as a whole.

The proportion of coal-fired electricity among RE-AMP states varies widely[25]. South Dakota and Illinois have the lowest amount of coal-fired capacity 43 percent and 48 percent respectively, while North Dakota and Ohio have the greatest, 93 percent and 86 percent, respectively.

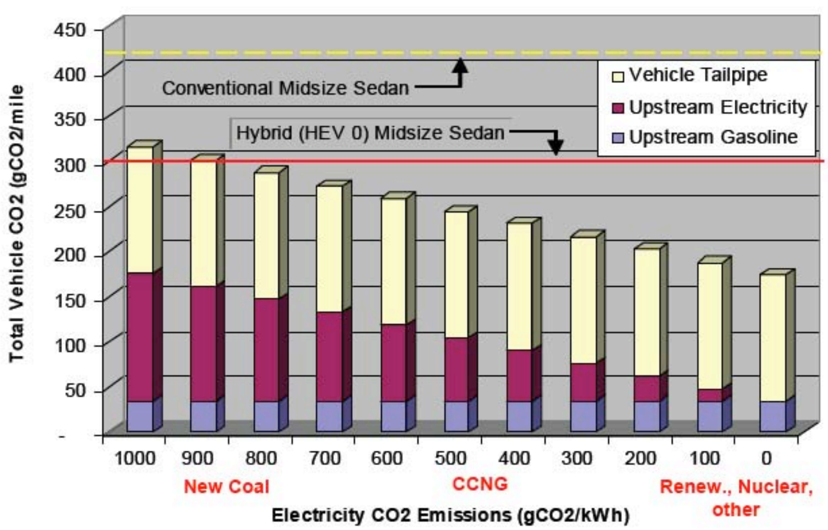
**Chart 5: Percent Coal-Fired Electricity Capacity in RE-AMP States**



A number of the impact studies have scenarios in which EVs charged their batteries solely with coal-fired electricity. Under the 100% coal scenarios, studies have concluded that EVs would reduce CO2 by 0%-59% compared with ICEs[26]. The efficiency of electric motors compared to the efficiency of ICE vehicles is the primary reason that even EVs fueled entirely by coal can result in GHG reductions.

The chart below from Southern California Edison's electric transportation team shows emissions reductions comparison of a PHEV with a 20-mile all-electric range (PHEV20) to an ICE and HEV across a range of electricity sources from various types of coal, combined-cycle natural gas (CCNG) and renewables. The data assumes half the miles traveled are on gasoline and the range of CO2 emissions is due to differences in fuel characteristics (e.g. different types of coal) and power plant efficiencies. They show that for any electricity source, a PHEV20 has lower emissions than a conventional vehicle. In only the highest coal scenario, a PHEV20 has slightly more emissions than an HEV. For most states, PHEVs will have lower emissions than conventional vehicles and HEVs.

**Chart 6: PHEV20 CO2 Emissions Breakdown**




Source: Chart from Ed Kjaer, Director of Electric Transportation, Southern California Edison

State level studies of the GHG impact of electrified vehicles have been conducted or are in process in several RE-AMP states. One by the Minnesota Pollution Control Agency was done in 2007[27]. Michigan is undertaking a $5 million, 2-year study of broad impacts of EVs[28]. Argonne National Laboratory has done a preliminary impact study of EVs in Illinois[29] and is expected to release data from a more detailed study in late 2009. The Center for Automotive Research[30] at Ohio State University is modeling potential emissions impacts of EVs on the grid in Ohio with some results coming out as early as December 2009.

The Minnesota study assumed an electricity mix that would be achieved after a 25 percent renewable energy mandate was achieved. It found that replacing a traditional ICE vehicle with an HEV or a PHEV will result in substantial CO2 reductions based on a 2020 scenario with a mix of 40% renewable/nuclear (zero carbon emissions) and 60% coal electricity. The report found that a "conventional passenger vehicle in 2020 releases 5.4 tons of carbon dioxide annually; a hybrid vehicle (HEV) releases 3.2 tons annually; a PHEV20 generates 3.5 tons per year; and a PHEV60 is responsible for 3.6 tons per year."

The fact that plug in vehicles might have higher emissions when compared to efficient HEVs reinforces the need for continued efforts to increase renewable energy supplies and decrease coal generation if plug-in vehicles are going to realize their full potential.

The Minnesota study (and other studies) found that other pollutants are also reduced by shifting to electricity, a notable exception is sulfur dioxide (see table below). However, as the Minnesota study notes, Clean Air Interstate Rules (CAIR) limit SO2, NOx and mercury emissions from the electric power sector. Thus power plants, "except for a few caveats, will not be allowed to increase on an overall, net basis due to new sources of electric demand." EVs will reduce emissions of small particulates ($PM_{2.5}$) and the remaining emissions themselves will be better from a health perspective since they will move from street level (tailpipes) to smokestacks (power plants).

**Table 8: Air Emissions as a Percentage of Emissions From Conventional Vehicles (60% coal and 40% wind/nuclear power in Minnesota)**

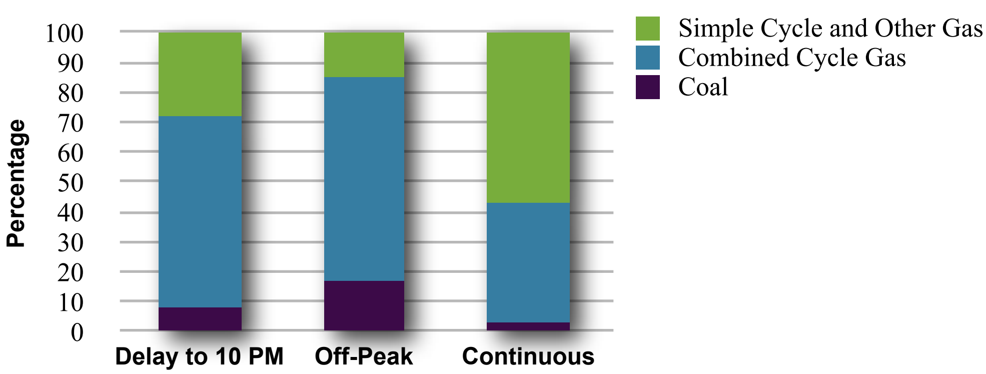
| | Hybrid Electric Vehicle | Plug-In Hybrid Electric (20-mile electric range) | Plug-In Hybrid Electric (60-mile electric range) |
|---|---|---|---|
| CO2 | 59% | 65% | 66% |
| VOC | 69% | 42% | 18% |
| CO | 100% | 60% | 25% |
| NOx | 80% | 62% | 48% |
| $PM_{2.5}$ | 76% | 71% | 66% |
| SO2 | 63% | 170% | 265% |

Source: Minnesota Pollution Control Agency

The impacts of EVs become less clear when we dig down into the micro level details. Most utilities want EVs to be charged at night when the potential impacts to the grid are low and their most profitable plants are operating but nighttime charging is not always going to be the best time of day if what you want are maximum GHG reductions.

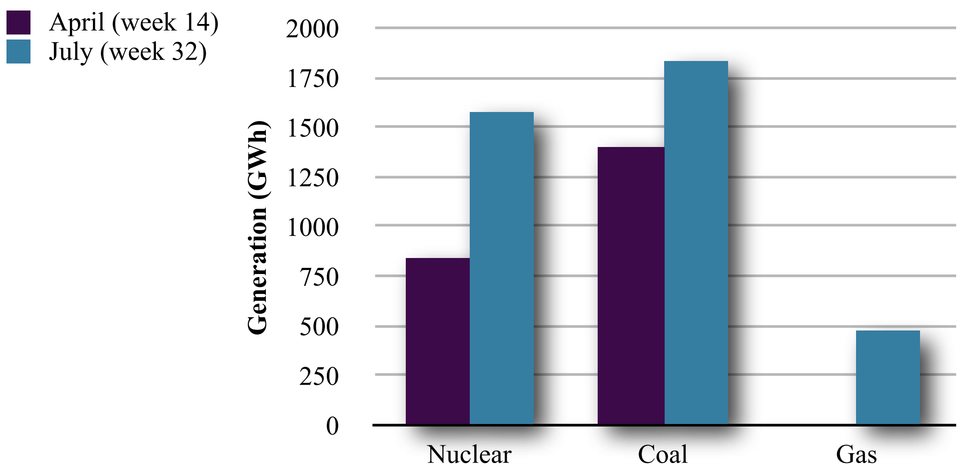
As the chart below from a study in Xcel Energy's Colorado service territory shows, charging EVs at off peak times will use more coal (e.g. higher GHG emissions) than charging at other times during the day. For example, the data in the chart would indicate that EVs controlled by the utility to only charge at off-peak times would generate more GHG emissions than vehicles that were allowed to charge during the daytime or earlier in the evening. Each utility will have a specific emissions profile based on the time of day and time of year and we'd recommend some further investigation within the RE-AMP region into the issue of what power plants will be operating during the likeliest nighttime charging periods so that each state's advocates will have a more accurate picture of what electricity sources will be fueling EVs.

**Chart 7: Sources Used for Charging 500,000 PHEVs in Xcel Energy's Colorado Territory**[31]



For example, Argonne National Lab's study of PHEV impacts in Illinois found that the change in generation mix during certain times of the year translates into different amounts of emissions from EV charging. For example, as shown in the figure below[32], in April vehicles would be supplied by about 65% coal and 35% nuclear and in July the breakdown would be 47% coal, 41% nuclear and 12% natural gas.

**Chart 8: Electricity Sources in Illinois – April and July**




The Argonne study also assumed that due to EV characteristics (e.g. high initial costs favor wealthier buyers) most of the sales would be to consumers in the Chicago area leading to a clustering of vehicles that at significant levels could influence electricity prices in and around Chicago. The scope of Argonne's next study will include more detailed factors including: incorporating the role of wind power and price responsive charging; addressing vehicle-to-grid (V2G) options; connecting with a detailed GIS-based vehicle adoption model; expanding the geographical scope of the study; including transmission and improving the capacity expansion analysis.

To add some real-world experience to this section, Bill Moore, editor of the on-line publication *EV World*, recently compared the GHG emissions from a Prius to those from a converted PHEV Prius[33]. He lives in Nebraska which generates nearly 58% of its electricity from coal, similar to that of Minnesota and Michigan. Another 27% comes from natural gas and oil and another 15 percent comes from nuclear.

Moore calculated that in the stock hybrid mode his Prius, which gets 45 mpg, generates about 217 grams/mi. In PHEV mode his car generates about 221 grams/mi, a figure that will improve as more renewable energy moves into the Nebraska grid.

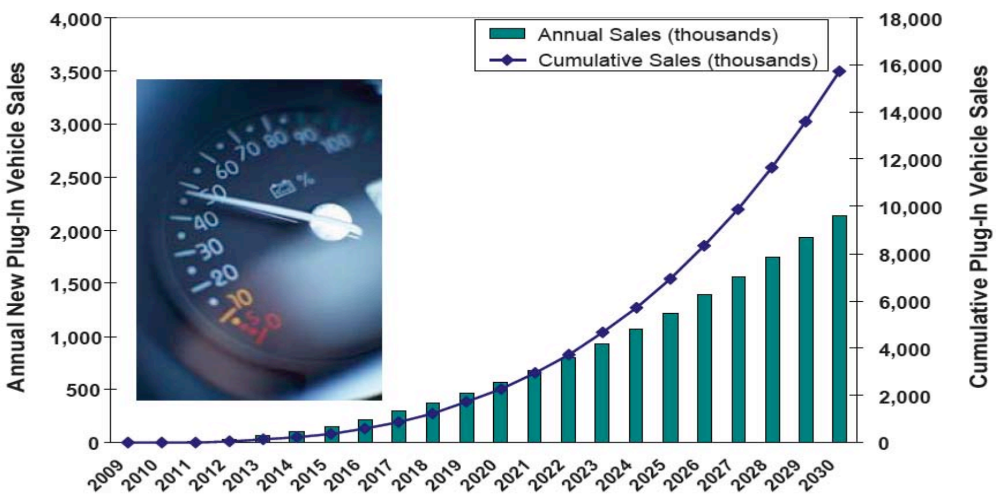
## How Fast Will EVs Displace Other Vehicles?

How quickly will EVs be added to our fleet? With the rapidly changing developments in public policy, energy storage technologies and EV manufacturing, it is difficult to make any precise estimate. President Obama has called for 1 million PHEVs on the road in 2015 (less than a half percent of the nations vehicles). The manufacturers we talked to indicated that President Obama's goal is aggressive but attainable.

We can use current statements on EV production by car companies as a basis for projections. GM expects 2010 production levels of the Chevy Volt to be in the range of 2,000 to 3,000. Within two years, GM reportedly expects to ramp that up to 60,000 per year. If that were to occur, and sales were 60,000 a year from 2012 to 2015 then there would be about 200,000 Volts alone on the road by 2015. Clearly that depends on demand but it indicates the level of capacity GM intends to build in the short term. Nissan has yet to announce initial production plans for its EV, the Leaf. Nissan's manufacturing plant and battery assembly plant going into Tennessee has been touted as being capable if needed to turn out batteries for 150,000 vehicles/yr.[34]

A 2008 study by Pacific Northwest National Laboratory concluded that by 2020, PHEVs could represent between 6 percent and 15 percent of the annual vehicle market. Assuming a stronger economy with 15 million vehicles sold each year, it would translate into annual EV sales of between 900,000 and 2.25 million by 2020.[35] The Electric Power Research Institute's EV market penetration curve[36] is below.

**Chart 9: Projected Sales of EVs in the U.S. – 2009 - 2030**




Source: graphic and data from EPRI

Very recently, a group of senior executives from the automotive, EV charging, energy storage and investment sectors known as the Electrification Coalition released their *Electrification Roadmap*[37] outlining steps needed to reach 14 million EVs on the road by 2020 and have EVs comprise 90 percent of all light duty vehicle sales by 2030. The timeline is extremely aggressive and by their own estimation would require a perfect storm of government policy, consumer acceptance, dramatic cost reductions and manufacturing expansion combining to drive rapid EV market penetration.

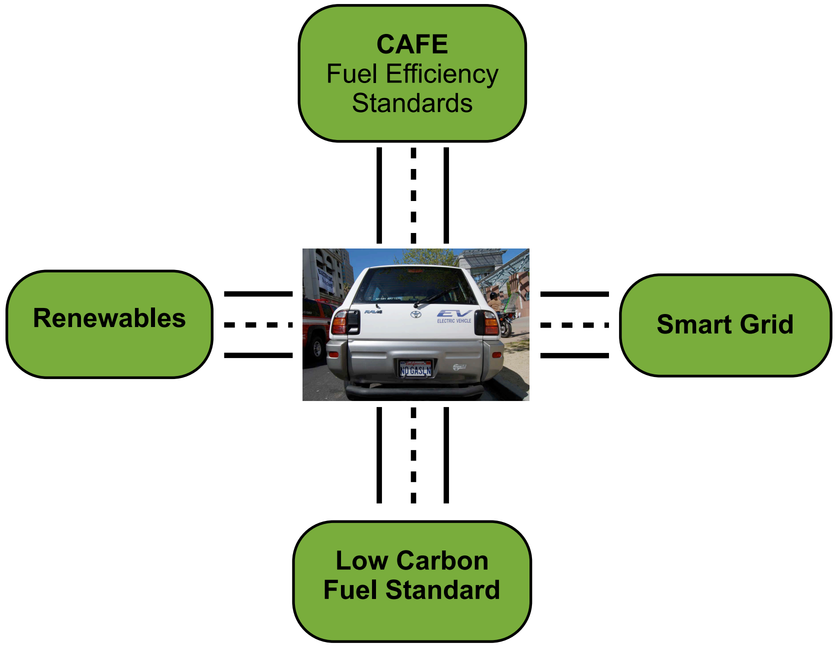
The fact that the Electrification Coalition contains a diverse set of major players and even some direct competitors bodes well for their plan receiving attention and consideration at the very highest levels of government.

Most estimates by outsiders, political leaders and the industry cluster around a projection of 1 million EVs on the road in the 2015-2017 timeframe, with a rapid expansion to 3 million nationwide by 2020 and 16 million by 2030.

If we use the 3 million figure and assume one-fifth in 2020 (600,000 vehicles) are in place within the RE-AMP states, and further assume that each EV results in GHG emissions 40 percent less than with a comparable vehicle, there would be a reduction in overall transportation sector emissions of about one-quarter of 1 percent. Certainly this is a small amount in the near term but that could grow rapidly as more EVs become available over time and as more renewable electricity comes into the grid.

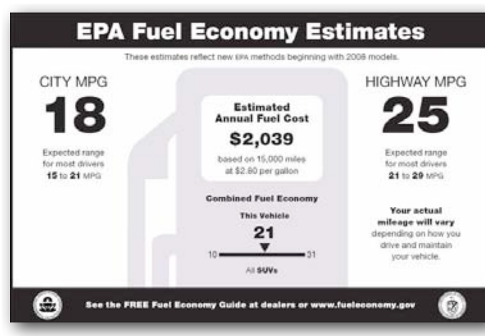
## The Relationship of Electric Vehicles to CAFE Standards and Low Carbon Fuel Standards

**Many Roads Lead To and From Electric Vehicles**




As we have seen, if we examine the impact of EVs on GHG emissions on a stand alone basis, we arrive at the conclusion that they should be, at best, a minor strategy. However, this ignores the fact that the electrification of the transportation system can be the hub of a multi-pronged strategy. As we shall see, electrified vehicles may play an important role in achieving mandated fuel efficiency standards and lowering the carbon density of transportation fuels. They may also play an increasingly key role in maximizing the use of renewable energy and smart grids. Thus the encouragement of electrified vehicles can be viewed as a key foundation in the creation of a sustainable, low carbon economy.

### EVs and CAFE




The federal government has given car companies a significant incentive to introduce EVs by awarding EVs a very high fuel efficiency rating. It has done this in part by multiplying the base efficiency factor by a petroleum avoidance factor. Only about 2 percent of our electricity is generated from oil. The EPA takes this into account by multiplying the base efficiency of an EV (in miles per gallon equivalent) by 6.6667. This is the reason GM and Nissan have announced that forthcoming EVs (Chevy Volt and Nissan Leaf) will receive, respectively, 230 mpg and 367 mpg fuel economy ratings by the EPA (see calculation in endnote)[38].

These high MPG ratings for EVs are important since the proposed CAFE rules allow manufacturers to earn credits by over-complying with the standard in a given model year, and apply those credits to achieve compliance in any of the three model years before or five model years after the year in which they are earned. They could also transfer the credits from the manufacturer's car fleet to the truck fleet or vice versa or trade (i.e., sell) them to another manufacturer. While it can quickly become complicated, a simplified calculation shows that a manufacturer selling 9 percent of it's sedans as EVs could potentially raise it's fleetwide passenger vehicles MPG by 2.5 miles per gallon. This would either allow for the manufacturer to generate CAFE credits or allow it to have some categories of vehicles that don't quite meet their particular CAFE requirements. Thus even modest sales of EVs could be very important for U.S. and foreign car companies to achieve the mandated fuel efficiency levels.

Issues related to how credits can be used are still being debated at this writing. It is likely that the use of credits will be somewhat limited since Congress has demanded that CAFE standards actually lead to reduced oil consumption and allowing too much use of credits could undermine that intent. NHTSA's proposed rules do not allow manufacturers to miss their annual MPG targets by a wide margin and then make them up by using credits. Manufacturers must meet a "minimum" standard (around 92 percent of the applicable CAFE standard) before any credits can be applied or they must pay fines. NHSTA is proposing that credits for exceeding fleetwide CAFE standards can be used to increase MPG by between 1.0 and 2.0 mpg in any given category of vehicles.

In addition to the MPG credits that EVs could earn under the NHSTA's proposed CAFE rules issued in September 2009, EPA also proposed to award additional credit for vehicle CO2 reductions to encourage the early commercialization of advanced vehicle powertrains, including EVs, PHEVs, and fuel cell vehicles. This comes as part of the CO2 emissions reduction component of the new CAFE standards. EPA requested comments on the idea (due November 27, 2009) that these advanced technology credits would take the form of a multiplier that would be applied to the number of vehicles sold such that they would count as more than one vehicle in the manufacturer's fleet average.[39]

EPA proposed to use the following definitions for vehicles eligible for advanced technology credits.

1. An EV must be recharged from a source off the vehicle.
2. In the case of PHEVs, the vehicle must have an electric-only range of no less than 10 miles.

These advanced technology vehicles would then count more heavily when calculating fleet average CO2 levels. EPA proposes to use a multiplier in the range of 1.2 to 2.0 for all EVs, PHEVs, and fuel cell vehicles produced from 2012 through 2016 with the multiplier eliminated after that. In addition, EPA is requesting comment on whether or not it would be appropriate to differentiate between all electric EVs and PHEVs for advanced technology credits. Under such an approach, PHEVs could be provided a lesser multiplier compare to all-electric EVs. Also, the PHEV multiplier could be prorated based on the equivalent electric range (i.e., the extent to which the PHEV operates on average as an EV) of the vehicle in order to incentivize battery technology development. This approach would give more credits to "stronger" PHEV technology.

While acknowledging that electricity production for EVs will likely generate CO2 emissions, for simplicity sake through at least the 2016 timeframe EPA is proposing that EVs be determined to have CO2 emissions of zero grams/mile and PHEVs have zero grams/mile for the portion of driving when they are operating as electric vehicles. In the proposed rules, EPA/NHTSA offer the following example of how advanced vehicle credits would work:

> With some simplifying assumptions, assume that 25,000 of Manufacturer A's fleet are now plug-in hybrid electric vehicles with CO2 emissions of 100 g/mi, and the remaining 475,000 are conventional technology vehicles with average CO2 emissions of 290 grams/mile. This gives a fleetwide average of 281 g/mi. If we assume that there is an advanced technology multiplier of 2.0 in place for PHEVs, then Manufacturer A's fleet average would be calculated to be 272 g/mi instead of 281 g/mi.

At this writing, advanced vehicle credits are proving to be controversial. Some advocates are stepping up to oppose such multipliers. ILSR would likely take the position of opposing such a scheme since there are plenty of government incentives in place to encourage EV purchasing as well as manufacturing and the CAFE rule's emission requirements would be clearer without them.

## EV Role in LCFS

A low carbon fuel standard also all-but-mandates a significant number of EVs. Since no RE-AMP states have yet enacted a LCFS, we must look to California as to how one might look in the Midwest. The California LCFS[40] is being overseen by the California Air Resources Board (CARB) and will require a 10 percent reduction in the overall carbon intensity of transportation fuels (gasoline and diesel) in the state by 2020. The reductions ramp up slowly and bigger reductions are required in the later years.

**Table 9: Proposed LCFS Timeline and Targets - California**

| Year | Carbon Intensity for Gasoline & Fuels Substituting for Gasoline (g/MJ) | Gasoline & Fuels Substituting for Gasoline (% reduction) | Carbon Intensity for Diesel and Fuels Substituting for Diesel (g/MJ) | Diesel and Fuels Substituting for Diesel (% reduction) |
|---|---|---|---|---|
| 2010 | Reporting | Only | | |
| 2011 | 95.61 | 0.25% | 94.47 | 0.25% |
| 2012 | 95.37 | 0.50% | 94.24 | 0.50% |
| 2013 | 94.89 | 1.00% | 93.76 | 1.00% |
| 2014 | 94.41 | 1.50% | 93.29 | 1.50% |
| 2015 | 93.45 | 2.50% | 92.34 | 2.50% |
| 2016 | 92.50 | 3.50% | 91.40 | 3.50% |
| 2017 | 91.06 | 5.00% | 89.97 | 5.00% |
| 2018 | 89.62 | 6.50% | 88.55 | 6.50% |
| 2019 | 88.18 | 8.00% | 87.13 | 8.00% |
| 2020 and later | 86.27 | 10.00% | 85.24 | 10.00% |

The table below reveals that the LCFS could become a key policy to promote EVs. This table shows some of the proposed fuel pathways[41] to meet the LCFS, with the grams per mile that each pathway would achieve. What we see is that a 10 percent ethanol blend, even with the most GHG-friendly production process for ethanol, would not achieve the overall 10 percent reduction in carbon intensity. To achieve this would require that large numbers of flexible fueled vehicles using E-85, 85 percent ethanol be on the road. That would require California to mandate the production of FFV vehicles, which is possible, but as with EVs, would only gradually penetrate the overall fleet. But it is hard to imagine California mandating statewide E-85 pumps and investing heavily in elaborating that infrastructure.

The only other pathway that's been approved so far that could achieve the required 10 percent reduction in carbon intensity is EVs. The reason this can succeed is in part because of the low carbon intensity of EVs but in larger part because electricity can displace a much greater quantity of gasoline, given the widespread availability of charging outlets and the fact that an electrified vehicle, once sold, has the capability of being powered largely or entirely by electricity.

Thus EVs look to play a starring role in meeting the LCFS, at least in California. NRDC's early analysis[42] of scenarios for meeting the California LCFS indicated that up to 4.1 million EVs might end up being used to meet the standard by 2020. That is likely on the very high side but theoretically possible.

**Table 10: Examples of Fuel Pathways Impacts in Meeting LCFS Targets - California**

| Fuel Pathway | Carbon Content - gCO2e/MJ | % change from standard baseline of 95.86 gCO2e/MJ | Meets LCFS until Year |
|---|---|---|---|
| CARBOB with 10% Midwest average ethanol | 96.21 | 0.37% | NA |
| CARBOB with 10% Midwest ethanol; Dry Mill, Dry DGS, NG | 96.11 | 0.26% | NA |
| CARBOB with 10% Midwest ethanol; Dry Mill; Wet DGS; 80% NG; 20% Biomass | 94.95 | -0.95% | 2012 |
| CARBOB with 10% California Ethanol: Dry Mill; Wet DGS; NG | 94.34 | -1.58% | 2014 |
| CARBOB with 10% California Ethanol; Dry Mill; Wet DGS; 80% NG; 20% Biomass | 94.02 | -1.92% | 2014 |
| CARBOB with 85% Midwest ethanol; Dry Mill; Wet DGS; 80% NG; 20% Biomass | 88.16 | -8.03% | 2019 |
| CARBOB with 85% California Ethanol; Dry Mill; Wet DGS; 80% NG; 20% Biomass | 80.20 | -16.33% | 2020 |
| CARBOB with 10% Brazilian Sugarcane Ethanol using average production processes | 93.61 | -2.34% | 2014 |
| 50% Electricity California Avg. and CARBOB with 10% California Ethanol: Dry Mill; Wet DGS; NG | 67.10 | -30.00% | 2020 |
| 100% Electricity California Avg. | 41.37 | -56.84% | 2020 |

Note: The table above doesn't have all of the proposed pathways included, and some like cellulosic ethanol are still under review in California. CARBOB refers to the typical reformulated gasoline used in California for oxygenate blending. Other abbreviations in the table include: DGS (Distillers Grain With Solubles) and NG (Natural Gas).

In the Midwest, especially those states that have significant ethanol production it is likely that a FFV mandate and expansion of E-85 fueling pumps could also become an important part of any low carbon fuel standard passed. Moreover, with a higher percentage of coal, the carbon intensity reduction for EVs in the midwest would be comparatively lower. Nevertheless, there would still be an advantage to pursuing an electrified vehicle approach to satisfy a midwest LCFS.

## EVs and Renewable Energy

Photo credit: Iberdrola Renewables Inc.

On an individual vehicle level, EVs will raise electricity consumption by households and depending on current usage this could represent a large increase of something more modest. A PHEV40 will use about 2,500 kWhs per year, about the same as a few flat screen televisions might use on an annual basis.

Unlike a flat screen television, an EV is an energy storage device capable of storing the output from any source of electricity generation. For clean energy advocates, the increased electrification of vehicles represents a key opportunity for storing energy from renewable energy expansion. For example, in some states wind energy is being generated at night when electricity use is low and some of that wind energy is not being consumed. Expansion of EVs will add nighttime electric load and will allow that electricity to be stored in the EV's batteries and used later as needed.

On a dispersed basis, electric vehicles will encourage trend setters to install rooftop solar arrays that can fuel their cars. On a more collective basis, electric vehicles will provide geographically dispersed, large-scale energy storage network that could allow for a greater penetration of variable renewable energy resources on the electricity network.

An expansion of EVs over the longer term could require a fairly substantial amount of new renewable energy development. As the table below shows, about 500 utility-scale wind turbines can supply enough electricity for 1 million EVs. While 500 turbines could easily be integrated into the windy Midwest, the RE-AMP region has about 25 million registered passenger vehicles.

**Table 11: Wind Energy Requirements for Electric Vehicle Expansion**

| | |
|---|---|
| **Wind Energy Capacity (MW)** | 1,150 |
| **kWh Produced Per Year (30% capacity factor)** | 3,022,200,000 |
| **EV Miles Traveled Per kWh** | 4 |
| **Total EV Miles/yr From Wind Energy** | 12,088,800,000 |
| **Average Miles Driven Per Year Per Vehicle** | 12,000 |
| **Total Number of EVs Possible** | 1,007,400 |

The benefits of pairing EVs with renewable energy was demonstrated in a 2006 study by Willett Kempton of the University of Delaware and Cliff Murley of the Sacramento Municipal Utility District (SMUD) that examined the impact of extensive use of EVs within SMUD's jurisdiction.[43] SMUD is the 5th largest public utility in the U.S. with 570,000 customers. It examined the use of EVs to provide ancillary services (e.g. reserves, voltage regulation) needed for minute-by-minute and hourly fluctuations in the grid. They conducted two examinations. One was for a modest role for electric vehicles for short term regulation to match wind fluctuations and optimum use of gas fired generators. The other was a more aggressive scenario in which EVs are used to store summer nights' wind energy to serve the next day's peak load. They assumed that 50 percent of the households have EVs with 30 kWhs of storage and the capacity to interact with the grid. The study concluded that the EVs enable a "much larger penetration of intermittent renewables."

### A Word About EVs and Photovoltaics (PV)

Fueling your vehicle with electricity from the sun is an ideal scenario for making an EV as green as it can be. EVs and solar power are an interesting pairing and photovoltaic (PV) charging stations are sprouting up around the country including in some RE-AMP states such as Elkhorn, IA, and Chicago, IL. (photo by SunPods)

As the data below shows, the economics of PV systems need to improve dramatically if they are to be widely accessible to homeowners for EV charging. Currently, using solar power for charging an EV can only be considered remotely competitive if they are displacing on-peak charging rates and receiving incentives for system installation. For example, some utilities have EV charging rates approaching 29 cents/kWh for daytime charging. The cost of traveling 10,000 miles on electricity at 29 cents/kWh (assuming 4 miles/kWh) would be similar to traveling that same distance with $2.50 gasoline (assuming fuel efficiency of 35 mpg) - about $725/yr.

As the table below indicates, even at 29 cents/kWh a solar system on a rooftop (including 30% federal tax credit) for charging a vehicle would take nearly a dozen years of electricity generation to recover the initial cost of the system.

**Table 12: Economics of Solar Power for Charging an EV** (10,000 miles of travel)

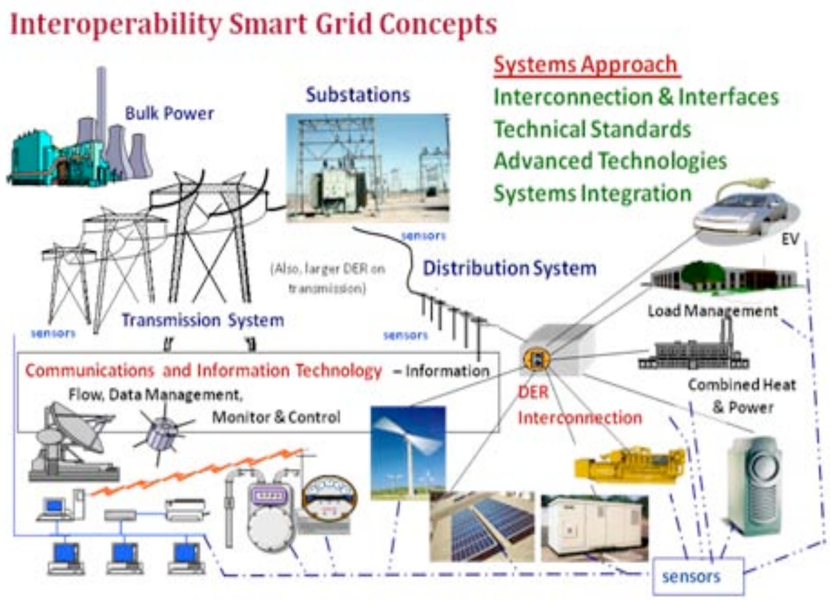
| EV Electricity Requirements (kWhs/yr) | PV System Required (kW) | Total PV System Cost (with incentives) | Value of Electricity Generated @ 29¢/kWh | Simple Payback (years) |
|---|---|---|---|---|
| 2,500 | 1.50 | $8,400 | $725 | 11.6 |

Since many utilities will be adopting low off-peak EV charging rates in an effort to drive consumers to charge their EVs at times that won't burden the electric grid, the economics of solar power will have to improve dramatically before many consumers will choose to install PV specifically for EV charging systems. Another problem is that households are most likely not going to be charging their EVs during the middle of the day when solar power is most plentiful. That means that PV charging of EVs would be more relevant at locations such as commuter parking lots, shopping centers or workplaces than at people's homes. The current 12-year payback period is probably still 2-3 times longer than businesses would find acceptable, although some might be willing to invest as a way to enhance their "green" credentials.

## EVs and Smart Grids

EVs have a symbiotic relationship to smart grids. Smart grids allow EVs to be integrated with the grid system in an optimized manner, while EVs allow smart grids to maximize the use of the existing distribution grid and to create tariffs that maximize energy efficiency.

A smart grid employs real-time, two-way digital information and communication technologies that will allow consumers to better manage and control their energy use and costs, allow utilities to better manage and maintain their existing transmission and distribution systems, and allow future two-way energy technologies like energy storage and electric vehicles to be fully integrated with the grid. EV and their link to smart grid applications are often talked about as Vehicle to Grid (V2G) technology.




Source: Graphic from IEEE

As part of the American Recovery and Reinvestment Act, DOE received applications in August 2009 for $3.9 billion in grants to support the development and demonstration of smart grid technologies. $3.3 billion is aimed at the projects to enable smart grid functionality on the nation's electrical grid as soon as possible. The cost-shared grants will support the manufacturing, purchasing, and installation of existing smart grid technologies that can be deployed on a commercial scale, with a maximum award of $200 million. About $615 million is available to identify and develop new and more effective smart grid technologies. About $3.4 billion in awards were announced by DOE in October 2009. Some $220 million will be going to projects in seven RE-AMP states.[44]

Around the world, governments and standards bodies at all levels are considering or adopting various foundational elements of the smart grid[45]:

- The European Commission has created an initiative called the European Technology Platforms (ETPs) for creating the electricity networks of the future.
- China has announced an aggressive framework for smart grid deployment and is supporting it with billions of dollars.
- The International Electrotechnical Commission (IEC) is spearheading a global initiative to support the new "smart" electric power grids around the world with a comprehensive framework of common technical standards.
- The Institute of Electrical and Electronics Engineers (IEEE) is developing a Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads called IEEE P2030.
- In the United States, the National Institute of Standards and Technology (NIST) is leading the effort for developing a framework of Smart Grid standards for device and system interoperability.

A directive in the Energy Independence and Security Act (EISA) of 2007 gives NIST "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems…" In September

2009, NIST released its 1.0 draft version of its Framework and Roadmap for Smart Grid Interoperability Standards[46]. The process involved more than 1,500 interested stakeholders.

The NIST roadmap highlights 14 critical smart grid standards that are on a fast track to be addressed by the end of 2010 including: electric storage interconnection guidelines (mid-2010) and interoperability standards to support plug-in electric vehicles (December 2010).

IEEE is also undertaking smart grid standards development[47] per a directive in the Energy Independence and Security Act (EISA) of 2007.

IEEE is working or has worked on other standards that are related to EVs and smart grid applications such as IEEE 1547. This is a standard originally approved in 2003 related to the technical criteria and requirements for interconnection of distributed generation (under 10 MW) into the electric grid and allows for bi-directional flow of power between the DG and utility.

## Conclusion on Transportation Emissions and GHG Reduction Strategies

Comparing the various transportation-related GHG reduction strategies – CAFE, LCFS, increased EVs, and reduced VMT – the fundamental conclusion is that no one policy can achieve the substantial reductions that the region needs in order to meet aggressive climate change goals. There needs to be a multiple-pronged effort.

The short-term impacts on GHG emissions of EVs will be small for at least the next decade because the vehicles will not enter into the market in large numbers until manufacturing ramps up. However, the use of EVs will be a significant component of both the CAFE and LCFS policies and EV use will be encouraged as communities become more compact and driving distances are reduced.

EVs also have a more indirect role as part of other GHG reduction strategies. Their energy storage capabilities can enable the use of larger amounts of renewable energy, and EVs will be an important component of a bidirectional, interactive smart grid.

If we are going to maximize the environmental benefits from the transformation to EVs there must be sustained effort to go well beyond our current renewable portfolio standards and toward a system where electricity used to fuel electric vehicles comes from a maximum amount of renewable energy resources rather than a minimum amount.

# CHAPTER 4. ELECTRIC VEHICLE ECONOMICS

## Electric Vehicle Economics – Costs and Benefits

From the manufacturers perspective, the first generation of any new vehicle line is bound to be more expensive to produce and a money loser. It is likely that the first generation of EVs will also likely be sold at a loss. Over time, as production volumes increase, marketing becomes less critical and R&D investments pay back, these vehicles will become profitable for the automakers. For example, it's been widely reported that first generation Priuses were sold at up to a $10,000 loss. However, moving to the 2$^{nd}$ and 3$^{rd}$ generation models, news reports indicate that Toyota and Honda (Insight) are making about $3,100 on each HEV sale.[48]

From a consumer's perspective, like their HEV cousins, EVs will likely carry a premium price above that of a comparable ICE vehicle. The price premium will be a result of a number of factors not the least of which is the fact that automakers will not be making large volumes of EVs at first despite having sunk millions of dollars into developing the new car. The biggest difference in terms of cost is the added cost of the advanced battery system in an EV. GM's forthcoming Chevy Volt's battery system (16 kWh) could cost about $11,000 (representing a cost of about $0.04 per mile over 60,000 miles). In contrast, we should recall that when air conditioning first became an option for cars, the additional price was $4,000 per vehicle.

Outside of the advanced battery, there will be some additional pieces of equipment in an EV that gas-fueled vehicles don't have while some ICE vehicle components might be eliminated. Pure battery electric vehicles, for example, will not have an exhaust system or an internal combustion engine or a gas tank. EVs will have electric drive motors, inverters and single speed transmissions, components not found in ICE vehicles. Not including the advanced battery, the November 2009 *Electrification Roadmap* report identified that EVs would have about $3,100 in new components and $3,350 in avoided components[49]. All of this points to the fact that reducing the cost of the EVs advanced battery system is key to bringing down the price premium of EVs.

At the current state of the technology and present production levels, batteries are so expensive that early releases of EVs will simply not be affordable for the average American unless the manufacturers find a way to defray the battery costs. Although not set in stone, its been reported that Nissan is considering selling its Leaf EV to consumers but leasing the battery system components and thereby spreading those "added" costs out over time. This might attract a class of consumers that might otherwise not be able to afford the upfront costs of the EV.

Most likely, EVs will not initially be sold to the average American but to those capable and willing to pay a higher price for various reasons including "green-ness" and "cool-ness" factors. Most of the EVs that have been announced by manufacturers have customer waiting lists with thousands of people putting down refundable deposits. The willingness to pay premium prices for green cars may be compared to the rapidly expanding willingness to pay premium prices for organic foods. How large a market this is remains to be seen. Research by Richard Curtin of the Institute of Social Research at University of Michigan found a $10,000 premium barrier for car buyers.

The $7,500 tax credit offered by the federal government will significantly reduce the price differential between the EV and ICE cars. With no government subsidies, the current market for hybrids that cost as much as $5,000 more than comparable non-hybrid models continues to expand.

The fuel cost of driving an EV is determined from the cost of electricity, the energy efficiency of the vehicle and any gasoline needed (if PHEV). If electricity is 10 cents/kWh, the cost is 2.5 cents/mile for EVs with efficiencies of 4 miles/kWh. In contrast, for an ICE vehicle getting 30 mpg and gasoline priced at $3.00 per gallon, the fuel cost of driving the ICE is 10 cents/mile.

In a simplified analysis, the table below compares energy costs of different vehicle types showing the economic benefits of EVs especially if gas prices get higher.[50]. The table shows that a conventional vehicle will have energy costs over 12,000 miles of $1,333 with gasoline at $3.00/gallon with a PHEV40 having costs of $405. A PHEV40 will halve the annual energy costs of a HEV. The table below presents a conservative estimate for EV energy costs since many EV owners will likely see off-peak charging rates approaching 5 cents/kWh – cutting their electricity cost in half compared to the data presented here.

**Table 13: Annual Energy Costs of Different Vehicle Types** (assuming 12,000 miles/yr traveled)

| Vehicle Type | Fuel Economy (mpg) | Annual Electricity Use (4 miles/ kWh) | Annual Gasoline Cost ($3.00/gallon) | Annual Electricity Cost (10 cents/ kWh) | Total Cost |
|---|---|---|---|---|---|
| Conventional | 27 | 0 | $1,333 | $0 | $1,333 |
| HEV | 45 | 0 | $800 | $0 | $800 |
| PHEV 20 (35% VMT electric) | 50 | 1,050 | $468 | $105 | $573 |
| PHEV 40 (75% VMT electric) | 50 | 2,250 | $180 | $225 | $405 |
| EV (100% VMT electric) | 0 | 3,000 | $0 | $300 | $300 |

To get to a more precise estimate of the total cost of an EV compared to a traditional vehicle or a hybrid we have to factor in other cost elements including: the price differential, incentives, charger infrastructure costs, differences in maintenance costs, etc.

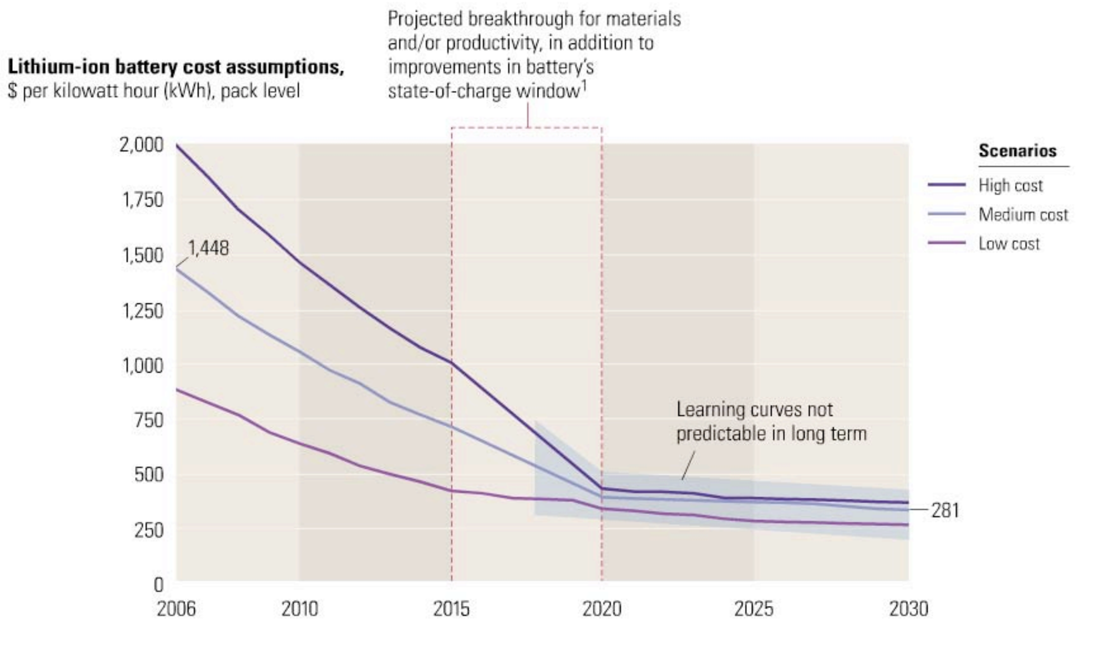
Looking at some of these costs for a Chevy Volt type of PHEV40, we'd have a $40,000 price tag for the vehicle, a $7,500 federal incentive and $2,100 for Level 2 charging equipment. This gives an upfront cost that may need financing of about $34,000 for a vehicle that might be comparable to a $25,000 small to mid-size sedan like the Toyota Prius or Honda Accord. The PHEV40 would have annual savings for about $900 including an estimated $500 reduction in annual maintenance and fuel cost savings of $400 (assuming $3.00/gallon gasoline) compared to an HEV. Therefore, the $11,000 price premium of the PHEV would take about 12 years to recoup.

Which brings us to the key question of batteries. Battery development is in a high state of innovation. Some analysts predict the current $9 billion dollar a year car battery market could grow exponentially and expand to $150 billion a year by 2030.[51]

Many kinds of batteries are being tested. Some are in the pilot manufacturing stage. It is unclear at this point which chemistry will be the winner. Many of the battery designs depend on lithium. Some question whether moving to EVs is simply moving us from one volatile resource (oil) to other scarce materials (lithium, nickel, cobalt, graphite), leaving us with the same vulnerabilities as we have now in our transportation fuels market.

It is a good question that should not be ignored. Some analysts believe that lithium supplies are robust and can meet the needs of the automotive sector for a long time before supply will become and issue. They also suggest that by that time any constraints are realized, it is likely that battery-recycling, new technology, more efficient use of existing lithium supplies and/or new battery chemistries that do not depend on lithium will reduce any potential stress on the market. Other analysts say lithium supply is limited and will not for long be able to supply the needs of the automobile market.

**Chart 10: Li-Ion Battery Cost Projections**




[1]State-of-charge window is the available capacity in a battery relative to its capacity when full. Conservative applications work within a 65% window, whereas more aggressive applications use 80%; over the next 5 to 10 years, most applications will likely migrate to the higher value.

Source: Figure by McKinsey and Co., http://www.mckinseyquarterly.com/Automotive/Strategy_Analysis/Electrifying_cars_How_three_industries_will_evolve_2370?gp=1

Based on the past, one might consider projections about the potential cost reductions in advanced batteries with an eye toward the conservative. In a 2000 report, DOE and Argonne National Laboratory predicted a needed price point of $250/kWh.[52] As investor-analyst John Petersen notes, since the release of the DOE report there have been "nine years of research that has failed to reduce costs."[53] Petersen found that Li-Ion batteries currently range in cost from about $700 to $1,200 per kWh. The range of his numbers are fairly close to the low and medium scenarios in projections by McKinsey & Co provided in the figure above. The table below shows the breakdown of Li-Ion batteries in the year 2000 indicating a cost of more than $1,125 per kWh.

**Table 14: Costs for High-Energy Li-Ion Batteries ($/kWh) in Year 2000**

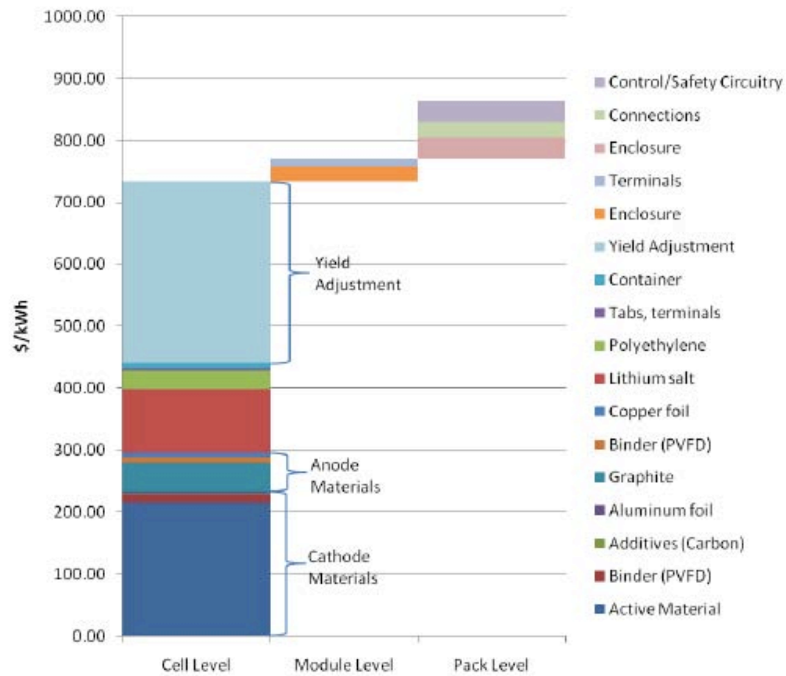
| Level of Integration | Cost Category ($/kWh) | | | Total ($/kWh) |
|---|---|---|---|---|
| | Materials | Manufacturing | Other | |
| Cell | 734.53 | 23.15 | 86.90 | 844.59 |
| Module | 771.79 | 26.77 | 86.90 | 885.47 |
| Pack | 864.38 | 31.68 | 230.27 | 1126.33 |

Source: David Anderson

However, optimism is widespread and industry analysts continue to project cost reductions for Li-Ion chemistries over the next decade. The latest projections predict at least a 50% cost reduction from more than $700/kWh today to $350/kWh by 2020.[54]

A compelling recent analysis on Li-Ion battery economics was completed by David Anderson[55]. In his May 2009 paper, he notes that the primary cost drivers for Li-ion batteries are cell-level materials cost and manufacturing yields (reducing waste and improving the number of manufactured battery cells which meet the quality control requirements mandated by the automotive industry). Improvements in these areas will be key for making EVs cost-competitive with conventional automobiles. He concludes his analysis saying, "Li-ion battery costs can feasibly decrease in the next two decades to the point that PHEVs and EVs will become economically competitive."

**Chart 11: Materials Cost Breakdown for Li-Ion Batteries**

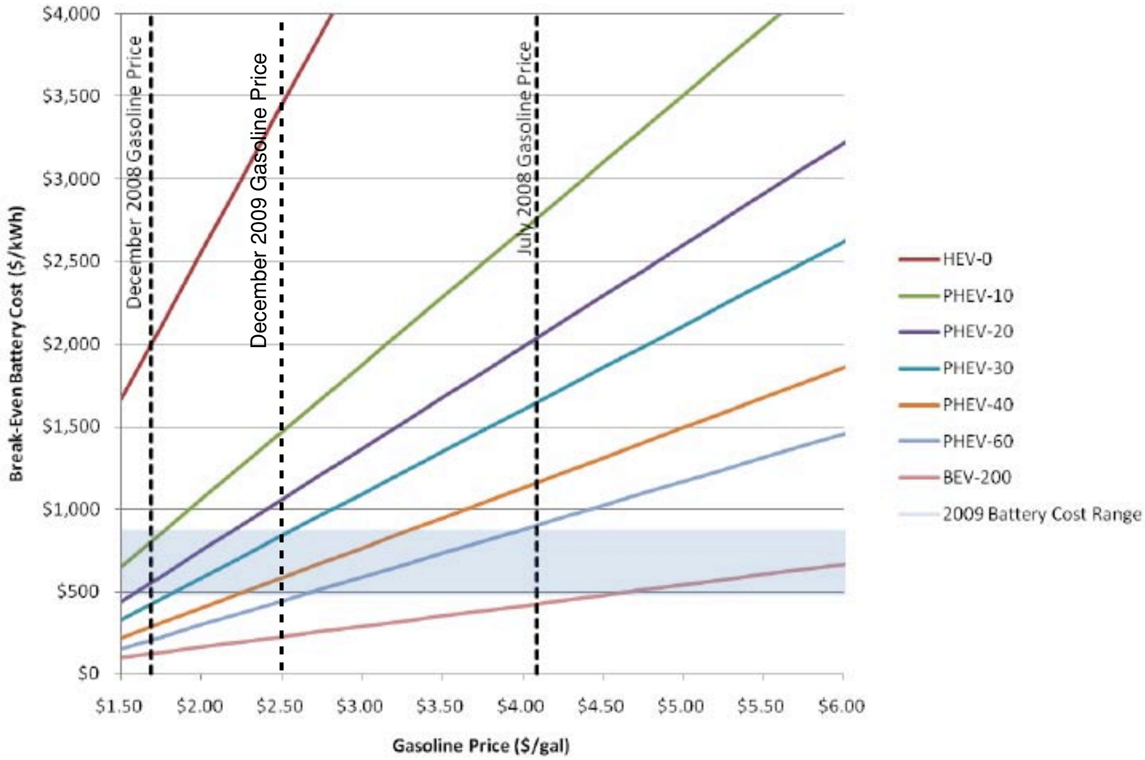



Source: Chart by David Anderson, "An Evaluation Of Current And Future Costs For Lithium-Ion Batteries For Use In Electrified Vehicle Powertrains." May 2009.

As the above figure shows, the cathode and anode materials combined with the costs of producing cells that don't meet auto manufacturer's specs (yield adjustment) are the key cost variables accounting for about 80 percent of the cell's material cost.

The figure below illustrates the interplay between battery costs and gasoline prices for various vehicle types including EVs and HEVs. The "break even" point is when the increased cost of the vehicle due to the advance batteries equals the avoided fuel cost-savings. For example, it shows that in July 2008 when gas prices were hovering around $4.00 per gallon, a PHEV40 (like the Chevy Volt) would have the break even costs with Li-Ion battery prices of about $1,150/kWh. When gas prices drop to today's level of about $2.50/gallon, the break even cost for batteries drops to about $625/kWh for a PHEV40 and $250/kWh for a BEV.

**Chart 12: Battery Break-Even Costs For Various Vehicles**




Source: Chart by David Anderson

The figure above doesn't account for the fact that the battery cost might be borne by the customer up-front and the fuel savings would accrue over time. That kind of estimate is trickier and would include a discount rate to account for the adjusted value of future cost savings. In Anderson's paper he found that a 7% discount rate would result in break even battery costs 30% to 40% lower than the non-discounted results above. So instead of a break even point of $625/kWh for a PHEV40 at $2.50 gasoline, the break even would be around $375/kWh. The data underscores the potential problem that gasoline prices play in the economic attractiveness of vehicles with battery technology.

Certainly, the federal government's $7,500 incentive for EV purchases will make the economics better but incentives are only in place for a limited number of vehicles and it remains to be seen if battery costs can come down before the incentives expire.

## A Note About EV Charging Equipment: Costs and Standards

Most EV buyers will likely charge their vehicles at home, an option discussed in detail below. Home charging is ideal for a couple reasons – the distributed nature of charging will lend itself to providing support and storage for the existing electricity grid and most of the charging will take place overnight when peak power needs are lowest and maximum utilization of the existing electric generation capacity can be employed.


In terms of charging stations outside the home, there different ideas are circulating. One company, Better Place, in partnership with Renault has established formal partnerships with Hawaii, Israel, Denmark and western Australia to construct a national/state battery-charging and swapping network. The swapping idea is uniquely a Better Place strategy and the company released a video in May 2009 showing the first public demonstration of how the 1.5-minute battery swap would work[56]. The company has announced a plan with California and the Bay Area cities and counties for a $1 billion infrastructure investment but to date nothing has happened with respect to that announcement.

Other companies are focusing on non-swapping solutions. Coulomb Technologies, ECOtality and a handful of other companies hope to establish a network of pay-as-you go charging stations in public and private locations. With the relatively low cost of electricity to charge up a vehicle, it's quite easy to envision electric charging stations turning into the something like the now ubiquitous "free wi-fi" service that many businesses offer to attract customers.

The lack of and challenge of establishing a public charging infrastructure on the scale of the current gasoline station network (about 120,000 stations in 2002[57]) is often viewed as a key barrier for prospective EV buyers. That may be true for some consumers, but what is often forgotten is that the most common place to charge future EVs will be at home which already represents a much larger potential "re-fueling" network than gasoline stations currently represent. According to the 2007 American Housing Survey for the United States[58], over 72 million households (out of a total of 110 million households) in the U.S. had access to a garage/carport. Even when accounting for possible locations that are not suitable (e.g. no electricity out to garage) or ready for home charging (e.g. electric service to garage but circuit not suitable for EV charging) there are likely tens of millions of charge points ready to go.

The basic elements of charging an electric car will soon be standardized for the equipment, communications, automation and control technologies by a variety of national and international standards bodies (more discussion below).

EV charging is broken up into three levels characterized by configuration and voltage rating[59]. Charging at levels 1 and 2 will be allowed for home charging.

> <u>Level 1 charging</u> uses simple 120-VAC and is not seen as “an ultimate charging solution” but is beneficial because of the frequency of 120 VAC outlets. Charging a 40-mile range EV will take between 6-8 hours.
>
> <u>Level 2 charging</u> requires a 208 to 240VAC, single-phase ≤ 80A circuit. A 20-40 amp circuit is the most likely level for home-charging and will allow for a 40 mile range EV to be charged in 3-5 hours. A 240-VAC with an 80 amp circuit will charge the car even faster.
>
> <u>Level 3 or "fast charging"</u> standards have not yet been established but some consider it to be at least a 300-600V DC, 3-phase, and 150–400A rates have been proposed. EVs are expected to achieve at least a 50% charge in 10 to 15 minutes. Since this charging level will require circuits with 100's of amps it is unlikely for households to have this capability.

Costs for implementing various charging level configurations are outlined below from a November 2008 report by the Idaho National Engineering Laboratory (INL).[60] Ideally, Level 2 charging infrastructure will be the main focus of infrastructure expansion. At Level 2, charging times will be short enough (~3 hours) to give consumers fast-enough re-charging of their vehicles and will give utilities some breathing room for controlling demand (e.g. "smart charging") on the distribution system. INL estimates that a residential installation of a Level 2 charging system from scratch will cost about $2,150.

**Table 15: Level 2 Charging Infrastructure Costs – Residential**

| | Labor | Materials | Permits | Total |
|---|---|---|---|---|
| 32 Amp wall box - charging equipment | | $650 | | $650 |
| Charge Cord | | $200 | | $200 |
| Circuit Installation (40-Amp branch circuit, 240-VAC) | $455 | $470 | $155 | $1,080 |
| Administrative Costs | $91 | $94 | $31 | $216 |
| TOTAL COSTS | $546 | $1,414 | $186 | $2,146 |

**Table 16: Level 2 Charging Infrastructure Costs – Apartment Building – 5 Chargers**

| | Labor | Materials | Permits | Signage | Total |
|---|---|---|---|---|---|
| 32 Amp wall box - charging equipment (five spots) | | $3,250 | | | $3,250 |
| Charge Cords (five) | | $1,000 | | | $1,000 |
| Circuit Installation (five, 40-Amp branch circuit, 240-VAC, w/ panel) | $1,400 | $696 | $165 | $350 | $2,611 |
| Administrative Costs | $280 | $353 | $33 | $70 | $736 |
| TOTAL COSTS | $1,680 | $5,299 | $198 | $420 | $7,597 |
| TOTAL PER CHARGER | $336 | $1,060 | $40 | $84 | $1,519 |

There is an important movement in the automotive industry to standardize the equipment and connectors used to charge EVs. A uniform standard will alleviate confusion and cut costs for consumers and allow manufacturers of EVs to market their products effectively. The primary bodies that are developing these standards are the Society of Automotive Engineers (SAE) and the IEEE. There are a number of standards under development or being modified by SAE's Hybrid Committee.[61] The key standard, known as J1772™, should be approved by the end of 2009 or in early 2010.

SAE J1772 Standard Connector and Receptacle

**J1772™ - Electric Vehicle Conductive Charge Coupler**

This standardizes the connection between the EV and the charging station. This standard is for North America but Japan has also adopted this approach. The J1772™ connector is designed for single-phase electrical systems with 120V or 240V charging. The connector is designed to withstand up to 10,000 connections (~ 13 years) and can handle exposure to harsh conditions without failing. There is a different connection standard being adopted for EV charging in Europe by the International Electrotechnical Commission (ITC) since the electricity system and operating voltages are fundamentally different than in North America.

**SAE Standards for EVs – Works in Progress as of September 2009**

J1711 - Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles
J1715 - Hybrid Electric Vehicle (HEV) & Electric Vehicle (EV) Terminology
J1772™ - SAE Electric Vehicle Conductive Charge Coupler
J2344 - Guidelines for Electric Vehicle Safety
J2464 - Electric Vehicle Battery Abuse Testing
J2836/1 - Use Cases for Communication between Plug-in Vehicles and the Utility Grid
J2836/2 - Use Cases for Communication between Plug-in Vehicles and the Supply Equipment (EVSE)
J2836/3 - Use Cases for Communication between Plug-in Vehicles and the Utility Grid for Reverse Power Flow
J2847/1 - Communication between Plug-in Vehicles and the Utility Grid
J2847/2 - Communication between Plug-in Vehicles and the Supply Equipment (EVSE)
J2847/3 - Communication between Plug-in Vehicles and the Utility Grid for Reverse Power Flow
J2894 - Power Quality Requirements for Plug In Vehicle Chargers - Part 1: Requirements
J2894/2 - Power Quality Requirements for Plug In Vehicle Chargers - Part 2: Test Methods
J2907 - Power rating method for automotive electric propulsion motor and power electronics sub-system
J2908 - Power rating method for hybrid-electric and battery electric vehicle propulsion

# CHAPTER 5. EV POLICY OPTIONS

This chapter surveys many policies that could accelerate the use of EVs. The next chapter selects those we consider most important for near term work in the RE-AMP states.

> "You know, policy makers don't want to make policies and create incentives for vehicles they don't know are coming. Automakers stand on this premise, we want to build cars that people are requesting by the millions, and people aren't requesting plug-in cars in that sort of volume, ergo, they must not want them. And we kind of stand back going, you know, we went around the country and most people don't even know that electric cars or plug-in hybrids are possible. So we face this challenge. I use this iPod analogy lately that, how many of us looked at our Walkmans about 15 years ago and said, gosh, I wish this were the size of a deck of cards and I could watch TV on it?"
>
> *Chelsea Sexton, former GM employee that appeared in "Who Killed the Electric Car?"*

Rocky Mountain Institute's Project Get Ready (PGR) [http://www.projectgetready.org/] has compiled, with the help of a key set of technical advisors from industry and other institutions, the most extensive listing of existing and proposed policies related to EVs that we found.[62] We've culled PGR's listing, ideas from the Center for Climate Strategies[63] work related to state-level climate change plans and proposals from many other groups and broken out our policy discussion into three broad categories:

**Enhancing Consumer Acceptance**

**EV Infrastructure and Integration**

**Expanding EV & Related Industrial Manufacturing**

## Enhancing Consumer Acceptance

While we see relatively strong support for PHEVs by consumers in recent polling, there still appears to be a great deal of consumer education to be done related to EVs and charging infrastructure. If consumers are unaware or uninformed they certainly won't be supporters and can't be leveraged in the upcoming policy debates. Clearly the bulk of public education will come from the private sector. But the public sector may play a crucial role in terms of its perceived impartiality to the issue, capable of discussing both the shortcomings and the advantages of EVs.

### Financial Incentives

With tight state budgets, finding a revenue stream to fund these types of incentive programs may be difficult. Throwing money at consumers to influence their purchase should be done with care. Questions should be addressed up front: Is the incentive really needed? Is it needed by everyone? Should it be a loan rather than a grant? What is the fundamental purpose of the incentive (e.g. GHG reduction vs. fuel savings, etc.) Another important consideration is whether we should make incentives more favorable the more efficient the EV is in terms of miles per kWh. Should we provide incentives for "Hummer-like" EVs that travel far less miles per kWh than more compact EVs?

A recent study, "Green Drivers or Free Riders? An Analysis of Tax Rebates for Hybrid Vehicles," from the University of British Columbia (UBC), found that the majority of consumers who purchase HEVs were not motivated to do so by government rebates.[64]

Sentech Inc.,[65] Project Get Ready (PGR) and others have proposed a "feebate" program relative to fuel efficiency that could be a way to provide incentives to EVs without impacting a state's general fund. Money would be raised by increasing fees on inefficient vehicles and using that money to cover incentives to highly efficient vehicles like EVs. Feebates are an interesting approach and have been proposed for decades in various sectors but rarely have they been implemented successfully.

**Examples**

**Oregon**-In 2009, legislation Oregon converted a $1,500 HEV tax incentive to only be available to purchases of EVs after January 1, 2010. Oregon residents that do not have an Oregon income tax liability may choose to transfer the tax credit to an Oregon resident who does. Many states have incentives for HEVs and with the maturing industry that should be shifted to plug-in vehicles instead.

**Austin, T**X-The city of Austin, Texas, had a program that was scheduled to end in 2009 to provide a $250 rebate for EV conversions.

**Vacaville, CA**-Boasting the highest number of leased EVs (25 Toyota RAV4 EVs) of any city in the country, Vacaville also provides a generous incentive to its residents to help buy down the cost of EV leases. More than 100 residents (out of total population of about 100,000) have taken advantage of the EV lease buy-down program. The city says that federal and regional grant money makes the program possible and that as of 2009, there is still money available.[66]

**Ontario, Canada**-The Ontario Government has introduced plans for a rebate of $3,600 to $8,900 (U.S.$) for customers buying plug-in hybrid and all electric vehicles after July 1, 2010. Drivers of plug-in and electric vehicles will also receive green license plates allowing them to drive in carpool lanes and use charging and parking facilities at government and public transport sites. This is part of the province's efforts to have 5 percent of the vehicles on the road be EVs by 2020. If the U.S. established such a goal it would represent over 12 million passenger vehicles. In contrast, President Obama has called for 1 million EVs by 2015.

**Electricity Rebate Program for First Four Years of Sales**

An idea proposed during Sentech's "2009 PHEV Market Introduction workshop"[67] was to give EV owners four years of free electricity for EV charging. This policy could represent from $100 - $300/year depending on the electricity rates and other terms. It would be likely that the utility would want to have some controls over when the vehicle could be charged and this would likely require some smart grid technology in order to accomplish it successfully.


Photo credit: Flickr user Steve Wampler

**Low Interest Capital Loans for EVs From Banks**

Project Get Ready and others have suggested that people might qualify for a bigger car loan than they might otherwise if they are purchasing an EV because of the reduced operating costs. Project Get Ready strongly suggests that when people buy an EV, that key items are bundled at vehicle point of purchase (purchase/installation of home charger system, state/federal rebates, etc.).

**Secondary Market for Used EV Battery Assemblies**[68]

With the limited number of EVs on the road, this idea hasn't had much real world testing but there is a potential for electric utilities (or consumers) to re-purpose the batteries in their EVs after their useful life is over in the vehicle. In general, EV batteries will retain 80 percent of their energy storage capacity and will still be suitable for other energy storage applications (e.g. storing variable renewable energy or off-peak electricity for use during on-peak times). The idea here would be to give EV owners an opportunity to regain some costs by selling their EV battery to another entity such as an electric utility. It remains to be seen if this is viable and the utilities we talked to about this are leery about jumping on this idea since they have no way to control how that battery is treated during the time when the consumer is using it in their EV.

**Electric Utility Leasing of EVs**
Electric utilities – either voluntarily or in response to regulations – would acquire EVs and lease them to customers at a cost similar to conventional vehicles. The incremental cost increase of the EV would be paid by the utility. The lessee (e.g. electric customer) would pay back all or a portion of the increased cost via electricity bills. The program could be designed so that the incremental vehicle costs could be included in the utility's rate base. One advantage to a program like this that has been identified is with control of the leased vehicles, the utility could establish and implement a protocol to acquire information on characteristics and performance of EVs over time. It could also specify battery recharging times, equipment, etc., in its agreements with those leasing vehicles.

## Non Financial Incentives

**Preferential Treatment for EVs: Parking, HOV Lane Access, and Other Discounts**
Some argue that giving handsome tax credits or cash for purchasing EVs is not necessary to spur the market and is simply giving money away to wealthy people that would have purchased these vehicles anyway. As an alternative, some believe that an equally effective approach would be to give preferential treatment and perks to EV owners. These could include giving EVs free access to HOV lanes, free special license plates, free road/bridge tolls, preferential public parking, exemption from congestion fees, and so on in order to acknowledge the early adopters. Property tax breaks and insurance premium discounts have also been suggested. Car Sharing Organizations within RE-AMP have been demonstrating PHEV vehicles for some time and if their EV fleets expand, they've suggested that they might be given preferential access to public charging stations.

Ontario's new green license plate for EV drivers – adopted October 2009

**Government and Corporate Fleets - EV Purchasing Requirements**
Many groups have called for the federal government to begin purchasing EVs for their fleet of vehicles. This idea can be extended to state and local governments as well as private fleets. Using Requests for Proposals for major purchases and creating buying consortiums or networks like Plug-In Partners[69] could make purchasing EVs more cost effective. Fleet demonstrations will ensure a stable market for manufacturers, create interest of consumers and will become an easy-to-monitor group of vehicles so that we all can learn from a substantial deployment of EVs.

Currently, the federal government acquires approximately 63,000 new vehicles annually and maintains a fleet of roughly 631,000. Using current cost structures, the financial burden of acquiring EVs would be minimal. For example, assuming a $10,000 premium for a 40-mile battery assembly, 20,000 EVs would cost $200 million a year more than comparable internal combustion engine counterparts. Much of that cost increase would be offset by government savings on gasoline consumption over the lifetime of the vehicles.[70]

**Oil Savings Performance Contract**
The Electric Drive Transportation Association (EDTA) supports the development of an "Oil Savings Performance Contract" to increase the number of federal fleet electric drive vehicles (could also apply to state fleets). This would be similar to energy savings performance contracts where the increased upfront

cost of the EVs is financed by a financial services entity and that cost would be paid off over time as the EVs save money through reduced fuel usage.

**Tracking Early EV Adopters**
Some tracking is already being done by Idaho National Laboratory,[71] NREL and EPRI and utilities around the country but more experience and data would be useful in the early years of EV expansion. We'd want to know about how the overall purchase and integration into daily life went, level of use, and charging requirements (timing, frequency, location and billing system), how the vehicle was used, etc.

**Breaking Out EV Electricity Costs on Utility Bills**
This could be done via a legislative or regulatory requirement similar to other efforts to provide consumers with clear cost information on a month-to-month basis. The EV charging cost information might also be accompanied by a comparison to what the consumer would have paid in gas to reinforce the operational cost saving of EVs.

## EV Infrastructure and Integration

The rules under this section include those related to charging infrastructure, EV batteries, utility rates, and smart grid. It is important to note that, despite the often cited pressing need for EV charging networks, EV charging infrastructure is quite robust in that it's actually in place already in millions of homes and businesses. Having said that, most homes and businesses will not be ready for EV charging using the faster charging methods of 220V/240V outlets so there still is a great deal to be done to get our infrastructure in shape to make EV charging faster and more controllable so that we limit the impacts EVs might have on the electric grid.

### Requiring EV Infrastructure Planning

There are provisions in the Waxman-Markey climate change bill (H.R. 2454: American Clean Energy and Security Act of 2009) that passed the U.S. House in 2009 that require utilities to develop an infrastructure plan for EVs. We strongly suggest that RE-AMP states adopt this approach in their next legislative session or by direct petition to their respective PSC/PUCs. At minimum, legislation should direct the state regulatory agency to open a docket and require regulated and non-regulated utilities to come up with a plan to ensure EV interoperability with the grid and address requirements and strategies for infrastructure, cost recovery, smart grid integration, TOU pricing, and billing issues. We would also suggest that there be an analysis of the types of power plants operating at different times of the day and year so there is a clearer picture of the best times for EV charging to maximize GHG reductions. There should also be an analysis of each utilities distribution system to identify areas where homes and/or the distribution system will need to be improved in order to handle increased EV charging.[72]

**Connecting Renewable Energy Increases To EV Sales**
This was an idea we heard that was posed as a question by Eric Sundquist at the Center on Wisconsin Strategy. This policy would ensure that as EVs bring new electric load to the system that there is enough additional renewable-fueled electricity on the grid to cover the increase. Design of the policy is important. If the policy just added additional requirements to a state-level RPS, obviously the new renewable energy would not necessarily be supplying energy directly to EVs, it would simply be sent into the grid without any specific end use.

We'd recommend trying to do something beyond a largely symbolic gesture of increasing statewide renewable standards, and require the new renewable energy to physically be supplying electricity to EVs via an on-site renewable energy charging station. There are a growing number of companies around the country (even in Iowa) that are building solar power EV charging stations. What's interesting in this is that the cost of solar electricity generation[73] actually matches fairly closely with some of the on-peak EV charging rates in place or proposed (~$0.28/kWh). This means that a public charging station using solar panels could be installed economically if they are able to sell the electricity at on-peak pricing rates.

Alternatively, the vast potential of wind energy in the RE-AMP states could expand to meet the new electricity requirements of EVs and that power could just be sent into the grid. We've shown earlier in the report that about 500 utility-scale wind turbines can supply enough electricity for 1 million EVs.

**Coordinating Vehicle Purchase and Home Charging Station Installation**
This is fast becoming one of the key issues in ensuring a smooth transition for EVs in the marketplace. Early experience has shown that many jurisdictions have a patchwork of regulatory and inspection related hurdles that must be met before a home charging station can be installed or operated. In some reports, it has taken more than a month to get systems installed. Ideally, the consumer would be able to walk into an EV dealership and in matter of days, not weeks, be able to make the purchase and get a level 2 home charging station installed.

**Allowing Municipal Energy Financing to Cover Level 2 EV Charging Systems**
Municipal energy financing with on-bill or on-property tax repayment is emerging as an effective way to increase investments in energy efficiency and renewable energy in homes and businesses. To get this going there is often a first step of enacting state enabling legislation to let municipalities start these programs (a few RE-AMP states have already acted on this). We recommend that the state enabling legislation specifically allow municipal energy financing programs to be used by homeowners and businesses to build out Level 2 charging stations and qualify for property tax repayment of those investments.

**Giving Utilities Cost Recovery Authority for Any Distribution System Upgrades Needed to Facilitate Growing Numbers of EVs.**
Utilities are rightly concerned that EVs have the potential to put strain on electric distribution lines if too many vehicles are charging at the same time on the same feeder system. This issue is currently under intense study in various places around the country. Certainly, if we believe that EVs are a key GHG reduction strategy then we should be willing to allow electric utilities full cost recovery of any upgrades to their distribution systems that might be needed. Additionally, cost recovery should be allowed for interconnecting charging stations fueled by renewable energy sources.

### Developing a State-Level EV Charging Installation Manual

The State of Oregon will soon be publishing a simple, easy-to-follow installation guide for installing EV charging stations. We looked at a draft version of their, "EV Charging Station Installation Manual" and it will provide instructions for preparing, purchasing, installing and maintaining EV charging stations at homes and businesses and state/local governments in Oregon. We think that RE-AMP states could and should use it as a model for preparing their own state-specific manuals. The OR report will be online at http://www.oregon.gov/ODOT/HWY/OIPP/inn_ev-charging.shtml

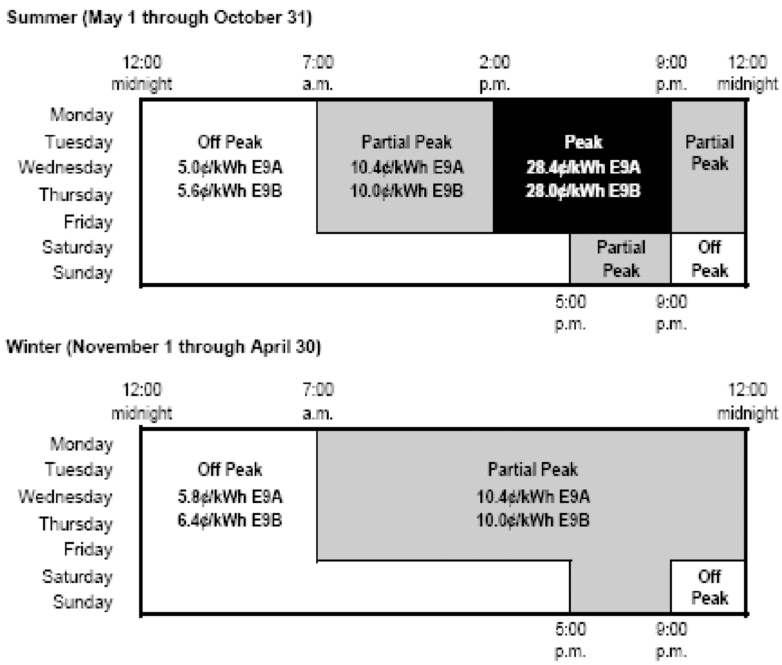
**Installing Public Charging Stations Along Visible Corridors**
The state could install a network of Level 2 charging stations (240V, 80 Amp) or future fast charging stations along major transportation corridors (e.g. at state rest stops or in prominent downtown locations). These would be a relatively cheap way to boost mileage capabilities of EVs, and allow drivers to stop for lunch and get at least a mile-a-minute recharge.

### Adopting Electric Vehicle-Friendly Charging Rates – an example from PG&E[74]

Pacific Gas & Electric Company (PG&E) and other utilities offer a rate to their customers that is constructed to entice people to charge their EVs at off-peak times when power is most available. By charging batteries during off-peak hours, EV owners minimize their energy bills and also make more efficient use of utility power plants, which in turn can reduce the average cost of electricity for all customers.

PG&E's Time-of-Use (TOU) Low Emission Vehicle rate is known as the "E-9 rate" (Schedule E-9). The E-9 rate is mandatory for those customers that are currently on a residential electric rate and who plan on refueling an EV on their premises. The rate is as low as 5 cents/kWh and as high as 28 cents/kWh depending on the time of day, day of the week and time of year. The E-9 rate has two basic options, metering the whole house (option E9A) or just the EV charger (option E9B).

The following graphs show how the E-9 rate works.




At this point, with limited information on how well this rate structure works in terms of getting EV owners to charge at off-peak times, we will note our concern that the peak pricing may be still too low to impact behavior. This is especially true when many of those purchasing EVs in the early years will have the financial means to afford even these relatively high, on-peak electricity prices. With a 40-mile all-electric range, a PHEV40 will require about 2,500 kWhs per year. At peak prices of the E-9 rate, that is $700/yr, equivalent to 233 gallons of gas at $3.00/gallon, representing 8,000 miles of travel at 35 mpg. Therefore the EV owner charging at PG&E's peak times is still saving hundreds of dollars compared to a highly efficiency gasoline car if they typically travel more than 8,000 miles per year.

**Fast Tracking Permitting And Installation Of EV Charging Systems**

We had this issue above under the consumer acceptance section and it deserves to be repeated here. This is a key issue to address and get right in terms of the competing aspects of speed vs. safety. EV expansion may be stalled if a consumer can't get a home charging station installed at the same time as purchasing the vehicle.

### Requiring EV Charging Systems Under Building Code – an example from Vancouver, British Columbia

In July 2009, Vancouver passed new requirement for charging ports in 20 percent of parking stalls in new multi-family developments. The outlets would be 240V – similar to those used by household dryers or stove – and charge EVs about four times faster than standard 110V outlets. The city expects the move will add 0.5 percent to the cost of an average building. The city estimated that over half of the residents in

Vancouver live in these multi-family homes. Vancouver also requires one and two-family dwellings to have plug-in vehicle charging capabilities.[75]

### Developing a Statewide Charging Network – an example from Oregon[76]

Oregon is seeking to become a leader in EVs. In 2008, Oregon's Governor issued an Alternative Fuels Infrastructure Executive Order that resulted in a recommendation by the Oregon Transportation Commission to issue a request for proposals (RFP) in 2009 for building a statewide EV charging network. The state was able to do this because of a provision in state law, the Oregon Innovative Partnership Program (ORS 367.800), that is fairly unique in that it is exempt from typical public procurement requirements and allows for direct public/private partnerships through negotiated agreements, subject to approval of the Department of Transportation's policy-setting commission. Just before the RFP was poised to be released, the process was suspended due in part to concerns about the emerging standards for electric vehicle supply equipment (EVSE) and wanting to ensure that the statewide network would meet those standards.

### Offering a Utility Subsidy For Charging Station In Exchange For Smart Charging Requirement From EV Owner

To help address the concerns by utilities about EVs charging during peak times, some are considering providing consumers with a subsidy for installing Level 2 charging stations on the condition that the utility be able to control when that vehicle is able to be charged. This would be done via a smart meter or radio controls similar to how many utilities cycle and control air conditioning loads during peak times. Project Get Ready suggests that utilities could also provides a reduced rate package for EV users, including discounts for off-peak charging, reduced monthly utility fees and a simple web interface to track electricity use

### Creating a "Battery Guarantee Corporation" to Underwrite Insurance on Battery Life for 10 years.[77]

Source: Nissan. Depicting Nissan Leaf's Battery Configuration

As the Brookings Institution notes, the idea for the proposed Federal Battery Guarantee Corporation was briefly introduced by David Sandalow in his book *Freedom from Oil*. If batteries fail to perform as promised for the full ten years, the government would pay out of an established insurance pool to have the battery serviced or replaced or to refund consumers for the value remaining on their warranty. Of course, battery manufacturers would have to be certified in some way in order to be covered under this type of program to ensure that only high quality products were being manufactured.

This could be a very important role for the government to take since EV manufacturers like GM and Nissan with vehicles coming out in the next couple of years have not indicated clearly what they plan on in terms of warranty for their batteries. If car makers use a similar model to existing vehicles the warranty for EV batteries could range from 1-5 years or 30,000 to 100,000 miles.

Many groups have identified the need for improved battery cost, performance, reliability and availability as the most important problems to solve to make EVs viable. The group, Sentech Inc., adds that manufacturing batteries to last the entire life expectancy of the vehicle, without needing replacement, is of utmost importance. A warranty or guarantee will raise consumer confidence around EV technology. We did not investigate whether it would be possible to use this approach at the state level.

## Examples of Statewide and Regional EV Planning Initiatives

**Statewide Comprehensive EV Proposal - Hawaii 2009**
Legislation was introduced in Hawaii (SB1612, HB1811)[84] that was not enacted but is the most comprehensive state level legislative effort on EV policy that we've found. The state's revenue department estimated that the bill would result in about $31 million in lost revenues from 2010-2015 from the tax incentives in the bill. Here's a summary of the main provisions in the bill:

- Section 1: requires electric vehicle charging for new homes built after 2015.
- Section 2: designates parking for electric vehicles.
- Section 3: enables electric vehicle networks to be established without being subject to regulation as a utility.
- Sections 4-6: establish a grant fund to encourage early adoption of electric vehicles and to attract electric vehicle suppliers to Hawaii.
- Section 7: provides a tax credit to offset a portion of the cost of establishing electric vehicle charging and alternative fuel refueling. Providing incentives encourages the pioneers in this area to make the investments, take the risks, and provide the initial market pull.
- Section 8: allows fuel economy leader vehicles and alternative fuel vehicles, which included electric vehicles and plug-in hybrid electric vehicles, to be exempt from the General Excise Tax on retail sales.
- Section 13: allows electric vehicles to be exempt from state portion of vehicle registration fees.

**Regional Plug-In Electric Vehicle Planning - Southern California**
Announced in December 2009, this regional effort is a collaboration between cities, utilities, automakers and others in the Southern California region who will work actively to support the region and build the necessary infrastructure for the commercial launch of electric vehicles.

The collaborative includes: Southern California Edison, Los Angeles Department of Water and Power, Southern California Public Power Authority, California Electric Transportation Coalition, Electric Research Power Institute, Southern California AQMD, Nissan, GM, Ford, and the cities of Burbank, Los Angeles, Pasadena, Santa Ana, and Santa Monica.

The Plan has the following eight objectives:

- Collaborate to help educate customers and stakeholders highlighting the environmental benefits of electric transportation; the benefits of electricity as an alternative fuel; the creation of public-access charging infrastructure; and the steps customers need to take to get plug-in ready.
- Collaborate and share information to prepare the LA Region for adoption of PEVs as a major market for the automotive industry; apply for or administer grant funding for the Region, and implement best practices to support the deployment and use of PEVs.
- Collaborate on charging infrastructure deployment including: working with funding agencies to upgrade the existing charging infrastructure, adding new infrastructure locations, and identifying charging solutions for multi-unit dwelling and workplace charging situations.
- Cities will work with stakeholders to develop and/or support purchase and ownership incentives (monetary/non-monetary) for both vehicles and infrastructure, including tax rebates for vehicles and charging installations, preferential and/or free parking at city meters, key parking locations, and community venues.
- Cities will work to streamline the process for installation of new charging infrastructure including local city permitting and inspections.
- Cities will review and revise where appropriate, local city building codes, standards, ordinances, etc. to help encourage adoption of PEVs.
- Utilities will develop a robust and streamlined customer service process that can scale up to support large numbers of plug-in vehicle customer service requests ranging from charging infrastructure installations to utility-specific rate options and programs.
- Cities and Utilities will collaborate on fleet acquisition plans, helping drive deployment of electric transportation solutions in light, medium and heavy-duty applications in accordance with operational and emergency response needs.

**Using Electricity Rate Base to Lower Cost of EV Batteries**
The Brattle Group's 2007 paper, *Advancing Plug-In Hybrid Electric Vehicles Via Utility Industry Battery Acquisition and Leasing*,[78] contained an interesting proposal to use electric utilities and their ratepayers to cover the cost of EV batteries and thereby lower the cost of the vehicles for consumers. The report notes that, "Regardless of the initial battery costs, utilities are uniquely poised to benefit from a U.S. vehicle fleet with a greater number of PHEVs, particularly if they incorporate emerging vehicle to grid (V2G) technology. Utilities will gain from PHEVs as a large new source of energy sales and as a resource for helping manage the grid."

The core idea is that the utilities would own the batteries of EVs sold in their area and treat them as their own asset. They would lease the battery free to the car owner (offsetting the incremental battery cost to the car owner) and utilities would recover this added cost through utility rates. The utility would amortize the battery investment through a small surcharge on distribution rates applied to their entire ratebase. The Brattle Group believes that the "program would be needed only for the first five years or so of PHEV sales, perhaps linked explicitly to the number of vehicles sold (say, the first half million PHEVs). After this, production volume and manufacturing cost savings should reduce costs to the point where much less support was needed." They estimate that this type or arrangement might lead to very small rate increases in the range of $0.15/month.

**Providing Incentives for Vehicle to Grid (V2G) Technology**


Professor Willet Kempton, from the University of Delaware, advocates that states can lay the groundwork and create proper conditions for future V2G business. One way is to enact laws that extend net metering rules to EVs that are plugged into the grid. He adds that, "an aggressive state could provide financial subsidies for electric vehicles, and give more incentives for a V2G-capable vehicle."[79] In September 2009, the State of Delaware became the first to allow EV owners to be eligible for a type of net metering with their utility. Delaware's new law[80] requires electric utilities to compensate owners of electric cars for electricity sent back to the grid at the same rate they pay for electricity to charge the EV battery. For electric customers with time of use rates, the kWh rate for charging and discharging is the rate in effect when charging or discharging occurs.

With many technical and operational aspects of V2G applications still needing study, this policy is not a high priority for implementation. Having said that, V2G services to support the grid (e.g. voltage regulation or peaking support) is often cited as a way for utilities to defer investments in infrastructure and a way for EV owners to reap substantial revenues by letting utilities use the energy stored in their vehicles. Prof. Kempton's team predicts potential revenues of between $1,000 - $5,000 per year depending on energy markets and the timing/availability of the EV to be connected to the grid.

**Replacing Gas Taxes Resulting from EV Expansion**
Oregon has proposed road use fees as a way to replace the current system of gasoline taxes.[81] This is an important issue in the long term as many states maintain their roads using gas tax revenues. As gas usage declines, infrastructure will have less money for maintenance unless another revenue source is developed. Alternative ideas have been to impose a fee on every kWh used for EV charging and send that revenue to the state highway trust fund.

The MN Dept. of Transportation completed a study in December 2009[82] that addressed, in part, the impact that PHEVs might have on the current funding mechanisms (e.g. gas tax) for the state's roadways and will provide suggestions on how to mitigate any impacts. As compared to the base case, PHEVs would result in about a 15 percent drop in revenue by 2030 if adoption reaches 50 percent, and a 30 percent drop if adoption reaches 100 percent. The study found that PHEVs would cause about a 25 percent decrease in revenue if adoption reaches 50 percent, and a 45 percent drop if they comprise all new vehicle purchases by 2030.

For example, if plug-in hybrid and all electric vehicles increase in popularity to the point that they constitute half of all new vehicle purchases by 2030, the Minnesota state fuel tax rate would require an increase to approximately $0.40 per gallon (nearly double what it is today) to maintain the 2013 level of gas tax revenue. The study looked at alternative revenue raising strategies including one where PHEVs would pay a VMT tax of $0.01 per mile (approximately the current average state fuel tax paid per mile) instead of the state motor fuel excise tax. So 12,000 miles/yr means $120/yr tax for PHEVs.

## Expanding EV and Related Industrial Manufacturing

Rules under this section focus on how to expand manufacturing in the U.S. of EVs, advanced batteries, electric drive trains, smart grid components, etc. Since we've already discussed it previously, we won't repeat the information about the vast public programs at the federal level that have thrown billions of dollars in grants and loans to companies in an effort to establish this new manufacturing industry in the U.S. The examples from Michigan we've outlined in previous sections can also serve as a possible approach that other states might emulate. We caution that duplication might be more difficult in other states since Michigan is uniquely positioned with its existing vehicle manufacturing infrastructure that can be re-purposed for EVs and the automakers have expressed a keen interest in "industry clustering", having the needed EV components being made close to one another. We are also not interested in promoting the idea that states work to "steal" manufacturing developments from each other through increasingly lucrative tax incentives.

**Phase in Gas Taxes to Fund EV development**

Sentech, Inc. and its collaborators have suggested a phased-in gas tax increase (e.g. 15 cents a gallon) to pay for manufacturing incentives for EVs, batteries and other components. This policy could be done at the state or federal level. We would put this idea in the category of "very difficult" to get enacted but we present it here in case there are states in which this might be more palatable.


**Enacting Investment Tax Credits For Domestic Battery Production Facilities**

This is a key recommendation from Sentech, Inc, to address one of the key "pinch points" in making EVs a reality.[83] The investment tax credit would work in the same fashion as the current investment tax credit for solar energy development covering 30 percent of the initial investment (subject to certain conditions).

**Implementing a Cash for EVs Program**

Former President Bill Clinton suggested we establish a "Cash for EVs" (C4EV) program, modeled on the successful Cash for Clunkers program that would give Americans direct payments to buy electric vehicles. The program's design may have to be thought out more carefully than Cash for Clunkers was in terms of GHG reductions. According to an analysis by University of California Berkeley[84], cash for clunkers was a very expensive way to reduce GHG emissions from vehicles. Conservative estimates of the implied carbon cost exceed $365 per ton with best case values of $237 per ton. However, while cost would still be high compared to other GHG reduction strategies, a C4EV program would certainly be more cost effective in terms of GHG emission reductions than the previous program. Based on the results of Cash for Clunkers, a similar EV program would help consumers but more importantly would help the manufacturing sector by bringing automotive industry people back to work.[85]

Some groups have also argued for a Cash for EV Conversion program to cover some of the upfront costs of converting a HEV into a PHEV. Companies that do conversions are sprouting up around the country. Conversions can run between $10,000 to $20,000.

**Increasing Federal Funding of Expanded EV and Battery Manufacturing Capacities and Technology Improvements**

As part of their EV Roadmap Policy Priorities[86] the Electric Drive Transportation Association (EDTA), the lobbying arm of the EV industry, suggests that the federal government expand its support for the EV industry. EDTA asks for full funding in FY10 budget and beyond for the Transportation Electrification & Energy Storage programs that were authorized in the Energy Independence and Security Act of 2007, including section 641 (Energy Storage Competitiveness), section 136 (Advanced Technology Vehicle Manufacturing Incentive Program) and section 131 (Plug-in Electric Drive Vehicle Program grants). EDTA also wants grants available for up to 30% of the cost of re-equipping or establishing advanced vehicle and component manufacturing facilities, equipment investment (including manufacturing process development) and engineering integration. It would be straightforward for RE-AMP states to lend their voice to continued strong Federal support for EV and related manufacturing expansion.

# CHAPTER 6. ILSR RECOMMENDATIONS FOR RE-AMP ORGANIZATIONS AND FUNDERS

ILSR suggests the following eight higher-priority, near-term options be pursued by the RE-AMP network organizations and funders in order to move EV policy forward in the Midwest. Since the political realities and regulatory environment varies quite a bit across the RE-AMP states, implementation of the ideas below will be easier in some states and more challenging in others. Most of the points below have a similar level of importance but we've subjectively put what we feel are the higher priority strategies at the top. Since they are keenly intertwined with EVs, in addition to the suggestions below, advocates should continue to push for stronger and expanded renewable energy standards, low carbon fuel standards and smart grid deployments.

## 1. Create a RE-AMP Electric Vehicle Readiness (RE-AMP-EVR) Adhoc Group

A selection of RE-AMP network organizations should be organized (probably as a subgroup under the current Transportation Working Group) and prepare a state-by-state Electric Vehicle Readiness (EVR) strategy. The initial mission would be to lay the groundwork to create a state-level EV stakeholder structure and bring together various players to develop a strong policy platform for future EV developments. The RE-AMP-EV group could also develop a model legislative proposal that could be used as the starting point for stakeholder discussions in each state. We would also suggest that a Midwest EV web site be developed and maintained to provide key updates on this fast changing sector. ILSR would be interested in leading this effort if additional funding can be secured.

Possible Future State Level Stakeholders

- Dedicated Lead Project Coordinator
- State Departments: Energy, Transportation, Pollution Control, Economic Development and Administrative
- City and County Representatives
- Clean Cities Programs
- Utilities: IOUs, Cooperatives and Municipally Owned
- PUC/PSC
- Building Code Officials
- Nonprofits – Climate/Energy
- EV and Renewable Energy Businesses and/or Business Associations
- University Representatives – research and students
- Legislative Leaders

## 2. Enact Legislation That Opens a Regulatory Proceeding Covering Electric Utility Related EV Issues

At a minimum, the legislation should require utilities to develop a coordinated infrastructure plan for EVs. Issues included would be: ensuring interoperability of EV equipment, requirements for infrastructure, cost recovery, smart grid integration, time-of-use (TOU) pricing, other rate and billing issues. The plan should include discussions on deployment of electrical charging stations in public or private locations, including, but not limited to, street parking, parking garages, parking lots, single and multi-family homes, gas stations, and highway rest stops. The proceeding should also bring to light a clear picture of what power plants will be operating during the likeliest nighttime charging periods for EVs. The example language below was derived in part from language in the federal Waxman-Markey climate bill. Here is a sketch of what a bill might cover:

> UTILITY PLAN FOR INFRASTRUCTURE.
> (A) Each electric utility shall develop a plan to support the use of plug-in electric drive vehicles, including heavy-duty hybrid electric vehicles. The plan will provide for deployment of electrical charging stations in public or private locations, including street parking, parking garages, parking

lots, homes, gas stations, and highway rest stops. Any such plan shall also include discussions on —
(i) battery exchange, fast charging infrastructure and other services;
(ii) triggers for infrastructure deployment based upon market penetration of plug-in electric drive vehicles; and
(iii) such other elements as the State determines necessary to support plug-in electric drive vehicles.

Each plan under this paragraph shall provide for the deployment of the charging infrastructure or other infrastructure necessary to adequately support the use of plug-in electric drive vehicles.

(B) SUPPORT REQUIREMENTS.
Each State regulatory authority (in the case of each electric utility for which it has ratemaking authority) and each utility (in the case of a nonregulated utility) shall—
(i) require that charging infrastructure deployed is interoperable with products of all auto manufacturers to the extent possible; and
(ii) consider adopting minimum requirements for deployment of electrical charging infrastructure and other appropriate requirements necessary to support the use of plug-in electric drive vehicles.

(C) COST RECOVERY.
Each State regulatory authority (in the case of each electric utility for which it has ratemaking authority) and each utility (in the case of a nonregulated utility) shall consider whether, and to what extent, to allow cost recovery for plans and implementation of plans.

(D) SMART GRID INTEGRATION.
The State regulatory authority (in the case of each electric utility for which it has ratemaking authority) and each utility (in the case of a nonregulated utility) shall, in accordance with regulations issued by the Federal Energy Regulatory Commission pursuant to section 1305(d) of the Energy Independence and Security Act of 2007—
(i) establish any appropriate protocols and standards for integrating plug-in electric drive vehicles into an electrical distribution system, including Smart Grid systems and devices as described in title XIII of the Energy Independence and Security Act of 2007;
(ii) include, to the extent feasible, the ability for each plug-in electric drive vehicle to be identified individually and to be associated with its owner's electric utility account, regardless of the location that the vehicle is plugged in, for purposes of appropriate billing for any electricity required to charge the vehicle's batteries as well as any crediting for electricity provided to the electric utility from the vehicle's batteries; and
(iii) review the determination made in response to section 1252 of the Energy Policy Act of 2005 in light of this section, including whether time-of-use pricing should be employed to enable the use of plug-in electric drive vehicles to contribute to meeting peak-load and ancillary service power needs.

(E) Off-Peak Power Plant and Emissions Analysis
The state regulatory authority shall examine and present findings about the types of power plants, emissions characteristics and seasonal variability of electricity being sent to the grid during off-peak periods.

Alternatively, some RE-AMP states might be more amenable to establishing such a regulatory proceeding via a direct petition to the PUC/PSC rather than through legislation.

## 3. Require a Performance Standard for New Construction to be EV and Renewable Energy Ready or Capable

Depending on the state, there should be a requirement at the state level or a directive from the state to local levels of government to establish a requirement for new residential construction to be EV ready (Level 2 charging). Multi-family homes and businesses should also be addressed. In addition, states should consider adding a requirement that new construction should be renewable energy ready so that consumers/businesses are easily able to provide all or a portion of the EV charging needs through on-site renewable energy projects. A typical PHEV-40 will require about 2,500 kWhs per year, matching the approximate output of a 2-kW solar photovoltaic system.

We've noted earlier in the report that this type of EV charging requirement is already in place for new residential and multi-family developments in Vancouver, British Columbia. On the renewable energy side, the city of West Hollywood, CA, requires builders of new homes to, at a minimum, install a conduit from an electricity room to the roof and document how solar power could be accommodated.

We would suggest that the RE-AMP Energy Efficiency or Clean Energy Working Groups consider taking on this issue as part of their ongoing efforts.

## 4. Allow Municipal Energy Financing to Cover Level 2 EV Charging Systems

Municipal energy financing[87] programs with on-bill or on-property tax repayment is emerging as an effective way to increase investments in energy efficiency and renewable energy in homes and businesses. Typically, cities use their bonding authority to provide a pool of low cost, long term money to cover the up-front investment costs. To get this type of program going there is often a first step of enacting state enabling legislation that authorizes municipalities to start these types of programs (a few RE-AMP states have already acted on this). We recommend that the state enabling legislation specifically allow municipal energy financing programs to be used by homeowners and businesses to build out Level 2 charging stations and qualify for property tax repayment.

We would suggest that the RE-AMP Energy Efficiency and/or Clean Energy Working Groups consider taking on this issue as part of their ongoing efforts.

## 5. Initiate Government Fleet Conversions to EVs

We're strongly supportive of public sector leadership by example and state and local government fleet demonstrations of EVs can work to enhance consumer understanding and acceptance of these new vehicles. States, cities and counties should begin a gradual conversion of its fleet to EVs over time. Minnesota has an existing law requiring PHEV purchases if the cost premium is no more than 10 percent above a comparable vehicle. At this point, to our knowledge this approach has not led to any EV purchasing by the state fleet. A new purchasing criteria or a direct mandate might be needed to ensure that EVs are indeed entering into the public fleets. Pooled purchasing efforts among many governments might allow for more cost effective programs. Fleet demonstrations will ensure a stable market for manufacturers, create interest of consumers and will become an easy-to-monitor group of vehicles so that we all can learn from a substantial deployment of EVs.

**Table 17: Publicly Owned Vehicles in RE-AMP States**

| | Federally Owned | | State/County/Municipally Owned | |
|---|---|---|---|---|
| | Cars | Trucks | Cars | Trucks |
| Illinois | 3,622 | 11,851 | 72,069 | 1,994 |
| Iowa | 712 | 3,666 | 11,811 | 26,754 |
| Michigan | 2,692 | 9,730 | 47,603 | 72,135 |
| Minnesota | 1,545 | 6,085 | 11,790 | 24,454 |
| North Dakota | 610 | 2,103 | 3,594 | 6,666 |
| Ohio | 3,165 | 9,883 | 62,271 | 77,419 |
| South Dakota | 1,614 | 5,362 | 10,054 | 23,534 |
| Wisconsin | 572 | 2,902 | 3,689 | 11,960 |
| **TOTAL (RE-AMP)** | **14,532** | **51,582** | **222,881** | **244,916** |

Source: Federal Highway Administration (FHWA), http://www.fhwa.dot.gov/

## 6. Begin Smart Grid Deployments

With many smart grid standards in place or coming soon, utilities should be encouraged to begin the deployment of smart grid technologies. At a minimum, any transmission project approvals should be accompanied by a required investment in smart grid infrastructure. Utilities should be directed to develop smart grid expansion plans and create benefit/cost scenarios.

Many RE-AMP states have formal regulatory proceedings and/or informal smart grid coalitions and we'd recommend that RE-AMP organizations become formal participants in those proceedings in order to influence the strategic development of smart grid technologies. There should also be some more formal structure within RE-AMP to share ongoing information about smart grid developments taking place within the region.

## 7. Fast Track or Simplify Permitting And Installation Of EV Charging Systems

This is a key issue to address and get right in terms of the competing aspects of speed vs. safety. EV expansion will run straight into a brick wall if a consumer or business owner can't get a charging station installed within hours/days of purchasing an EV. Early experience has shown that many places have a patchwork of regulatory and inspection related hurdles that must be met before a charging station can be installed or operated. There have been reports that in some cases it has taken more than a month to get systems installed. Oregon has developed a charging station installation manual that other states might replicate based on their specific requirements.

The first step would be to identify in each RE-AMP state, the steps that a consumer or business would have to take in order to get a Level 2 charging system installed and develop some cost/time estimates. Once that data is gathered and analyzed, a solution and strategy (e.g. legislative, regulatory, etc.) could begin (designed for each state, if necessary).

## 8. Allow Utilities Cost Recovery Authority for Any Distribution System Upgrades Needed to Facilitate Growing Numbers of EVs

Utilities are rightly concerned that EVs have the potential to put strain on electric distribution lines if too many vehicles are charging at the same time on the same feeder system. The issue of how EVs might impact the local distribution system is currently under intense study in various places around the country. We should allow electric utilities full cost recovery of any upgrades to their distribution systems that might be needed to facilitate EV charging. Additionally, cost recovery should be allowed for interconnecting public charging stations fueled by renewable energy sources. With the different utility regulatory schemes throughout the RE-AMP states, this idea will have to be modified as needed for the respective state.

# APPENDIX A: DESCRIPTIONS OF EXISTING EV ACTIVITIES IN RE-AMP STATES

**Note:** Since Michigan has the most active and comprehensive set of EV and related policies we put the descriptions of their initiatives in the main text of the report in Chapter 2.

## Illinois

### Financial Incentives


**Illinois Alternate Fuels Rebate Program**
This program provides rebates for 80% of the incremental cost of purchasing an AFV or converting a vehicle to operate on an alternative fuel. The maximum amount of each rebate is $4,000. Eligible vehicles include natural gas, propane, and electricity (must be fully electric). (http://www.illinoisgreenfleets.org/fuels/index.html)

### Non-Finanncial Incentives

**Smart Grid Initiatives**
The Illinois Statewide Smart Grid Collaborative (ISSGC), ordered by the Illinois Commerce Commission, is convening a wide range of stakeholders to address the full range of implementation issues that will shape smart grid deployment for Illinois. They are charged with developing "a strategic plan to guide deployment of [the] smart grid in Illinois, including goals, functionalities, timelines and analysis of costs and benefits." The ISGC is directed to complete its work by October 2010. (http://www.ilgridplan.org/)

The Illinois Smart Grid Initiative's April 2009 report, *Empowering Consumers Through a Modern Electric Grid,* provides key guidance for stakeholders as they get down to the nuts and bolts of smart grid implementation in Illinois. This was a project of the Center for Neighborhood Technology http://www.ilsmartgrid.org and appears to be the most advanced Smart Grid policy development effort in the Midwest outside of State government.

In September 2008, the Illinois Commerce Commission approved a rate increase of about $270 million for Illinois utility ComEd to fund, in part, the first phase of a smart grid project, including the deployment of 200,000 smart meters to begin in 2010.[88] The ICC is also considering whether to require utilities to provide time-of-use pricing capable meters to all customers in the state.

**NEV Speed Limitations and Access to Roadways[89]**
Effective January 1, 2006, NEVs may be operated only on streets where the posted speed limit is 35 miles per hour (mph) or less and may cross a road or street at an intersection where the road or street has a posted speed limit of more than 35 mph (except for any state highway, tollroad or interstate highway). NEVs are defined as self-propelled, electronically powered four-wheeled motor vehicles which are capable of attaining in one mile a speed of more than 20 mph, but not more than 25 mph (625 Illinois Compiled Statutes 5/11-1426.1)

# Iowa

## Financial Incentives


**Electric Vehicle (EV) Registration Fee**
The annual registration fee for an EV is $25.00 unless the vehicle is more than five model years old, in which case the annual registration fee is reduced to $15.00. This section does not apply to low-speed EVs. Registration fees for most other vehicles in Iowa are based on the age, value and weight with a minimum fee of $50.00. (Reference Iowa Code 321.116)

**Iowa Power Fund**
The $100 million Iowa Power Fund has provided a small amount of funding to Consumer's Energy to "purchase and retrofit a standard hybrid electric vehicle (HEV) to an EV. They will be monitoring performance levels and assessing the viability of converting the existing fleet of ICE vehicles to PHEVs.[90]

## Non-Financial Incentives

**NEV Access to Roadways**[91]
A low-speed vehicle may not be operated on a street with a posted speed limit greater than 35 miles per hour (mph). A low-speed vehicle may cross a street with a posted speed limit greater than 35 mph. (Reference Iowa Code 321.381A)

**Miscellaneous Initiatives**
In terms of related policies, in 2007, the Iowa Utilities Board decided not to adopt "Time-Based Metering and Communications" standards. The Board determined that mandating deployment of smart meters was not cost-beneficial. There are plans for some utilities to do pilot TOU programs.

Also tangentially related to EV expansion is the Iowa Department of Transportation's efforts to develop future strategies to fund transit, rail and other projects in the state that won't necessarily be reliant on gas taxes. Taxes or fees on EV charging might factor into their recommendations.

Small towns in Iowa including, Elk Horn, will soon be unveiling EV charging stations that will be powered by solar photovoltaics.[92] The 8 charging stations planned for Elk Horn are being installed by Iowa-based Iron Eagle Technologies.

# Minnesota[93]

## Research

**PHEV Task Force**
In 2006, Minnesota law established a plug-in hybrid electric vehicle (PHEV) task force. It's charge was "identify barriers to the adoption of plug-in hybrid electric vehicles by state agencies, small and large private fleets, and Minnesota drivers at-large and develop strategies to be implemented over one-, three-, and five-year time frames to overcome those barriers. Included in the analysis was to be an examination of financial incentives to encourage Ford Motor Company to produce plug-in hybrid, flexible-fueled vehicles at its St. Paul Ranger plant."

The PHEV task force issued its final report in April 2007.[94]

**EV Charging Standards and Gas Tax Impact Study**
A 2009 law requires that electric vehicle infrastructure installed in the state must be compatible with Society of Automotive Engineers standards and be capable of providing bidirectional charging, once electrical utilities achieve a cost-effective capability to draw electricity from electric vehicles connected to

the utility grid. The MN Dept. of Transportation completed a study in December 2009[95] that addressed, in part, the impact that PHEVs might have on the current funding mechanisms (e.g. gas tax) for the state's roadways and will provide suggestions on how to mitigate any impacts.

As compared to the base case, PHEVs would result in about a 15 percent drop in revenue by 2030 if adoption reaches 50 percent, and a 30 percent drop if adoption reaches 100 percent. Electric vehicles would cause about a 25 percent decrease in revenue if adoption reaches 50 percent, and a 45 percent drop if they comprise all new vehicle purchases by 2030.

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## Financial Incentives

**Pilot EV Home Rebate and Off-Peak Charging Program – Great River Energy (G&T Cooperative)**
In August 2009, Great River Energy (GRE) began a pilot program with a number of its member distribution cooperatives to provide a rebate on "ChargeWise" charging stations[96] and some related equipment to be installed in garages that will provide off-peak (11 pm – 7 am) electricity for charging EVs. GRE says that charging EVs during these hours allows them to "store wind energy allowing PHEVs to receive a significant amount of power from renewable sources." The participating coops will cover $500 of the costs for the first 50 qualified EV owners. The electricity cost for the EV could be as low as $0.02 - $0.05 per kWh, meaning that annual electricity for an EV might cost the consumer as little as $50 to $125. Of course, if the vehicle also uses gasoline, the consumer will be spending money on liquid fuel as well.


## Non-Financial Incentives

**PHEV and Neighborhood Electric Vehicle (NEV) Purchasing Preference**
The Minnesota Department of Administration oversees a 2006 law that direct state funded vehicle purchases toward PHEVs and NEVs as soon as they become commercially available. The PHEVs (must be able to travel at least 20 miles on electricity) and NEVs must meet performance specifications and carry a price premium of no more than 10% above the price for comparable gasoline-powered vehicles.

**NEV Definitions and Access to Roadways**[97]
A neighborhood electric vehicle (NEV) is defined as an electric vehicle that has four wheels, and has a speed attainable of at least 20 miles per hour (mph) but not more than 25 mph on a paved level surface.

An NEV must be titled according to state law and may be operated on public streets and highways if it meets all equipment and vehicle safety requirements in Code of Federal Regulations, title 49, section 571.500 and successor requirements. An NEV may not be operated on a street or highway with a speed limit greater than 35 miles per hour, except to make a direct crossing of that street or highway. A road authority, including the commissioner of transportation, may prohibit or further restrict the operation of NEVs on any street or highway under the road authority's jurisdiction. (Reference Minnesota Statutes Sections 168.011, 169.01, and 169.224)

**State Agency Energy Plan and Vehicle Acquisition Priorities**
Using 2005 as a baseline, state agencies are required to achieve a 25% reduction in gasoline use by 2010 and a 50% reduction by 2015. Additionally, state vehicles are to achieve a 10% reduction in petroleum-based diesel fuel use by 2010 and 25% reduction by 2015, respectively.

**Smart Grid Collaborative Established**
The Minnesota Department of Commerce along with the University of Minnesota are coordinating a state level collaborative process to engage stakeholders on issues related to smart grid development in Minnesota.

**Ford Motor Company, Cities and NGOs EV Stimulus Proposal**
There has been an effort to secure federal stimulus money for a public/private collaborative project to purchase and deploy up to 60 Ford EVs in Minnesota along with public charging infrastructure. The necessarily level of funding was not secured and the project is being reevaluated.

# North Dakota

## Research


In May 2007, North Dakota cooperatively-owned utility, Basin Electric, added two new 2008 Ford Escape Hybrids to its vehicle fleet. The cooperative partnered with the National Rural Electric Cooperative Association Cooperative Research Network (CRN) and the state of North Dakota to convert one of the Ford Escapes into a PHEV. Basin's distribution cooperatives are keeping detailed records of the use and energy requirements of the vehicles. The co-ops and CRN will use the collected data to analyze the reliability, economy and performance of the "plug-in" vehicles.

## Non-Financial Incentives

**NEV Access to Certain Roads**
NEVs are included under rules for low speed vehicles in North Dakota, applying to vehicles with attainable speeds of at least 20 mph but not more than 25 mph. An NEV may not be operated on a street or highway with a speed limit greater than 35 miles per hour, except to make a direct crossing of that street or highway.

# Ohio

## Research

**Research Partnerships for Electric Vehicles**
Through a state funded "Third Frontier" program grant of $3 million, Ohio State University's Center for Automotive Research (CAR) research to help state become the "Silicon Valley for vehicle electrification."[98] CAR is studying the impacts of EVs on the Ohio electric grid in partnership with

several electric utilities.

**EPRI Studies EV Impacts in Ohio**
A 2009 study by the Electric Power Research Institute (EPRI), *Regional Economic Impacts of Electric Drive Vehicles and Technologies: Case Study of the Greater Cleveland Area*,[99] examined the potential regional economic impacts due to increasing electric transportation in the Greater Cleveland Area (GCA). This region contains over 2.9 million people living in 1.2 million households. EPRI found the region well suited for this analysis: all of the counties in the GCA are in non-attainment status for at least one criteria pollutant, motor vehicles are responsible for the majority of criteria pollutant emissions, the GCA has a relatively high number of vehicles per capita, and the GCA could benefit from the increase in manufacturing and employment opportunities created by EVs.

EPRI found that PHEV and electric drive technologies (EDTs) offer economic and regional benefits, as these technologies displace expensive petroleum with cheaper electricity.

Another EPRI study released in July 2009, *Cleveland Transportation Electrification Roadmap.*[100] The conclusions and recommendations of the report are instructive and can easily become the basis of a RE-AMP wide initiative on EV readiness:

- The current electricity transmission and distribution infrastructure in the should be evaluated to assess its capability to support EVs.
- Develop a collaborative strategy between state governors
- Launch a public awareness campaign
- Provide EV cash buy-down grants
- Demonstrate PHEV and BEV technology in public and private fleets

## South Dakota

We could find nothing about EV public policy, regulations, incentives or initiatives in South Dakota except for allowing low speed electric vehicles to operate on roads with speed limits lower than 35 miles per hour. Feedback from RE-AMP groups in South Dakota confirmed this assessment indicating that "EVs are not on the radar in South Dakota" and that other transportation issues (bus, trains) might have to be addressed first before EV policy will be entertained.


Communications with Kelly Fuller (Plains Justice) and Pat Spears (Intertribal Council On Utility Policy) reveal that in South Dakota EVs will be perceived as an "urban" thing, a word that is usually pejorative in the state. South Dakota has very few urban areas and those we have are small by the standards of other states. For instance, Sioux Falls is the largest metro area in the state with around 155,000 people. The largely rural population in SD tends to drive longer distances, South Dakota has 25% higher VMT per capita than Illinois, for example. The consumer perception of EV's having short ranges may be a big hurdle.

## Wisconsin[101]

### Financial Incentives


**Vehicle Battery and Engine Research Tax Credits**
As of July 2007, companies doing "qualified research" in select sectors are allowed a 10% tax credit. Qualified research includes research and development of automotive batteries for use in hybrid-electric vehicles that reduce the demand for natural gas or electricity or improve the efficiency of its

use. Corporations may also claim tax credits equal to 5% of the cost of building new facilities or to expand existing facilities used in Wisconsin for qualified research. (Wisconsin Statutes 71.28(4)(ab 2), 71.28 (ad 2 and 3), and 71.28(5)(ad))

## Non-Financial Incentives

**NEV Roadway Access Limits**[102]

NEVs in Wisconsin are defined as four-wheeled vehicles, self-propelled by electric power with a top attainable speed in 1 mile of more than 20 mph and not more than 25 mph on a paved level surface. NEVs may be operated on local roads that have a speed limit of 35 miles per hour or less, provided the municipality that has maintains the road has passed an ordinance allowing NEV operation on those specific routes.

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It's not surprising that the attention on EVs from policymakers is small when compared to energy efficiency or renewable energy initiatives. NCSL notes that in 2009 there were 751 bills relating to energy efficiency with bills introduced in every state (more than 100 new laws have been enacted) and at least 2,000 bills introduced across the country related to renewable energy.

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[23] http://www.afdc.energy.gov/afdc/vehicles/plugin_hybrids_publications.html

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[26] For example, see Electric Vehicle Association of Canada, http://evworld.com/library/CanadaFuelCycle.pdf ; Center for Energy Efficiency and Renewable Technologies, http://www.ceert.org/PDFs/reports/FCVCChangeFinalLFDraft051407.pdf ; National Renewable Energy Laboratory/American Solar Energy Society, http://www.ases.org/images/stories/file/ASES/climate_change.pdf ; Institute of Transportation Studies, University of California Davis, http://www.lcacenter.org/library/pdf/PSME2002b.pdf

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[38] http://www.hybridcars.com/fuel-economy-numbers/confusion-over-mpg-ratings-electric-cars-25946.html - The proposed CAFE calculation begins with a gasoline-equivalent energy content factor in electrical terms: 12,307.3 W·h/gal, which equals approximately 41,994.3 Btu. The 12,307.3 W·h/gal figure is based on multiplying factors developed for fossil-fuel electricity efficiency (0.328) and electricity transmission efficiency (0.924), as well as the energy content of a gallon of gasoline (33,705 W·h/gal, or approximately 115,006 Btu). The result is divided by a factor for petroleum refining and distribution efficiency (0.830). The DOE also applies a "doesn't use petroleum" incentive adjustment (analogous to the CAFE bonus for flex-fuel). The adjustment, which also allows for some changes in "well-to-tank" efficiencies, is a 6.6667 multiplier, raising 12,307.3 to 82,049 W·h/gal for an electric vehicle with no petroleum-fired heating or other accessory. If an electric car has a single petroleum-fired accessory, such as a heater, the 82,049 W·h/gal equivalency factor drops to 73,844 W·h/gal, and the CAFE number drops accordingly.
The electric vehicle is dynamometer-tested on the city and highway cycles, producing electric power consumption numbers in W·h/mi. The numbers then are weighted 55% urban and 45% highway for an average. Nissan has not disclosed its electric car test numbers, but if the Nissan-measured weighted average is 223.57 W·h/mi, dividing 82,049 W·h/gal by 223.57 W·h/mi would equal 367 mpg.

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