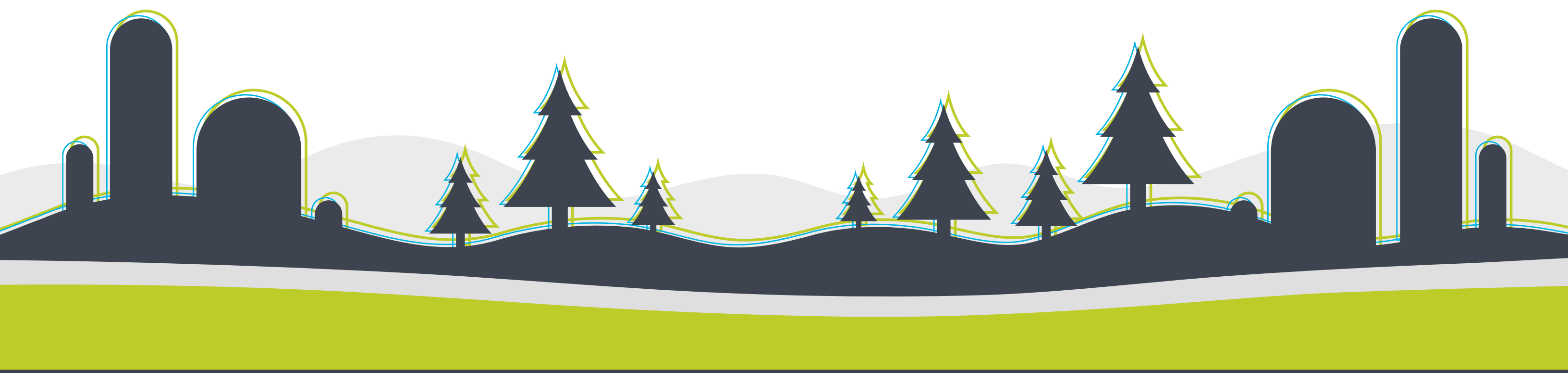
Colorado Electric Vehicle and Infrastructure Readiness Plan



electricridecolorado.com

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Colorado Electric Vehicle and Infrastructure Readiness Plan

A product of Project Fever–

Fostering Electric Vehicle Expansion in the Rockies

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the Electric ride — electricridecolorado.com

Clean Cities Denver Metro Coalition — denvercleancities.org

American Lung Association in Colorado — lungcolorado.org

Acknowledgements

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This publication is the product of collaboration between the following organizations that have managed aspects of the project as subcontractors:

Clean Cities Northern Colorado Clean Cities

Clean Cities Southern Colorado Coalition

CLEER

DOT Department of Transportation

Colorado Energy Office

iCAST community powered results.

Move Colorado

Project Get Ready An RMI Initiative

SWEEP Southwest Energy Efficiency Project

Stakeholders across Colorado shared their experiences and perspectives on the electric vehicle market, as well as contributed to the writing of the Colorado Electric Vehicle and Infrastructure Readiness Plan. The following list identifies these contributing stakeholders, but does not necessarily constitute or imply their endorsement, recommendation, or favoring of content within this document.

Organization Type	Organization Name
Clean Cities Coalitions	Denver Metro Clean Cities
	Northern Colorado Clean Cities
	Southern Colorado Clean Cities
Subcontractors	Clean Energy Economy for the Region (CLEER)
	Colorado Energy Office
	iCAST
	MOVE Colorado
	rabble + rouser
	Rocky Mountain Institute (RMI)
	RWHarrison & Associates
	Spensley and Associates
	Southwest Energy Efficiency Partnership (SWEEP)
	University of Colorado, Boulder
	Wheelhouse Associates
Federal Agencies/ National Laboratories	Department of Energy
	Environmental Protection Agency Region 8
	National Parks Service
	National Renewable Energy Laboratory
State Agencies/ Regional Partners	Colorado Public Utilities Commission
	Colorado Department of Personnel and Administration
	Colorado Department of Public Health and Environment
	Colorado Department of Transportation
	Colorado State Fleet Management
	Denver Regional Council of Governments
	Regional Air Quality Council
	Regional Transportation District
Municipal Governments/ Transit Agencies	Boulder County Land Use Department
	Boulder County Transportation Department
	Boulder Valley School District
	City and County of Denver
	City of Aurora
	City of Boulder

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Organization Type	Organization Name
Municipal Governments/ Transit Agencies	City of Brighton
	City of Colorado Springs
	City of Commerce City
	City of Englewood
	City of Evans
	City of Fort Collins
	City of Fort Lupton
	City of Grand Junction
	City of Lafayette
	City of Lakewood
	City of Longmont
	City of Loveland
	Denver Public Works - Policy and Planning
	El Paso County
	Logan County
	Pueblo County
	Roaring Fork Transportation Authority
	Routt County
	Town of Berthoud
	Town of Carbondale
	Town of Estes Park
	Town of New Castle
	Town of Rifle
	Town of Superior
Nonprofits	Alliance for Sustainable Colorado
	Boulder Community Hospital
	Colorado Cleantech Industry Association
	Denver Museum of Nature and Science
	Drive SunShine Institute, a division of The Renewable Energy Initiative (TREI)
	Electric Vehicle Information Exchange

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Organization Type	Organization Name
Nonprofits	Environment Colorado
	Environmental Defense Fund
	International Brotherhood of Electrical Workers 68
	Colorado School of Mines
	University of Colorado, Colorado Springs
	Western Resource Advocates
Private Industry	Aramark
	Beyond Aviation
	Boulder Hybrid Conversions
	Canopy Airport Parking
	Chamberlain (Consulting)
	Charlotte Robinson
	Clear Energy
	CSU Ventures-System Solutions
	David J. Erb & Company
	Eaton
	ECOtality
	EETrex
	eGo Car Share
	Energy Planning Consultants
	Ephibian
	Fleet Energy Company
	General Motors
	IKEA
	Jacobs
	Kum & Go Convenience Stores
	Nissan

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Organization Type	Organization Name
Private Industry	OpConnect
	Parsons Brinckerhoff
	PK Strategies
	RDS Environmental
	Schneider Electric
	Sustainable Systems of Colorado
	VIA Motors
	Zam Energy, LLC.
Utilities	Black Hills Energy
	Colorado Springs Utilities
	Longmont Power
	Xcel Energy
	Yampa Valley Electric Association
	San Miguel Power Association

I. Executive Summary

This Colorado Electric Vehicle Readiness and infrastructure Plan (Plan) provides the framework for Colorado to become a first-tier market for plug-in electric vehicles (PEVs), transportation technology, and PEV charging infrastructure. A thriving and competitive PEV marketplace is imperative for the economic, social, and environmental well-being of Colorado. By becoming a first-tier PEV market, Colorado has the opportunity to create:

- A transportation sector fueled by domestic energy sources
- A thriving economy that attracts new business and creates more jobs in key sectors for the state, including energy, manufacturing, transportation, and construction
- Improved air quality, particularly in high density areas

Based on the participation and input of a vast consortium of industry partners, this Plan provides an analysis of the Colorado PEV market and consumers, an assessment of current market barriers, and strategies to optimize growth. With this clear picture of the remaining challenges and opportunities, the Colorado PEV market is ready to launch.

As of 2012, Colorado is home to approximately 1,300 PEVs and more than 70 electric vehicle supply equipment (EVSE) sites, commonly referred to as charging stations as well as a wide variety of industry stakeholders invested in the PEV future. A survey of Colorado drivers suggests that the top consumer considerations for purchasing a PEV include a desire for decreased environmental impact and dependence on foreign oil as well as vehicle purchase costs and range. As vehicle technology and market factors continue to increase the ability of PEVs to meet these consumer demands, PEV adoption will continue to grow.

In Colorado, sales and market forecasts project that PEVs will see significant growth over the next 2 to 12 years, with up to 10.2% of the light duty fleet being PEVs in 2025. The most immediate need to accommodate this expected shift towards electric transportation is the charging infrastructure to power the vehicles. Based on analysis of charging behavior patterns across residential, workplace, and public attraction sites, this Plan lays out a statewide infrastructure deployment plan. With the participation of many stakeholders, Colorado can create a strong network of EVSE infrastructure that is cost-effective, highly utilized, and truly serves the entire state.

In addition to deploying a robust charging network, creating a first-tier market also requires strengthening the underlying pillars of the PEV market and establishing a far-reaching groundwork to support long-term market growth. These pillars are represented in this Plan as seven issue areas: Education and Outreach, Permitting and Installation, Local Ordinances, Fleets, Policy, Regulatory and Utility, and Emissions Impact. The following assessment of the challenges and opportunities across each issue provides insight into the current state of affairs, giving way to recommendations and strategies to enhance the Colorado market.

Education and Outreach

Despite growing awareness about PEVs, many questions and misperceptions regarding PEV technology, electrical infrastructure, safety, and political support remain for consumers and industry-leaders. For the industry, PEV training and education will further enhance the ability of key professional groups—such as elected officials, first responders, electricians, and car dealerships—to serve PEV drivers. For consumers, *The Electric Ride* campaign and website (www.ElectricRideColorado.com) is the premier resource for information on PEVs in Colorado and a mechanism to launch outreach efforts.

Permitting and Installaion and Local Ordinances

At the local level, the main factors that can contribute to furthering the PEV market include a streamlined permitting process, clear planning guidelines, and supportive ordinances and codes. Further streamlining the current permitting process for EVSE installations will allow consumers to get their new PEV up and running as quickly as possible, minimizing perceptions of and experiences with cumbersome processes. Creating collaborative channels between tenants and owners of multi-dwelling housing units will also serve to increase access to residential charging. A model ordinance, which includes sample language for building codes and zoning and parking regulations, provides guidelines to help foster PEV-friendly communities and economic development within the local context.

Fleets

Optimizing the advantages for PEVs to meet the needs of fleet owners will stimulate fleet electrification. Above all, PEVs will need to help fleet owners achieve their primary goal to purchase and operate vehicles that make financial sense. Other key elements of vehicle selection in fleets include aligning the right vehicle for the job, purchasing user-friendly vehicles, ensuring reliability and safety, and reducing petroleum consumption. Matching these elements with PEV capabilities will create new opportunities for fleet operators to improve performance.

Policy

States and local government agencies with policies conducive to PEVs and EVSE are more likely to attract investors, OEMs, and consumers. Public policy serves to incentivize infrastructure development, ease non-financial barriers to purchase, create financing options, and otherwise enable PEV adoption. Assessing the role of PEVs in the excise tax system will also help alleviate concerns surrounding the revenue shortfall for transportation infrastructure.

Regulatory and Utility

The continued provision of safe, reliable, reasonably priced electricity from the grid is required to power the PEV market and build consumer confidence in electricity as a transportation fuel. The incremental increase in electricity demand due to PEV charging is not expected to result in any grid impacts in the near term. However, electric utilities will continue to play an active role in monitoring PEV grid impacts as the market grows and proactively consider minimization strategies to avoid any such impacts. These utilities are also enabling the market in other ways, such as fleet electrification, consumer education, and other communication strategies.

Emissions Impact

Compared to internal combustion engine (ICE) vehicles, PEVs have the potential to reduce petroleum consumption and emissions of several air pollutants. This Plan includes a Colorado-specific emissions impact study with "wells-to-wheels" analysis to assess emissions across the entire life cycle of the vehicles. Under a high penetration scenario, the well-to-wheels emissions of greenhouse gases, carbon monoxide, volatile organic compounds, and nitrogen oxides are consistently lower with PEVs than ICE vehicles.

II. Introduction

This Plan is designed to help Colorado become a first tier market for PEVs. The recommendations contained within provide a menu of options, rather than strict guidelines, so that any industry leader can select the actions that are most appropriate to core competencies. Building on an in-depth look at the current status of the Colorado PEV market, the Plan provides a framework to increase the number PEVs on the road and create a statewide charging infrastructure.

For the purposes of this document, PEV includes any vehicle that draws electricity directly from electrical power sources (grid or off-grid) and uses electricity to power the motor. The PEV heading includes both battery-electric and hybrid-electric vehicles:

- Battery electric vehicles (BEVs), also called pure or all-electric vehicles, use electricity exclusively to power the engine, e.g. the Nissan Leaf or Ford Focus.
- Plug-in hybrid vehicles (PHEVs), which include extended range electric vehicles, use batteries which powers an electric motor in addition to another fuel, such as gasoline or diesel, to power an internal combustion engine (ICE vehicle); e.g. the Chevy Volt.

Electric vehicle supply equipment (EVSE) is used to refer to charging infrastructure. For a full list of definitions for terms and acronyms, refer to the glossary of terms (Appendix 1).

As the PEV market impacts the transportation, energy, and business environment in Colorado, the Plan's comprehensive analysis of the opportunities and challenges in a growing PEV market is crucial for all of Colorado as well as specific audiences. The following demonstrates the relevant information to each type of audience. Intended audiences are also listed by section throughout the document:

- *Policy-Makers* at both the state and local levels will find relevant information on the economic, social, and environmental impact of PEVs for their constituents as well as concrete policy actions that could advance the market. This Plan also provides guidance and recommendations for how localities can work together to promote a statewide and regional network for PEVs that also meets local and contextual needs.
- *Business Leaders* will find information on the business case for participating in both the PEV and EVSE markets. Businesses within the PEV/EVSE market will be interested in proposed business models, investment options, regulations, and success stories. The Plan also makes the case to business leaders outside the formal market to participate in promoting PEV adoption through workplace charging, incentive structures, or education.
- *Fleet or Operations Managers* will find specific information on how to match vehicle jobs and operations with the most cost-effective vehicle and financing options and other avenues to reap the benefits of this alternative fuel.
- *Utilities and Energy Professionals* will garner a new understanding for the role of utilities in enabling the PEV market, navigating the regulatory environment, and promoting electricity as a transportation fuel.
- *The General Public*, including current and potential consumers, interested citizens, and drivers, will find information on the key economic and practical benefits of PEVs, service providers and industry leaders, expected emissions and grid impacts, and general movement in the market. More information is available on the public education website, www.electricridecolorado.com.

About the Plan, Project FEVER

This Colorado PEV Readiness Plan is one of 16 projects, covering 25 states, funded by the U.S. Department of Energy (DOE) as part of the Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure Funding Opportunity (DE-FOA-0000451).

In Colorado, the DOE awarded the PEV Readiness grant (Award DE-EE0005584) to the Denver Metro Clean Cities Coalition (DMCCC), a program administered by the American Lung Association of Colorado, as part of their efforts to reduce petroleum consumption in the transportation sector. This one-year, $500,000 project is called Project FEVER (Fostering Electric Vehicle Expansion in the Rockies).

Through a collaborative research and analysis process, Project FEVER identified market barriers to PEV penetration in Colorado and developed strategies to overcome these barriers in the transportation and utility sectors. As a result of these efforts, this Colorado PEV Readiness Plan will serve to guide the PEV industry forward at the local, state, and national level.

Project FEVER Methodology

Project FEVER implemented a highly collaborative approach to ensure the development of a truly statewide plan, applicable in a variety of urban and rural settings. Stakeholders and industry experts were engaged throughout the entire process, from the grant proposal to the final PEV Readiness Plan.

Upon release of the DOE funding opportunity in March of 2011, DMCCC held a working meeting for leaders in the alternative fuel market to identify the major barriers facing PEVs in Colorado. Experts laid out all the market barriers, which were then classified into five key topic areas: permitting, planning, policy, regulatory, and education. These issue areas are the framework for both the grant proposal and implementation.

Upon grant award, the FEVER team had one year (October 1, 2011 through September 30, 2012) to organize the team, conduct collaborative research, and complete the Plan. Simultaneous to the industry research, FEVER implemented many public outreach events throughout 2012, such as Colorado PEV Day, a website event, and National Plug-in Day.

The project was administered under the direction of DMCC with the support of subcontractor and partner organizations. The core FEVER team was comprised of 13 local organizations that were awarded subcontracts to complete research, analysis, and outreach tasks. With both the Northern Colorado Clean Cities Coalition and Southern Colorado Clean Cities Coalitions as subcontractors, all three Colorado Clean Cities Coalitions were part of the effort. Further, a partner network representing more than 100 organizations and 180 individuals supported the project.

These stakeholders engaged in market research, analysis, and information gathering, according to their areas of expertise, through a series of meetings throughout 2012.

Issue Area	Meetings	Purpose
Regulatory and Utility	January 4 & June 26, 2012	Assess regulatory environment and determine grid minimization strategies and role of utilities
Permitting	January 30 & May 29, 2012	Assess permitting process and recommend improvements
Planning	January 31 & June 4, 2012	Develop best management practices for buildings, zoning regulations, and parking
Policy	February 21 & June 25, 2012	Assess and recommend state and local policy strategies
Education and Outreach	No Meetings[1]	Conduct public outreach efforts, including website and events
Fleets	April 25, 2012	Recommend actions to increase fleet electrification
Data	Several times throughout 2012	Provide data and quantitative analysis necessary to complete PEV/EVSE market forecasts and emissions study

For each meeting, Project FEVER facilitated discussions designed to capture partner expertise. The working group meetings successfully established the key limitations and gaps and developed recommendations to overcome these barriers. For the working groups that met twice, the first meeting focused on limitations and gaps while the second utilized storyboard exercises to achieve a solutions-oriented discussion that could develop recommendations and elicit action. The fleet working group was able to achieve both of these goals in one meeting.

The data group, established in January 2012, prepared the Assumptions and Methodologies paper (Appendix 2), which served to provide a common understanding of the market and the data required for the emissions impact study. This group consisted of several stakeholders and subcontractor agencies experienced in data collection, quantitative analysis, and market forecasting.

Finally, the information gathered throughout the partner engagement process was compiled into the final product, the Colorado PEV Readiness Plan. Under the direction of the Program Manager, the work of approximately 30 writers and ideas from 180 partners were compiled into this Plan over the course of 4 months. Partners reviewed and provided comments on Plan drafts through three stakeholder comment periods. The final draft was also reviewed by a professional editor and formatted by creative firm, rabble+rouser.

Given this collaborative approach, the ideas and recommendations presented in this Plan do not reflect the views or policies of any one organization or entity. Rather, this Plan provides a comprehensive analysis of the combined wisdom of the entire market. In particular, the recommendations represent a menu of options and a flexible path forward for a diverse set of individuals and entities, rather than a prescribed or mandated course of action. The future of the market rests on the ability of individual organizations to continue to overcome the market barriers and pursue actions that further the adoption of PEVs.

[1] The education and outreach working group provided input electronically throughout the project; the majority of campaign design was completed under a contract with local public relations firm, Rabble + Rouser, and implemented under the leadership of DMCCC.

Appendices

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Appendices are publicly available on *The Electric Ride* website (electricridecolorado.com).

III. Colorado PEV Market Assessment and Stakeholders

Section Summary:

This section provides an overview of the current PEV market in Colorado, including information on vehicle availability, market challenges and opportunities, consumer behavior, and stakeholder activities. By highlighting the unique characteristics in Colorado, the analysis demonstrates the momentum towards becoming a first-tier PEV market.

Audience:

Policy Makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

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With an ever-increasing number of PEVs and charging stations across the state and highly engaged industry stakeholders, Colorado presents a ununique opportunity to expand PEV adoption in both fleets and personal vehicles. While the state's geography and demographics bring challenges, Colorado is ideally suited to become a top-tier PEV market.

Signs of PEV growth are rampant. As of July 2012, there were nearly 1,300 registered PEVs in the state of Colorado and approximately 70 public charging stations. There are currently 11 PEV models available (or soon to be available) in the state, the most seen in the history of the market. In addition to these new vehicles, there are more than 200 consumer-driven conversion vehicles (ICE vehicles that have been converted to PEV either at home or at conversion shops).[2] For both new sales and aftermarket conversions, Colorado has one of the highest state tax credits available, bringing down the PEV purchase price by as much as $6,000. Combined with the $7,500 Federal tax credits, Colorado drivers can receive up to $13,500 off the purchase price of a PEV. This product choice and competitive pricing suggests that the PEV market is well situated to grow.

[2] The two conversion shops in Colorado are Duke's Garage and Boulder Hybrid Conversions.

Table 1: Current PEV models and estimated cost[3]

Make	Model	Vehicle Class	Year Introduced	Cost (starting at)	Total Federal[4] and State[5] Incentives	Estimated Total Cost after Federal and State Incentives (starting at)	Charging Level Support	Type
Ford[6]	Focus	Hatchback	June 2012	$39,995	F: $7,500 S: $6,500	$26,495	I/ II	BEV
Mitsubishi[7]	i (iMiev)	Hatchback	Dec. 2011	$29,125	F:$7,500 S:$4,770	$16,855	I/ II/ DCFC	BEV
Nissan[8]	Leaf	Hatchback	Dec. 2010	$35,200	F: $7,500 S: $6,000	$21,700	I/ II/ DCFC	BEV
Tesla[9]	Model S	Full Size	Mid 2012	$49,900	F: $7,500 S: $4,856	$37,544	I/ II/ DCFC	BEV
Tesla[10]	Roadster	Sport	Dec. 2011	$109,000	F: $7,500 S: $6,000	$95,500	I/ II	BEV
Toyota[11]	Rav4 EV	SUV	Sep. 2012	$49,800	F: $7,500 S: $6,000	$36,300	I/ II	BEV
Wheego	Whip LiFe	Compact	April 2011	$32,995	F: $7,500 S: $6,000	$19,495	I/ II	BEV
Chevrolet[12]	Volt	Compact	Dec. 2010	$39,145	F: $7,500 S: $6,000	$25,645	I/ II	PHEV
Fisker[13]	Karma	Sport/Sedan	July 2011	$105,000	F: $7,500 S: $6,000	$91,500	I/ II	PHEV
Ford[14]	C-MAX Energi	Wagon	Fall 2012	$33,745	F: $2,500 S: $1,225	$30,020	I/ II	PHEV
Toyota[15]	Prius	Hatchback	Jan. 2012	$32,000	F: $2,500 S: $1,055	$28,450	I/ II	PHEV

[3] The costs and available tax incentives listed here are for general information only and may be subject to change. Tax incentives may also depend on the individual's tax liability. Interested PEV purchasers should consult an accountant and dealership representative prior to purchase.

[4] *Qualified Vehicles Acquired after 12-31-2009*. Internal Revenue Service, n.d. Web. 2012. <http://www.irs.gov/Businesses/Qualified-Vehicles-Acquired-after-12-31-2009>.

[5] *FYI Income 67: Innovative Motor Vehicle Credit*. Colorado Department of Revenue Taxpayer Service Division, February, 2012. Web. 2012. <http://boulderhc.com/FYI_Income67.pdf>.

[6] *Focus Electric*. Ford Motor Company, n.d. Web. 2012. <http://www.ford.com/electric/focuselectric/2012/>.

[7] *i MiEV*. Mitsubishi Motors, n.d. Web. 2012. <http://www.mitsubishi-motors.com/special/ev/>.

[8] *Leaf*. Nissan USA, n.d. Web. 2012. <http://www.nissanusa.com/leaf-electric-car/index>.

[9] *Model S*. Tesla Motors, n.d. Web. 2012. <http://www.teslamotors.com/models/features#/performance>.

[10] *Roadster*. Tesla Motors, n.d. Web. 2012. <http://www.teslamotors.com/roadster/specs>.

[11] *Rav4 EV*. Toyota Motor Sales USA, n.d. Web. 2012. <http://www.toyota.com/rav4ev/index.html>.

[12] *2012 Volt*. General Motors, n.d. Web. 2012. <http://www.chevrolet.com/2012-volt-electric-car.html>.

[13] *Karma. Fisker,* n.d. Web. 2012. <http://onward.fiskerautomotive.com/en-us/karma/>.

[14] *Model: C-Max Energi*. Ford Motor Company. n.d. Web. 2012. <http://www.ford.com/cars/cmax/trim/energi/>.

[15] *Prius Plug-In Hybrid. Toyota Motor Sales USA, n.d. Web. 2012. <http://www.toyota.com/prius-plugin/trims-prices.html>.*

Table 2: EVSE Distribution as of 2012

Geographic Area	Number of EVSE
Denver Metro	54
Colorado Springs	4
Fort Collins	2
Federal Heights	2
Foxfield	1
Fountain	1
Monument	1
Longmont	2
Durango	1
Greeley	2
Pueblo	1

Table 3: Denver Metro Area EVSE Distribution

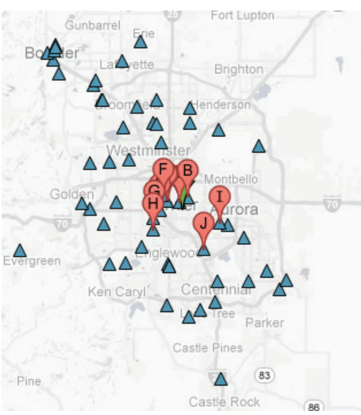
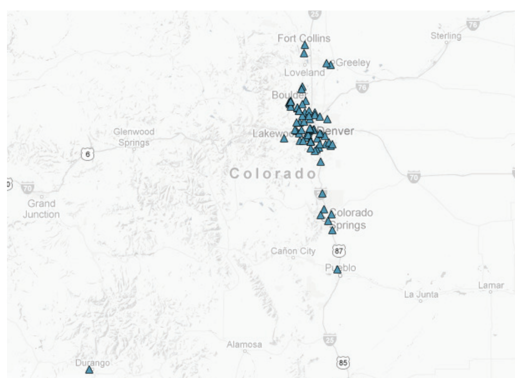


Table 4: Colorado EVSE Distribution



Further, other opportunities, such as stakeholder activities, the energy industry, and travel patterns, exist for the Colorado market. For one, stakeholder activities described in the following section demonstrate significant industry momentum, which can be capitalized on to drive growth.

Second, Colorado is home to a strong energy industry, which can serve to support PEV expansion efforts. Colorado is the fifth largest solar and 12th largest wind industry in the U.S.,[16] and has one of the most aggressive Renewable Portfolio Standards (RPS), requiring investor-owned utilities to provide 30% of retail electric sales from renewable energy sources by 2020. This means that PEVs powered from the grid will see less emissions impact over time, and PEV drivers might have more opportunity to install residential solar or wind charging options. The natural gas industry is also thriving in Colorado, making up 7.3% of the state economy and 6% of state jobs.[17] This means that PEVs can be powered on domestic sources and contribute to economic growth. Finding synergies between the PEV market and these domestic and renewable energy markets creates an opportunity to make a stronger economic and environmental case for PEVs in Colorado.

Lastly, the everyday travel and traffic patterns seen in Colorado are well suited to PEV capabilities. More than 85% of Colorado's population lies along the urban corridor from Fort Collins to Pueblo.[18] In these urban settings, the average one-way commute is only 8 miles.[19] Many commuters in these areas also use public transit, Regional Transportation District (RTD), options. The average daily commute for these travelers is only 5 miles.[20] All PEVs can meet this everyday travel demand using electric power. For occasional trips to the mountains, PHEVs provide a great option because they can go longer distances on gasoline. BEV drivers could access another vehicle or plan charging stops carefully on the occasions that long distance travel is required. Overall, drivers will find that PEVs can accommodate regular trip and travel patterns.

Despite this growing market potential, the Colorado PEV market does face a number of challenges. While some of these challenges are real market barriers that merit industry action, others are consumer perceptions that require education. Mainly, the cold winters and hot summers, mountain ranges, and distances between rural areas tend to raise questions about PEV performance, especially range.

First, the impact of temperature on battery performance, while real, may not hinder driver uses of the vehicle. For example, the biggest temperature-related drain on PEV batteries is the passenger use of the heat or air conditioning. Depending on the vehicle and the temperature, the use of the climate control system can decrease battery range up to 35% for BEVs,[21] but this impact is minimal the majority of the time (Table 5). Drivers can reduce this range impact by either pre-cooling or pre-heating a car while it is plugged in to an electric source.[22] Drivers must be educated on this potential for decreased range so that they can optimize driving and climate control patterns. However, this consumer awareness needs to be achieved in a way that does not continue to dampen excitement around the PEVs.[23]

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16 "Renewable Energy in Colorado." American Council on Renewable Energy. Feb. 2011. Web. 2012. <http://acore.org/files/pdfs/states/Colorado.pdf>.

17 "Natural Gas." Colorado Oil & Gas Association, n.d. Web. 2012. <http://www.coga.org/index.php/Natural%20Gas>.

18 "Understanding Colorado Regions." 9 News. Multimedia Holdings Company, 22 August 2012. Web. 2012. <http://www.9news.com/weather/resources/region_guide/default.aspx>.

19 Denver Regional Council of Governments. "Front Range Travel Counts Household Survey Data Released." Front Range Travel Counts, 20 June 2011. PDF file.

20 Cryer, Lee. "Re: RTD." Message to FEVER Team. 4 September 2012.

21 Barnitt, Rob A., Aaron D. Brooker, Laurie Ramroth, John Rugh, and Kandler A. Smith, National Renewable Energy Laboratory. Analysis of Off-Board Powered Thermal Preconditioning in Electric Drive Vehicles." Presented at the 25th World Battery, Hybrid, and Fuel Cell Electric Vehicle Symposium & Exhibition, Shenzhen, China, November 5-9, 2010. Golden, Colorado, 2010. Print. 2.

22 Barnitt, et al., 2010, 6.

23 Shepard, Scott. Colorado Energy Office. Colorado's Place in the Changing Face of Transportation. Denver Colorado, 2011. Web and print.

Table 5: Average ranges with climate control by PEV type[24]

	Range with No Climate Control (miles)	Range with Heat (miles)	Range with AC (miles)
PHEV15 (Prius Plug-In)	11.7	9.4	7.9
PHEV40 (Volt)	36.8	23.9	24.3
BEV 100 (Leaf)	101.7	66.4	68.5

Another unique challenge to Colorado is the misperception that high altitude negatively affects operation of a PEV. Altitude has no impact on PEV operational performance any more than a conventional car. However, while the altitude itself is not an issue, both ICE vehicles and PEVs require more power to ascend hills, which decreases the vehicle range. For ICE vehicles and PHEVs that can easily refuel on gasoline, the impact of the lower range is minimal; however, BEV drivers will need to carefully plan charging points to account for the decreased range.

Lastly, Colorado's varied topography and geographic span present challenges in terms of accommodating rural and recreational transportation that effect vehicle purchasing decisions. Many Colorado residents live in rural mountain communities or make long drives through the mountains on a consistent basis. These travel patterns may make PEVs less attractive as a primary household vehicle; thus, adoption rates might be slower for this population. However, there may be ways to accommodate these trips and make PEV technology a possibility. In the short term, PHEVs, with extended range and a gasoline fueling option, can accommodate these travel patterns. In the long term, building a charging infrastructure that connects urban areas along the Front Range I-25 corridor as well as recreation and resort areas along the mountainous I-70 corridor from Denver to Grand Junction will support PEVs as a primary transportation option.

Overall, Colorado benefits from a strong energy industry, significant involvement of business and market leaders across all industries, and several dense urban areas. Overcoming the remaining market barriers has the potential to unleash new economic and environmental opportunities for the state.

Colorado PEV Consumer Analysis

Ultimately, PEV market growth depends on Colorado drivers switching to electric. To understand these drivers, the following section analyzes the demographics and decision factors of PEV consumers. To help us understand unique attributes of Colorado PEV owners, 16 Colorado PEV owners were surveyed in a Colorado-based study. The results of the study were then compared to the current literature on PEV users across three areas: demographics, PEV purchase decision criteria, and charging patterns. In the near term, the demographic characteristics of current PEV owners can be used to predict the next set of adopters and target marketing efforts. In the long-term, the decision criteria and process of these groups will play a key role in determining the future of product and infrastructure development. The full study is in Appendix 3: Colorado Based Study on PEV Consumers.

[24] These scenarios assume an AC operating at 95 degrees and heat at 20 degrees (Fahrenheit). Barnitt, et al., 2010, 5.

Demographics

Current literature has identified PEV consumers as "early adopters,"[25] a set of consumers that others in the social system look to before choosing to adopt an innovation.[26] The results of this analysis reveal that Colorado PEV owners share demographic similarities with the average United States PEV consumer, as seen in Table 6.

Table 6: Demographic Characteristics of Colorado and U.S. PEV Drivers

Demographic Characteristics	US consumer[27]	Colorado Study Participants
Wealth	Income over $100,000	More than 55% with income over $100,000 or more; 25% income between $40,000-$70,000
Education	College degree or higher	Bachelors or higher
Vehicle Ownership	2 or more vehicles	75% own two or more vehicles
Age	50 or older	38 to 78
Political Affiliation	Democrats, Greens, and Independents	Democrats

PEV Purchasing and Charging Decision Criteria

Despite demographic similarities, the criteria driving PEV purchases are slightly different for Coloradans than the average consumer. Based on the survey of the 16 Colorado drivers, the top considerations include environmental impacts, purchase costs, range, and dependence on foreign oil. These concerns match closely with the purchase reasons cited by Nissan Leaf owners: environmental impact (40% of owners), cost savings (20% of owners), and oil independence (40%).[28] However, they are slightly different than the average U.S. consumer, for whom the environment and foreign oil dependence is not a top decision factor, but operational expense, purchase cost, and range are major factors.

[25] Deloitte. Gaining Traction: A Customer View of Electric Vehicle Mass Adoption in the U.S. Automotive Market." Deloitte Development LLC. 2010.

[26] Sahin, Ismail. "Detailed Review of Rogers' Diffusion of Innovations Theory and Educational Technology-Related Studies Based on Rogers' Theory." The Turkish Journal of Educational Technology 6.2 (April, 2006):19. Web. 2012. <http://www.tojet.net/articles/v5i2/523.pdf>.

[27] Heutel, Garth, and Erich Muehlegger. "Consumer Learning and Hybrid Vehicle Adoption." HKS Faculty Research Working Paper Series, RWP10-013, John F. Kennedy School of Government, Harvard University. 2010. Web. <http://dash.harvard.edu/bitstream/handle/1/4448996/Heutel_Consumer-Learning.pdf?sequence=1.Scarborough Research. "Hybrid Vehicle Owners are Wealthy, Active, Educated and Overwhelmingly Democratic." Hybrid Vehicle Owners are Wealthy, Active, Educated and Overwhelmingly Democratic, According to Scarborough. Scarborough Research USA, 4 December 2007. Web. 2012. http://scarborough.com/press_releases/Scarborough-Hybrid-Vehicle-Owner-Consumer-Profile.pdf.

[28] Nissan. EV Market and Consumer Presentation, EV Conference in Los Angeles.

Once an owner, PEV drivers will decide how and where to charge. For all PEV drivers, the main decision factors determining charging behavior include access to home charging, economics, and range. The most important criterion for charging decisions is the ability to charge at home: about 80% of the charging events take place at residential locations.[29] The next most important criteria include economic considerations, such as the cost of charging, and vehicle range. In terms of range, consumers are look at commuting distance and location of charging stations.

These decision factors demonstrate that overcoming "range anxiety" is a factor in making both PEV charging and purchasing decisions. Further, ensuring access to home charging, even in multi-unit dwellings or areas without dedicated parking spots, will be crucial for the growth of the consumer PEV market.

A full analysis of this study, methodology, and findings are provided in Appendix 3: Colorado Based Study on PEV Consumers. Industry professionals can find more information to target future outreach efforts in Appendix 4, including, flow diagrams of decision factors and a tool for potential PEV purchasers to evaluate their personal decisions is provided in this Appendix 4.

PEV Business Case

While customers will consider a variety of non-financial factors, financial factors may play a dominant role in a PEV purchase. Despite higher upfront costs, PEVs actually represent an opportunity for drivers to pay lower total ownership costs. The following compares the costs of PEVs to ICE vehicles across three major ownership milestones: purchase, ownership, and resale. The final Table 10 summarizes the total cost of ownership of PEVs versus ICE vehicles, demonstrating the potential for costs savings over the life of a PEV.

Purchase: On the day of purchase, drivers can expect to pay more for a PEV. With the tax credits available through 2015, Coloradans would pay an additional $275 to $2,400 for a PEV instead of a comparable ICE vehicle.[30] In the absence of federal and state tax credits, this price difference is higher. However, the price differences between PEVs and ICE vehicles are expected to decrease over time as battery technology develops. By 2017, the price difference without taxes is expected to be between $3,600 and $11,000. Notably, these estimates assume conservative battery development, with battery costs at $250 per kWh in 2020. More dramatic decreases in battery costs are possible, which would further reduce incremental difference in purchase prices.[31]

[29] Refer to Appendix 4.

[30] Colorado Department of Revenue Division of Taxation. Alternative Fuel Income Tax Credits. State of Colorado, 2012. Web. 2012. <http://www.colorado.gov/cs/Satellite?c=Document_C&cid=1178305445492&pagename=Revenue%2FDocument_C%2FREVXAddLink>.

[31] Lower battery costs are expected to reduce incremental PEV purchase costs by up to 47% by 2017, 75% by 2025 and 80% by 2030. Southwest Energy Efficiency Project. Net Economic Benefits of Replacing Gasoline Vehicles with Plug-in Electric Vehicles Support Policies to Reduce Barriers to Electric Vehicle Ownership. Presented to Senate Transportation Committee. Issue brief. 2012. Print.

Table 7: Incremental PEV Purchase Price[32]

	2015		2017
	With Federal and State Tax Credits	Without Federal and State Tax Credits	Without Federal and State Tax Credits (expired)
PHEV-10	$2,400	$4,400	$3,615
PHEV-40	$1,200	$14,700	$11,260
BEV	$275	$275	$7,598

Ownership: The incremental price difference of purchasing a PEV can be recuperated across the life of the vehicle: PEV owners will reap savings through lower fuel and maintenance costs. In fuel costs alone, PEVs offer a great opportunity to save money.

At current prices, a PEV driver pays approximately $0.1104 per kwh,[33] which translates to 3.9 cents per mile. An ICE vehicle driver getting 22 mpg pays $3.50 per gallon, or 15.8 cents per mile. Thus, PEV drivers save 11.9 cents per mile in fuel costs. A case study in Boulder showed PEV drivers saving up to 7.6 cents per mile ($2.68 per gallon equivalent).[34] For a person that drives 11,000 miles per year, 11.9 cents of savings per mile translates into an annual fuel cost savings of $1,319. These savings are also expected to increase over time as electricity prices remain low and fuel prices increase.

Further, BEV drivers will see lower annual maintenance costs since electric motors have fewer moving parts and do not require continual maintenance operations such as oil changes. With maintenances costs of approximately 2.22 cents per mile,[35] the annual maintenance costs of BEVs are estimated to be up to 50% less than ICE vehicles,[36] for an annual savings of $244 for a vehicle driving 11,000 miles.

[32] Sankey, Paul, David T. Clark, and Silvio Micheloto. "The End of the Oil Age 2011 and beyond: a reality." Deutsche Bank. Global Markets Research Company, 22 December 2010 Web. 2012. <http://bioage.typepad.com/files/1223fm-05.pdf>;
Transportation's Role in Reducing US Greenhouse Gas Emissions. Department of Transportation, April 2010. Web. 2012. <http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf>;
The Recovery Act: Transforming America's Transportation Sector. Department of Energy, 14 July 2010. Web. 2012. <http://www.whitehouse.gov/files/documents/Battery-and-Electric-Vehicle-Report-FINAL.pdf>.

[33] US Energy Information Administration Census Division. Residential average monthly bill. Department of Energy, 2011. Web. 2012. <http://www.eia.gov/electricity/sales_revenue_price/xls/table5_a.xls>.

[34] Farhar, Barbara, Dragan Maksimovic, and Alison Peters. The Human Dimensions of Plug-In Hybrid Electric Vehicles in Boulder. Renewable and Sustainable Energy Institute at CU Boulder, 18 September 2012. Web 2012. <https://www.dora.state.co.us/pls/efi/EFI.Run_Document?p_session_id=&p_document_id=3602858>.

[35] ICE vehicles average $0.0444 per mile.

[36] Van den Bulk, Joost. "Costs of the electric car." Olino Renewable Energy, 17 February 2009. Web. 2012. <http://www.olino.org/us/articles/2009/02/17/costs-of-the-electric-car >;
"Getting Charged Up Over Electric Vehicles." Touchstone Energy. n.d. Web. 2012. <http://www.touchstoneenergy.com/efficiency/bea/Pages/GettingChargedUp.aspx>;
Cuenca, R.M., L.L. Gaines, and A.D. Vyas. Evaluation of Electric Vehicle Production and Operating Costs. Center for Transportation Research, Energy Systems Division, Argonne National Laboratory, Department of Energy, November 1999. Web. 2012. <http://www.transportation.anl.gov/pdfs/HV/14.pdf>.

On the cost side, the potential (although unlikely) operating cost for a PEV is a battery replacement outside the vehicle manufacturer's warranty period. A non-warranty battery replacement is only expected after 10 years of ownership.[37] Although all current vehicle models are within their warranty period, battery replacement is estimated at approximately $250 per kWh of battery capacity[38] which translates to approximately $6,000.

Re-sale/Residual value: The main factors determining the re-sale value of a PEV are the residual values of the battery and vehicle. A significant portion of the battery cost may be recovered through residual battery markets which are continuously developing. The residual value is currently estimated between $397 and $3,010 (Table 9). However, the residual value of the vehicle is currently unknown due to variability in the market as a whole. Initial estimates in 2011 suggest that the value will decrease 43% over 3 years, which suggests a zero resale value after a 10-year vehicle life. Even with these low values, PEV owners may still see lower costs of ownership.

Table 8: Residual Value of PEV Batteries[39]

	Residual Value	Residual Value (NPV)
PHEV-10	$850	$397
PHEV-40	$3,230	$1,510
BEV-100	$6,450	$3,010

Considering these costs and savings across purchase and ownership, the following provides a back-of-the-envelope look at the total cost of ownership of a PEV as compared to a comparable ICE vehicle:[40]

Table 9: Total Cost of Ownership of PEVs versus ICE vehicles

Assumptions: Tax credits applied with purchase, 11,000 miles driven per year for 10 years, zero residual vehicle value

	Line Item	PHEV-40	BEV
Purchase	Incremental upfront cost	-$1,200	-$275
	Incremental purchase cost	**($1,200)**	**($275)**

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[37] Smith, Kandler, Mathew Earleywine, Eric Wood, and Ahmad Pesaran. Comparison of Battery Life across Real-World Automotive Drive-Cycles. National Renewable Energy Laboratory. 7-8 November 2011. Web. 2012. <http://www.nrel.gov/docs/fy12osti/53470.pdf>.

[38] Sankey, Paul, David T. Clark, and Silvio Micheloto. "The End of the Oil Age 2011 and Beyond: A Reality." Deutsche Bank. Global Markets Research Company, 22 December 2010 Web. 2012. <http://bioage.typepad.com/files/1223fm-05.pdf>.

[39] Williams, Brett. Plug-In-Vehicle Battery Second Life: Integrating Grid Energy-Storage Value. Transportation Sustainability Research Center, University of California Berkeley, 16 December 2011. Web. <http://phev.ucdavis.edu/research/pge-symposium/Williams%20PGE.pdf>.

[40] This analysis does not include potential differences in depreciation of the value of the vehicles.

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	Line Item	PHEV-40	BEV
Ownership	Annual Fuel Savings	$791	$1,319
	Annual maintenance savings	$0	$244
	Annual savings	$791	$1,563
	Total savings after 10 years	**$7,912**	**$15,627**
Re-sale	Residual Value of Battery	$1,510	$3,010
	Residual Value of Vehicle	$0	$0
	Total Re-sale	**$1,510**	**$3,010**
Total ownership costs/savings		$8,222	$18,362

In this scenario, where tax credits are applied and no battery replacement is required, PEV drivers recoup the incremental purchase price difference in 1 to 2 years (PHEVs in under two years and BEVs within a year) and see significant lower total costs of ownership (PHEVs over $8,000 in savings, and BEVs over $18,000). Considering these expected lifecycle costs of ownership, there is a strong financial benefit to purchasing a PEV in Colorado.

Despite this positive financial outlook, the higher up-front purchase price remains a deterrent for some potential buyers. According to one survey, if the PEV purchase price were the same as a comparable ICE vehicle, 60% of consumers would consider purchasing the PEV. When that PEV purchase price is higher, only 26% would consider the purchase, even if the additional cost is recovered over the life of the vehicle.[41] As such, until the market purchase price for PEV comes down, ensuring consumers are aware of the savings potential, tax credits, and other financial benefits of PEV ownership will be important to attracting new PEV owners. The recommendations below provide avenues to strengthen the business case, and overcome remaining reluctance to pay the additional up-front costs for a new, emerging technology:

- Leverage non-financial values of the PEV driver experience: quiet, smooth driving with exceptional ride and handling and exciting torque.
- Promote battery technology development: As the largest cost contributor to the price of PEVs, improved battery efficiently and economies of scale will bring down the costs of PEVs.
- Educate the public: Distribute and develop PEV user guides (Appendix 5: PEV Consumer Handout) to demonstrate the business case to general consumers.
- Spread the word on tax credits: The Colorado tax credits significantly reduce the incremental price of PEVs. Making sure consumers know how to access tax incentives reduces one financial barrier. (See education and policy sections)
- Use real-life examples to demonstrate cost savings: Since some lifecycle costs have yet to be proven in the real world, collect and disseminate information regarding cost savings realized by Colorado PEV owners.
- Create an end-of-life market for PEV batteries: Continue research into stationary energy storage units or other uses to ensure batteries maintain residual value.

[41] Lovy, Howard. "In Michigan, automakers plan road to the future." Midwest Energy News. Re-Amp, 14 Aug. 2012. Web. 2012. <http://www.midwestenergynews.com/2012/08/14/in-michigan-automakers-plan-road-to-the-future/#.UCun5LTDiOo.email>.

Colorado PEV Market Achievements

With a solid understanding of the current PEV market and consumer, organizations in Colorado across all sectors, including utilities, businesses, government, and transit agencies, are taking the lead in creating an infrastructure and marketplace that encourages PEV market expansion.

As evidenced by the 106 partner organizations engaged in this particular PEV project, significant momentum has been achieved in Colorado. In addition, these stakeholders have enthusiastically promoted the PEV market through a variety of activities in the last 5 years, successfully overcoming market barriers. Based on a stakeholder survey, the section below highlights the significant achievements of several Colorado industry leaders:

Government Activities To-Date

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
City of Colorado Springs, Parking Enterprise	Purchased a PEV for maintenance within garages						
City of Boulder	Modeled the GHG emissions of PEV in the city fleet using the Argonne National Laboratory's GREET tool Worked under IBM Smarter Cities Challenge to examine smart grid network and next steps for PEVs Awarded a federal grant of $500,000 for the "Boulder Smart Grid - Plug-In / Electric Hybrid Vehicle Project" Purchased 3 PEVs (2 for fleet, 1 for car sharing) and installed 7 EVSE Co-hosted an EVSE ad Energy Performance Contract ribbon cutting with more than 175 attendees	Receiving great comments from citizens about PEVs on the streets	x	x		x	x

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Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
High Plains Library District	Included PEV fleet and EVSE facility integration into Sustainability Statement that guides organizational decisions			x		x	x
City and County of Denver	Incorporated 3 PEVs into fleet Led by example: participate and display PEVs at public events. Deployed 2 EVSE to 2 non-profit entities in the community Installing 2 EVSE at Denver Performing Arts Center, 2 EVSE by the Denver Art Museum, and 5 EVSE in the west parking garage at Denver International Airport (DIA) DIA has 1 EVSE and 50 parking spaces allocated for PEVs and hybrids	Air quality benefits and fuel diversification Networking with stakeholders in alternative transportation Collaboration on projects with other cities to identify solutions and mitigate barriers		x	x	x	x
City of Aurora	Beginning the process of identifying and installing EVSEs at facilities Assigned a planner as a point of contact for PEV infrastructure issues Incorporated PEV into new development and coordination with the regional initiative	Introducing the subject to city management Regional consistency in policy and infrastructure		x		x	x

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
Colorado State Fleet Management	Integrated retrofitted PHEV and 3 PEVs into the fleet Installed 9 EVSE	Reduce petroleum usage, as part of Greening Government goals	x	x		x	x
Mesa Verde National Park	Applied for Clean Cities grant to acquire PEVs and install EVSE (not funded) Planning deployment of sustainability program	Increased knowledge and understanding of the topic				x	x

Private Sector: Activities To-Date

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
RunAbout Cycles Inc.	Increased awareness and acceptance through promotions, shows, education, events, races, and digital communication	Created awareness about products	x				x
OpConnect, LLC	Deployed numerous charging stations to cities across the nation at Naval bases, Enterprise Rent-a-Car locations, Doubletree Hilton, among other locations Supported pilot programs and efforts to build awareness for PEV adoption		x				x

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Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
OpConnect, LLC	Worked with Clean Cities Coalitions, cities, counties, universities, the Navy, and private businesses to plan and build the PEV infrastructure Participated in the Washington Metro Council of Governments	Grow brand recognition and reputation as a thought and technology leader throughout the PEV community		x		x	x
Schneider Electric	Worked to develop standards for EVSE Raised awareness of the value of PEVs beyond the environmental benefits	Improved awareness of Schneider Electric and company's involvement in supporting the implementation of PEV's	x	x	x	x	x
Fleet Energy Company	Contributed research, forecasting, and pilot implementation to promote PEV adoption Initiated the first vehicle-to-grid demo project with a consortium of utility, auto manufacturer, university, fleet operator and vehicle outfitters	Set priorities for vehicle to grid (V2G) projects to occur in Colorado	x			x	
The EV Information Exchange (EVIX)	Provided market penetration and infrastructure readiness reports to ~100 utilities on behalf of 4 major PEV manufacturers and EVSE partners. Signing data sharing agreements with four other PEV OEMs	PEV activities have broadened partner base to include utilities and governments	x	x		x	x

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
The EV Information Exchange (EVIX)	Enabled utilities to understand where PEVs are being charged and understand potential impact to electrical service equipment Conducted advanced statistical analysis for PEV industry stakeholders, including market segmentation and propensity profiling Conducted internal market planning, education and outreach, proof of regulatory compliance and policy lobbying Helped utilities prevent PEV-related infrastructure issues and provided the framework for strategic education and outreach campaigns	Showcasing data and software expertise has led to new business, both related and not related to PEVs	x	x		x	x
General Motors	Conducted unprecedented transparency into building an advanced vehicle, the Volt Built partnerships necessary to ensure the Volt's success Collaborated with organizations across the U.S., including Rocky Mountain Institute's Project Get Ready, EPRI, NFPA, EVITP Conducted technology demonstrations with OnStar	The Chevrolet Volt showcases the ingenuity and spirit of the new General Motors	x	x	x	x	x

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Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
General Motors	Conducted “Klout Influencer” social media campaign in Denver to build awareness Collaborate with Colorado stakeholders on ride-and-drive and outreach events Provide first-hand progress of the total number for PEV miles driven and number of gallons of gasoline saved: www.chevrolet.com/volt		x	x	x	x	x
Dietze and Davis	Supported passage of legislation to allow EVSE providers to re-sell electricity as a third-party without being regulated as a public utility (HB12-1258) Testified before the legislature on two occasions in support of the bill		x			x	

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
IKEA Centennial	Provided EVSE across the U.S. as a benefit to visitors as part of overall focus on sustainability		x			x	x
Zam Energy	Developed Solar PEV Charging for workplace and public sectors Assisted the City of Boulder to integrate pure Solar charging stations	Opportunity to expand market with installations experience	x	x			
Eaton Corporation	Supplied EVSE equipment Worked with vehicle OEMs on compatibility issues Incorporated equipment into SmartGrid projects	Increase in net business sales and increased stature as a responsible manufacturer	x	x	x	x	x
VIA Motors, Inc.	Developed eREV technology platform Engaged largest U.S. fleets in Beta eREV vehicle testing program Initiated deployment of these vehicles		x			x	x

Non-profit: Activities To-Date

Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
CSU Ventures Systems Solutions Group & Colorado State University College of Engineering	Incorporated PEV core content in college-level education and education websites, e.g. www.goorulearning.com, a web-based platform for teaching and learning for K-12						x
Energy Efficiency Business Coalition	Advocated for Xcel Energy to run a PEV charging pilot through DSM programs Xcel Energy agreed to run a pilot program to test PEV demand management/demand response products			x		x	x
Denver Museum of Nature & Science	Installed public EVSE		x				x
Southwest Energy Efficiency Project	Worked on house bills for PEV tax credits and to deregulate sales of electricity for EVSE stations Presented analysis on the economic benefits of PEVs to the state			x			x
Regional Air Quality Council	Involved with policy promotion, education, outreach, and secured grant funding Obtained grant funding to support EVSE Planned forum in November	Air quality and fuel savings for partners	x	x	x	x	x

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Organization	PEV Activities And Outcomes In The Last 5 Years	Organizational Benefits Resulting From PEV Activities	Regulatory	Planning	Permitting	Policy	Education
University of Colorado at Boulder	Installed EVSE in a parking garage Showcased new PEV technologies Determined the effects of significant PEV adoption on the power system and on overall air quality in the state of Colorado			x		x	x
The Renewable Energy Initiative (TREI)	Provided more than a dozen Drive SunShine corporate and community test drive events for major employers in the Denver Metro Area Developed partnerships with individual dealerships in Colorado	Reached 2,000 potential purchasers through 200+ test drives A national leader in providing corporate test drives					x

Utility: Activities To-Date

Organization	PEV Activities and Outcomes in the last 5 years	Organizational benefits resulting from PEV activities	Regulatory	Planning	Permitting	Policy	Education
Colorado Springs Utilities	Partnered with Norwood Development to install Colorado Springs first public charging station Developed a local PEV readiness strategy						

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Organization	PEV Activities and Outcomes in the last 5 years	Organizational benefits resulting from PEV activities	Regulatory	Planning	Permitting	Policy	Education
Black Hills/Colorado Electric Utility Company, LP d/b/a Black Hills Energy	Acquired a Chevrolet Volt for the company fleet with vehicle wrap-advertising	Early adoption of PEV technology for company fleet operations	x				
Xcel Energy	Committed to the PEV market readiness pledge from Edison Electric Institute (EEI) Pursued demonstration projects with the Toyota Prius PEV and Ford Transit Connect EVSE outreach, including hosting Clean Transportation Group meetings, customer support, website information/fact sheets, repowering transportation inbox, and call center staff training	Learned about customer's interest in the technology and its potential to lower their transportation cost, increase the efficient utilization of infrastructure, and improve the environment	x			x	x

IV. PEV/EVSE Market Forecasts

Section Summary:

To enable and plan for expanding PEV transportation, the following section answers two questions: How much growth is expected? Where and when will it occur? Based on projected sales and other data, three market penetration scenarios forecast the expected growth in PEV adoption and corresponding EVSE infrastructure in Colorado in 2015 and 2025. The EVSE forecasts include information on the number of charging stations by type (level), location (residential, workplace, or public), and geography necessary to accommodate the PEV growth.

For a detailed description of the assumptions, data, and methodology underlying this analysis and scenario development, refer to Appendix 2: Assumptions and Methodologies.

Audience:

Policy-makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

PEV Market Penetration Scenarios, 2015 and 2025

The following three PEV market penetration scenarios provide a framework to understand and plan for the growth of PEVs in Colorado. Based on current and projected sales data, these scenarios represent the expected integration of PEVs in the Colorado light duty vehicle (LDV)[42] fleet over the next 12 years. The scenarios will be referenced throughout this Plan as the basis for further analysis and planning efforts.

The 3 scenarios—baseline, medium, and high—are provided for the PEV market in 2015 and 2025 in Table 11: Colorado PEV Market Penetration Scenarios for 2015 and 2025. The baseline scenario is the least aggressive, anticipating 103,881 PEVs in 2025, or 2.2% of the LDV fleet. The high scenario is the most aggressive, anticipating 471,477 PEVs in 2025, or 10.2% of the market. The scenarios are based on projected light duty sales estimates from the Energy Information Administration (EIA) and the Environmental Protection Agency (EPA) applied to the Colorado market, assuming the Colorado LDV makes up 24.1% of the Rocky Mountain Region's fleet.

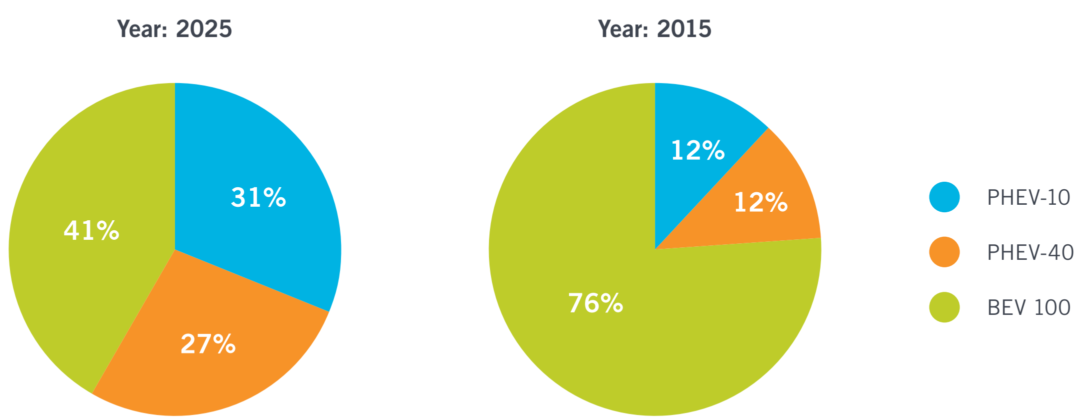
[42] Light duty vehicles include all vehicles and trucks under 8,500 pounds.

Table 10: Colorado PEV Market Penetration Scenarios for 2015 and 2025[43]

	2015			2025		
	% of Sales	% LDV	Total PEVs	% of Sales	% LDV	Total PEVs
Baseline[44]	2.3%	0.6%	27,677	3.9%	2.2%	103,881
Medium[45]	4.3%	0.8%	34,747	13.0%	6.1%	287,679
High[46]	6.3%	1.0%	41,818	22.1%	10.2%	471,477

Breaking down the PEVs by type, PHEV or BEV, Colorado will likely see a relatively even split, with the exception of a low penetration scenario in 2015. Under a low penetration scenario, EIA data[47] suggests that BEVs will make up a higher percentage of sales in 2015, but will become even by 2025. Under a high scenario, there is a relatively even split between BEVs and PHEVs in both 2015 and 2025. While driving patterns and infrastructure needs are slightly different for BEV and PHEVs, the goal is to enable the highest number of vehicle miles to be powered by electricity, thus this breakdown may not ultimately affect planning efforts.

Table 11: Percentage breakdown of PEVs by Vehicle type, Low Penetration Scenarios



[43] The analysis assumes that vehicle retirement and rollover will have no effect on the number of PEVs for this analysis. The average life of a light duty vehicle in Colorado is between 12 and 13 years (per CDOT), and the final analysis year (2025) is 12 years from the current year.

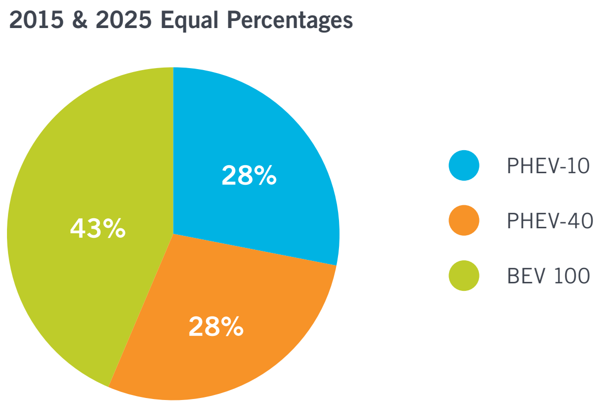
[44] US Energy Information Administration. *High Oil Price scenario, Transportation Demand Sector. Table 48: Light Duty Vehicle Sales by Technology, Report DOE/EIA-0383*. Department of Energy, 2011. Web. 2011. <http://www.eia.gov/forecasts/archive/aeo11/data_side_cases.cfm#tabs-3>.

[45] The medium scenario is an average of the Baseline and High Scenarios.

[46] *EPA Analysis of the Transportation Sector: Greenhouse Gas and Oil Reduction Scenarios.* Environmental Protection Agency, 10 February 2010. Web, 2011. <http://www.epa.gov/oms/climate/GHGtransportation-analysis03-18-2010.pdf>.

[47] The sales percentages are based on the Energy Information Administration forecasts and projections retrieved in early 2012. They do not reflect OEM or actual sales numbers.

Table 12: Percentage breakdown of PEVs by vehicle type, High Penetration Scenarios



EVSE Market Penetration Scenarios: 2015 and 2025

The EVSE market penetration scenarios provide insight into the type and distribution of the charging infrastructure needed to fuel the projected vehicle growth. Planners and business leaders can use the distribution analysis to understand potential high-density growth areas and make profitable investment decisions. However, EVSE technology and standards are evolving rapidly and these projections are only based on the current understanding of market conditions. Decision makers will need to consider market changes across several characteristics, including:

- PEV technology, range, and cost
- Commuting and travel patterns of PEV owners
- Demographic profiles of PEV owners
- Population growth
- Fuel prices
- Government policies and incentives
- Automakers' priorities and marketing strategies
- Other market drivers

Based on the current status of these market drivers, early adopter charging patterns indicate that drivers will spend the most time plugged-in at residential locations and secondarily at workplaces and public attraction sites. Compiling research from charging pattern studies in both Colorado and elsewhere, Table 13 demonstrates the breakdown of charging time at each location. Residential charging will account for up to 95% of charging events in 2015 and up to 75% in 2025. This shift to residential fueling represents a significant difference from fueling patterns for traditional vehicles and requires a different outlook for infrastructure planning. Workplace and public attraction charging become increasingly important over time, making up to 35% and 10% of charging events respectively in 2025.

Table 13: Percentage of Charging Events by Location Category

Charging Location	2015	2025
Residential	75-95%	60-75%
Work Place	5-20%	15-35%
Public Attractions	0-5%	5-10%

Based on this new fueling behavior, Table 15 demonstrates the number of EVSE needed to accommodate charging at each location. In total, between 128,852 and 591,662 EVSE will be needed by 2025. As reflected in the higher percentages of charging events occurring at residential locations, the majority of these charging stations (including standard 120V outlets) will be installed at residences.

Table 14: Number Of EVSE By Location Category And Year[48]

	2015			2025		
	Low	Medium	High	Low	Medium	High
Residential	27,677	34,747	41,818	103,881	287,679	471,477
Work Place	2,768	3,475	4,182	10,388	28,768	47,148
Public Attraction	5,535	6,949	8,364	20,776	57,536	94,295
Total:	**35,980**	**45,171**	**54,364**	**135,045**	**373,983**	**612,920**

These projections demonstrate significant opportunity for the EVSE market. In order to achieve these numbers, a variety of stakeholders will need to be engaged and motivated to participate in the EVSE market. Providing charging access at a variety of locations will enable PEV drivers to overcome range anxiety. Building this infrastructure is crucial to providing the range and fueling options necessary to attract new PEV drivers to the market. A plan to engage these stakeholders and deploy the charging infrastructure is discussed in the next section, EVSE Deployment Plan.

[48] EVSE projections are derived from the PEV penetration scenarios in 2015 and 2025. Slightly different EVSE projections were used for the mapping exercise.
Appendix 6: Charging Station Analysis.

V. EVSE Deployment Plan

Section Summary:

The EVSE deployment plan provides the framework for Colorado to build a robust statewide EVSE infrastructure, foster investment in the market, and create an environment for PEV technology to thrive. The full cost of the statewide infrastructure is considered along with EVSE deployment plans for each charging location. Ownership models and compelling business cases are also presented for individual entities seeking to participate in the EVSE infrastructure market.

Audience:

Policy-makers, Business Leaders, Utilities and Energy Professionals, and the General Public

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This EVSE deployment plan addresses two major barriers to PEV adoption. First, a high-level deployment plan will ensure that investments in EVSE infrastructure are cost effective, highly utilized, and create a network that truly serves the entire state. Providing a master plan not only promotes smart transportation infrastructure, but also assures potential PEV consumers that fueling needs will be met in a systematic and effective manner. From rural areas like Delta or Gunnison to dense urban populations like Denver, Coloradans can be confident that they can get where they want to go in a PEV.

Second, a deployment plan will help spur the investment and action necessary to create a long-term EVSE infrastructure by providing investors with a level of certainty. In the absence of a plan, the charging network will continue to develop in an ad-hoc manner and struggle to compete with the well-developed gasoline infrastructure. The following provides analysis on the investment and planning necessary to create this charging network at a state and individual location level.

Statewide Infrastructure Cost Analysis

To meet charging demand in 2025, investors and consumers in all sectors will participate in installing charging stations one-by-one over the course of many years. Due to the evolving nature of this new market, the current cost estimates provide a general framework to understand the market, rather than specific costs. Utilizing the projected EVSE numbers and current dollar costs for implementation, the statewide investment is estimated to cost between $1.3 and $8.4 billion. Notably, much of this cost is associated with individual residential charging and no one party will be responsible for the cost. As cost information and empirical data increases, projections will become more accurate and less variable (See sensitivity analysis in Appendix 7).

Table 15: Capital, Installation, and Annual Operation Costs in Millions of Dollars for each Scenario and Year[49]

	Capital Costs		Initial Costs		Operation Costs		Total Costs	
	2015	2025	2015	2025	2015	2025	2015	2025
Baseline	$18 - $73	$518 - $840	$24 - $103	$704 - $983	$1 - $19	$2 - $38	$43 - $196	$1,225 - $1,858
Medium	$22 - $91	$1,444 - $2,340	$29 - $128	$1,963 - $2,735	$1 - $24	$7 - $105	$53 -$243	$3,414 - $5,173
High	$27 - $67	$2,349 - $3,804	$36 - $92	$3,192 - $4,444	$2 - $11	$10 - $166	$64 - $110	$5,552 - $8,402

These cost projections represent a growing market and business opportunity. The success of this network relies on creating a compelling business case for businesses to participate in the market, rather than government investment. As the majority of EVSE will be residential, this means building the business case for service providers, manufacturers, and dealerships to help consumers install EVSE. For workplace and public charging, the business case for EVSE installation needs to incentivize property owners, developers, and businesses. Despite the up-front costs, there is money to be made.

EVSE Deployment and Cost Analysis, by Location Type

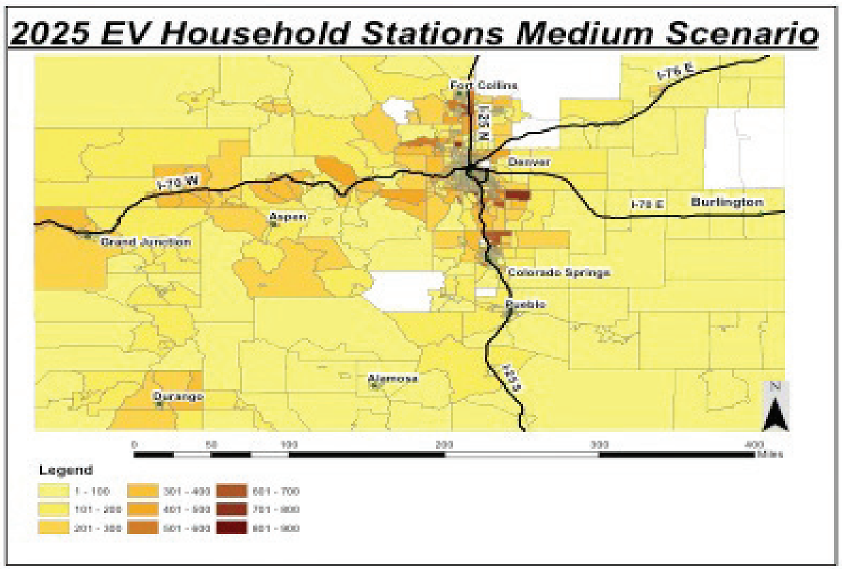
Residential Charging

As evidenced in the EVSE market projections as well as the Colorado consumer analysis, access to residential charging is the primary fueling option for PEV drivers and plays a significant role in the purchase decision. To accommodate the high level of charging events that occur at residential locations (up to 75%), every PEV owner will likely have access to charging at home. This charging access may include both dedicated 120v electrical outlets, which require minimal

[49] Appendix 8: Determine EVSE management, installation, operation, & maintenance costs.

installation effort and equipment, or 240v level 2 charging stations. Utilities, electricians, home services, and EVSE providers will need to be equipped to conduct the most efficient installations and plan for the expected increase in demand.

Residential charging patterns will closely resemble the expected geographic distribution of PEV purchases, as seen in the map below. As early PEV adoption is more likely in dense urban areas where trip distances are shorter, residential charging stations will be concentrated in the nine-county territory of the Denver Regional Council of Governments, and then distributed along the I-25 and I-70 corridors. The more rural areas with limited highway access will see residential charging (and PEVs) grow more slowly.



The deployment of residential charging stations is expected to occur naturally as drivers install their own station or use a dedicated outlet upon purchase of a PEV. Dedicated outlets are often already available at residences, so installation costs are minimal, ranging between $0 and $250. PEV drivers who want to install a faster charging station, such as a level 2, may see higher costs due to the electric capacity requirements, but these installations are comparable to installing outlet for electric clothing dryer and are often quite easy. EVSE are not expected to have any consistent maintenance costs beyond vandalism or collision repairs, which are not likely in a residential setting.

Table 16: Individual EVSE Capital, Installation, and Operation Costs

	Capital	Installation[50]	Total Installed Cost[51]	Annual Operations and Maintenance
Level 1 Residential (120V)	$0	$0-$250[52]	$0-$250	$0
Level 2 Residential (240V)	$500-$1,500[53]	$500-$2,000[54]	$1,000-$3,000[55]	$0

A flow chart that displays the variation in costs expected at each step of the residential installation process is also provided in Appendix 8. For further information on the installations and permitting processes for single-home and multi-unit dwellings, refer to the Installations and Permitting section. For information on financial incentives, refer to the Policy section.

Workplace Charging

Workplace charging makes up a lesser percentage of charging events, with projections showing between 5% and 20% in 2015 and 15-35% in 2025. However, it can still play a big role in PEV-related decisions. For this analysis, workplace charging stations are assumed to be 240v level 2 or above, even though 120v outlets may be sufficient in many scenarios. With more than 47,000 workplace charging stations projected by 2025, encouraging major employers, property owners, utilities, and EVSE providers to install these charging options will make PEV an option for more drivers that spend significant amounts of time at work.

The geographic distribution of workplace charging stations mirrors that of residential charging deployment. The EVSE market sees the most density in urban areas, particularly in the Denver Metro area, and is more lightly dispersed throughout the state, largely following the highway corridors. However, the eastern portions of the state may be less likely to see workplace charging stations, while the western areas may see more rapid growth.

[50] Permit fee is not included here. For permit pricing by jurisdiction, refer to Table 18; for detailed breakdown of installation costs refer to Appendix 26.

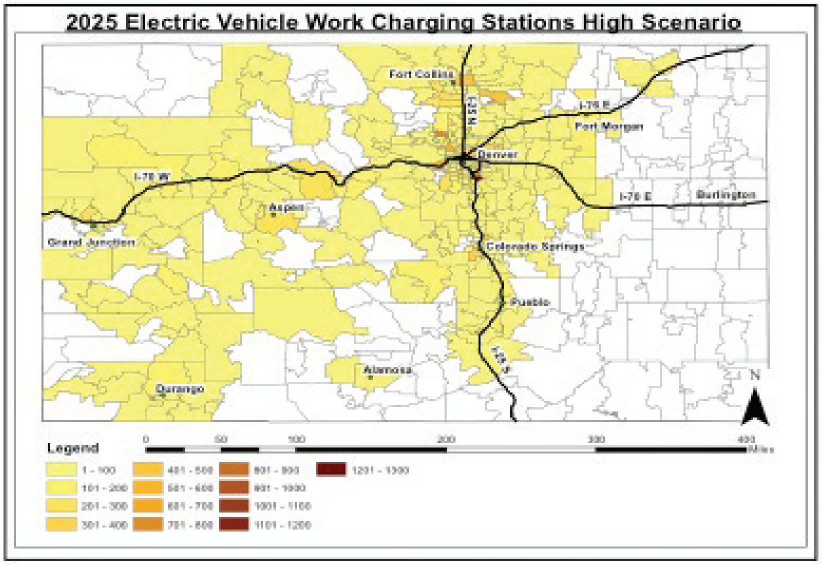
[51] The "total installed cost" is an average range based on the available data. There may be cases where installation costs are higher or lower than represented here.

[52] J52"Cost of Repairs." Home Inspector Locator. 2012. Web. 2012.
<http://www.homeinspectorlocator.com/resources/Costtorepair.htm#Electric%20Repairs%20-%20Upgrades>;
Discussions with International Brotherhood of Electrical Workers, 68. 2012;

[53] "Accessory Tracker." Plug In America, 2012. Web. 2012.
<http://www.pluginamerica.org/accessories>.

[54] "Charging Stations." Advanced Energy, 2012. Web. 2012.
<http://www.advancedenergy.org/transportation/charging_stations/>.

[55] Hunter, Christel. "Electric Vehicle Charging." IAEI Magazine, 9 May 2011. Web. 2012.
<http://www.iaei.org/magazine/2011/05/electric-vehicle-charging>.



In terms of deployment, workplace charging may require more coordinated effort than residential locations because the installation requires employer involvement, as well as negotiations about who will bear the installation costs. PEV drivers can work with their employers to establish policies, procedures, and cost-sharing programs that are mutually beneficial. Some employers may also be naturally motivated to provide access to charging to meet future employee needs, attract new hires, or further sustainability plans. Installing the wiring and electric capacity during building upgrades or construction can also decrease the cost of installation.

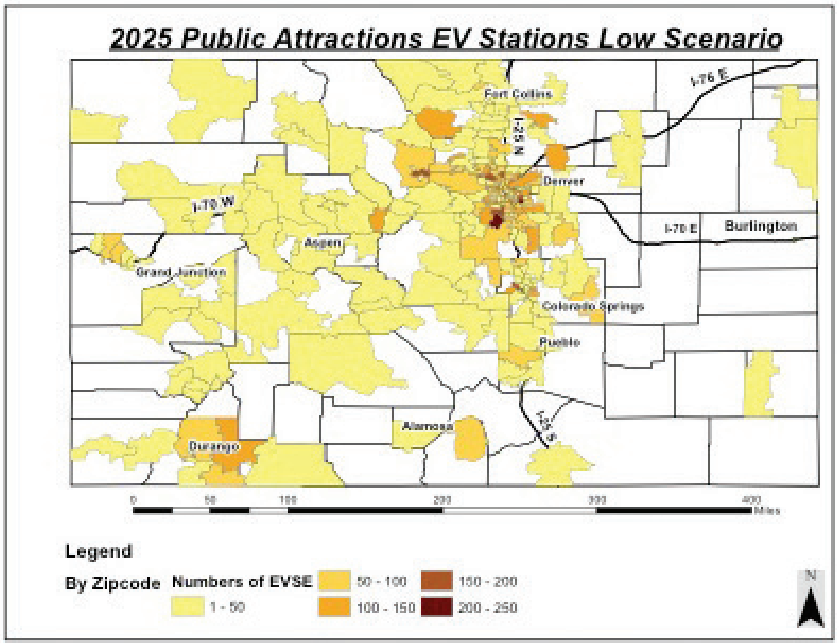
Movement towards more workplace charging is well under way in Colorado. Companies like Xcel Energy are working through policies and access issues to provide charging to employees. Some companies are finding charging facilities already in place. For example, a facilities management company discovered a charging station had already been installed during building construction, and was able to provide charging for an employee who recently purchased a Volt. Also, organizations such as The Renewable Energy Initiative are working to promote employer engagement by organizing ride-and-drive events at major companies in the Denver area. Increasing this access to charging at work will mutually support the growth of PEVs.

The costs associated with workplace charging will depend on the level of charging station required. For 120v outlets, the price will be similar to the residential charging prices above. However, there could be additional installation costs if the electric supply is not readily available. For 240v level 2 charging, the prices will be similar to the public attraction costs described in the following section. Companies can either bill the employees on a per kilowatt-hour or flat daily fee, offer charging as part of an employee benefit, or set up another kind of cost-sharing model.

Public Attractions Charging

Charging stations at public locations also represent a small percentage (up to 10%) of charging stations. However, they are extremely important for public perception, preventing emergency situations, and extending the range of PEVs. In order to accommodate the percentage of charging events projected to occur at public attractions, the forecast predicts that there could be more than 94,000 stations by 2025. These will be mostly 240v level 2 stations with some DC fast-charge stations.

As opposed to residential and workplace charging, the geographic distribution of future public charging sites is slightly more erratic. There is still clustering in the urban centers on the Front Range, but the distribution along the highway corridors is less pronounced. Local planning agencies or EVSE manufacturers and installers can use this map in tandem with Appendix 6 to develop an EVSE implementation strategy according to forecasted EVSE in their area.



In terms of deployment, public attraction sites will likely require the most coordinated effort because the process, costs, and distribution are more intensive and the technology is still evolving. While there may be a business case for participation in the public attraction charging market, as discussed below, decision makers, planners, and investors will need to consider several factors—such as co-location, charging level, insurance, and distribution—when installing public attraction charging.

Since PEV charging takes more time than fueling a traditional vehicle, public charging stations are likely to be successful when co-located at destinations where PEV drivers spend time. According to a Colorado price study, consumers are less willing to pay for level 1 or level 2 charging unless the station is co-located with a desirable destination. While economic analysis shows consumers would be willing to pay for DC fast charging anywhere, they are willing to pay more at stations that are co-located with current destinations.[56] This difference is due to the value consumers place on their time and how that relates to the longer refueling times for EVSE. Shopping centers, restaurants, and indoor entertainment venues will make up about 73% of the destinations where PEV drivers will likely plug-in.[57] For instance, movie theaters, ski resorts, sporting venues, and other recreational destinations could be good public charging station sites. Installations at these locations may require insurance coverage for the provider.

In terms of charging distribution, the optimal number of public charging stations may need to be adjusted over time as PEV charging patterns are better understood. In this Colorado analysis, the public station numbers may be over-estimated when

[56] Appendix 9: Public Willingness to Pay for EVSE.

[57] Appendix 6: Charging Station Analysis, See Table: Public Charging stations in Colorado according to trip purpose.

compared with the current fueling infrastructure. For instance, there are currently 9,708 gasoline pumps[58] to support 4 million gasoline vehicles, or one pump for every 412 ICE vehicles. In contrast, the baseline scenario for PEV market penetration suggests 13,787 public charging stations are needed to support 100,000 PEVs, or one public station for every 7.25 PEVs. These predictions are based on assumptions and a preliminary understanding of charging patterns. However, a smaller public infrastructure may be possible, considering many PEV drivers are expected to have access to residential and workplace charging.

A similar consideration for planners is the distribution of charging by level. The price study suggests that PEV drivers are willing to pay for DC fast chargers because they want to be able to fill up to 80% in less than 30 minutes. While EVSE installers may achieve a return on investment, DC fast chargers are very expensive. In the Colorado EVSE cost analysis, when DC fast chargers make up 9% to 10% of stations, they account for approximately 90% of the total costs.[59] An alternative solution is to provide a higher quantity of level 1 and 2 charging under the same budget. Even simple 120v outlets allow drivers to top off and are compatible with any vehicle, even conversions or other vehicles that do not follow J1772 standards. Investors and planners will need to find a balance between cost and charging time as the market evolves.

EVSE Costs and Business Case

In addition to these higher-level considerations, the ability of EVSE installers to make profits from public charging stations will drive the immediate market. The following will consider the costs, revenue streams, ownership models, and payback periods.

The cost of installing and operating a public EVSE vary considerably depending on the requirements of the installation. While the equipment is relatively inexpensive, the installation costs vary greatly depending on location and electrical requirements. Table 17 demonstrates a bird's eye view of these potential costs. However, each EVSE installation is unique, and potential installers should get a site-specific estimate from a licensed electrician. EVSE are not expected to have any consistent maintenance costs beyond the potential for vandalism or collisions, which are not considered here.[60] Commercial EVSE are expected to have operating costs based on the cost of processing payments. For a flow chart representing these costs on a step-by-step basis for commercial level 2 locations, refer to Appendix 8.

Even early EVSE market entrants that may have taken financial losses from offering public charging have benefited from other non-financial benefits that could result in long-term revenue gains, such as:

- Priceless advertising and branding opportunity
- Position as a community and industry leader
- Contributes toward LEED certification
- Attract a specific audience interested in sustainable property development
- Further sustainability plans and achieve emissions reduction goals[61]

[58] According to the US Census, there are 1,618 gasoline stations with 6 pumps per station in Colorado.

[59] Appendix 8: Determine EVSE management, installation, operation, & maintenance costs.

[60] Buchwald, David and Wilson, Mike. Personal Interview. 18 January 2012.;
Altman, David. Personal Interviews. 11 November 2011 and 20 March 2012.;
Barrett, Will. "Maintenance Costs for Clipper Creek Chargers." Message to the author. 18 May 2012. E-mail.;
Kara, Megan. "SPX Volt Contact Form." Message to the author.18 May 2012. E-mail.;
Lewett, Maryline. "Product Technology Inquiry." Message to the author. 18 May 2012. E-mail.

[61] For more information on the benefits of EVSE, refer to Appendix 14: How Electric Vehicles Can Benefit. Property Developers.

Table 17: Commercial EVSE Capital, Installation, and Operation Costs[62]

	Capital	Installation[63]	Total Installed Cost[64]	Annual Operations and Maintenance
Level 1 Commercial (120V, up to 1.4 kw)	$800 - $900[65]	$200 - $450[66]	$1,000 - $1,250	$0
Level 2 Commercial (240V, up to 6.6 kw)	$1,000 - $5,500[67]	$2,000 - $8,000[68]	$3,000 - $11,000[69]	$200 - $300[70]
DC Fast Charging (up to 50 kw)	$40,000 - 50,000[71]	$55,000[72]	$100,000 - $120,000	Unknown

62 Appendix 8: Determine EVSE management, installation, operation, & maintenance costs.

63 Permit fee is not included here. For permit pricing by jurisdiction, refer to Table 18: Permit Fees for residential and commercial EVSE installations across Colorado ; for detailed breakdown of installation costs refer to Appendix 8: Determine EVSE management, installation, operation, & maintenance costs.

64 The "total installed cost" is an average range based on the available data. There may be cases where installation costs are higher or lower than represented here.

65 Shorepower offers a 4 port Level 1 commercial charging stations for between $2,900 and $3,500. Altman, David. Personal Interviews. 11 November 2011 and 20 March 2012.; Plug In America, n.d. Web. 2012. <http://www.pluginamerica.org/>.

66 Price is based on cost of installing a dedicated circuit for Level 1 residential and estimated cost of installing EVSE from Project Get Ready.

67 "EV Charging Overview." Nissan North America, 2010. Web. 2012. <http://www.franklingov.com/Modules/ShowDocument.aspx?documentid=3119>; Botsford, Charles W. The Economics of Non-Residential Level 2 EVSE Charging Infrastructure. AeroVironment: EVS26 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, 6-9 May 2012. Web. 2012. <http://www.e-mobile.ch/pdf/2012/Economics_of_nonresidential_charging_infrastructure_Charles-Botsford-EVS26.pdf>.

68 "Charging Stations." Advanced Energy, 2012. Web. 2012. <http://www.advancedenergy.org/transportation/charging_stations/>.

69 Meyn, Stephanie. Seattle's EV-Readiness Planning. Western Washington Clean Cities, 3 May 2012. Web. 2012. <http://www.gscwest.com/Presentations/Session3TranStephanieMeyn.pdf>; Duvall, M. Transportation Electrification: A Technology Overview. Electric Power Research Institute. July 2011. Web. 2012. <http://www.smartgridinformation.info/pdf/4525_doc_1.pdf>.

70 "EVSE Payback Calculator." Clear Energy Group, 2012. Web. 2012. <http://clearenergyinc.com/products/about-ev/evsolutions/>; Kearney, Michael. Electric Vehicle Charging Infrastructure Deployment: Policy Analysis Using a Dynamic Behavioral Spatial Model. Massachusetts Institute of Technology, 2011. Web. July 2012. <http://dspace.mit.edu/handle/1721.1/65504>; "Calculator: Charging for Charges." Plugin Recharge, n.d. Web. July 2012 <http://www.pluginrecharge.com/p/calculator-charging-for-charges.html>; Botsford, 2012.

71 Meyn, Stephanie. Seattle's EV-Readiness Planning. Western Washington Clean Cities, 3 May 2012. Web. 2012. <http://www.gscwest.com/Presentations/Session3TranStephanieMeyn.pdf>; Calise, Michael J. Electrify Your Business: A Guide for Moving Forward With Electric Vehicles. Business Council on Climate Change and the Bay Area Council, n.d. Web. 2012. <http://www.calcleancars.org/docs/electrify_your_business2.pdf>; Refer to Appendix 8 for more information on price estimates from EVSE providers.

72 Meyn, 2012.

Case Study: Lyons High School Micro-grid Island Project

Project Summary and Goals:
Transportation demands of rural schools present an exciting market opportunity for large-scale electric vehicle (EV) deployment and have the potential to realize significant environmental benefits. EV charter buses have the potential to reduce the associated emissions and fuel costs from the longer commuter distances required by students in rural communities. Utilizing clean renewable energy to power the buses will reduce emissions further and will make schools into self reliant systems—a benefit to both the school and the community. However, financing the steep upfront capital costs of such projects remains a problem. Grant funding, the primary mechanism for a project like this, is usually limited and highly competitive to obtain.

The Lyons High School (HS) Micro-grid Island project takes an innovative and holistic approach to sustainable financing and environmental goals. The proposed project is an integrated system comprised of electric transportation, electric generation, and multi-use storage capacity. By generating localized power for transportation and building use, providing an emergency storage opportunity, and incorporating this into a teachable situation for students, the Lyons HS project has the potential to be a replicable and sustainable model for other rural communities.

The goal of the project is to gather data to develop an energy performance contract (EPC)-type funding mechanism. The EPC financing mechanism is a sustainable and well-established tool for commercial buildings that has yet to be applied to the transportation field. The potential payoff of energy and fuel savings is an attractive venture for third-party investors and will have significant emissions reductions in a rural community like Lyons. Third party investors pay for the upfront capital costs of the entire project and capture various revenue sources as a return on investment (ROI). The revenue sources include tax credits, power purchased by the utility provider, and the school's energy bill savings.

This project will take place after the Project FEVER grant timeline. Lyons HS is in the process of changing utility providers, the outcome of which is critical in negotiating a power purchasing agreement (PPA). The details of the project however are outlined to convey best practices with others interested in exploring a holistic approach to EPC and electric transit.

The proposed system utilizes the following components and corresponds to Figure (1):

- *Solar PV Generation*
  Rooftop generation from a 100 kW system provides DC power directly to the battery. The battery, with a 1 mWh capacity storage, in turn, powers the school. The storage capacity also allows for a variety of power delivery scenarios: For example, it could deliver 100kW over 10 hours or 500kW over 2 hours. The PV system incorporates interactive displays for hands-on learning for the students and compliments existing energy curriculum for use in the classroom.

- *BYD Electric Charging Bus*
  An electric charter bus transports students between Longmont and Lyons. The bus will be set up to charge from the battery through a charging station, but also will be capable of vehicle-to-building power in case of an emergency. Charged from the micro-grid, the bus will be extremely low in emissions relative to both traditionally fueled transit vehicles and other electric vehicles charged from the utility grid. Replacing the current multiple personal vehicles used to transport magnet students to the school with an electrified transit system increases the emissions reductions.

- *Natural Gas Micro-Turbine*
  The existing emergency diesel generator will be replaced by a natural gas micro-turbine. As a backup to the solar/battery combination, the micro-turbine can provide base load generation and emergency power when demand exceeds the capacity of the solar/battery system.

- *Local Utility*
  The local utility can purchase power from the school during peak hours from the Town of Lyons. This power is a local source and can supplant the need to purchase higher cost power on the wholesale market. In addition, the utility can use the battery storage unit as well as natural gas micro-turbine as emergency power in the event their charging substation goes down.
- *Emergency Shelter*
  The school is the community's designated emergency shelter. Since the school would be set up as a micro-grid, it could be operated independently from the utility grid. With the transportation component, it can also serve as an emergency transportation facility.

Project Benefits:
One of the major benefits of having an electric bus centered project is emissions reduction. Lyons HS is a magnet school for the area and has more than 134 students commuting each day into Lyons from an average of 8 miles away. By providing an electric bus service for those students, both congestion and emissions are drastically reduced by 119 metric tons per year Renewable, clean energy powers the bus as well as the school creating a net-zero emissions environment. In addition, the components proposed in this islanded system avoid the need for diesel generators that are highly polluting, expensive, and go largely unused.

The high school will be capable of delivering power to the Lyons municipal system, but will primarily operate as an individual unit. When the school does not require much energy (e.g. in the hot summer months when the load is high in the municipality and the school is largely vacant) the utility provider can access a local distributed energy source, forgoing the need to purchase power on a wholesale market, located outside of the state. This local power can also be accessed during peak hours throughout the school months.

The micro-grid island generates power that is clean, localized, self-sufficient and has emergency power benefits for the larger community. Lyons HS is already a designated community emergency shelter, so the capability to operate separate from the utility grid increases its value. The power source is local and on the utility side of the closest sub-station located five miles from town.

Many schools in rural areas across the nation are similar to Lyons HS and could employ the system design and financing mechanism. For example, communities like Lyons that project increases in load with high transmissions costs could benefit from a local school becoming a micro-grid island. Areas of the country too remote for transmission construction or that need to tie in to the existing utility infrastructure could also benefit. Furthermore, every community has a designated emergency shelter and, in many instances, that designated facility is a local school.

Projected Costs:

Project Components	Cost	Financing sources
Solar PV (installation and capital)	$500,000	Reduced energy bills
3 EV charter busses (and connectivity)	$950,000	Solar tax credits and rebates

Continued on next page

Continued from previous page

Projected Costs:

Project Components	Cost	Financing sources
Storage (installation and capital)	$900,000	REC payment by utility @ $0.15/kWh
Metering	$200,000	
TOTAL	**$3,100,000**	

Partners:

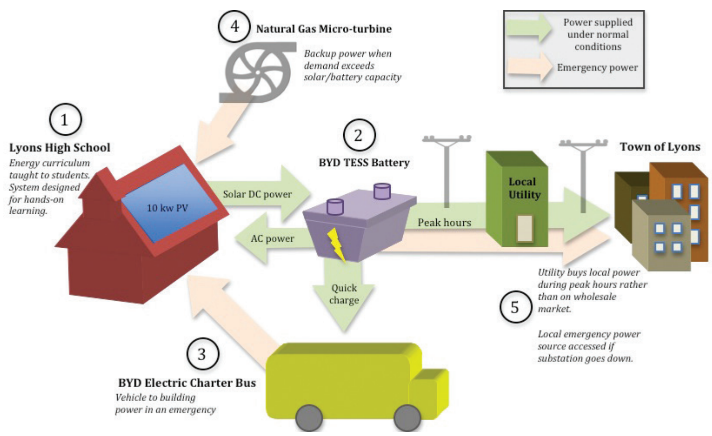
Based on the initial investigatory work, the following types of partners have been identified as critical in moving such a project forward:

- *Municipality – An advocate on city council is needed to champion a project and gain town support.*
- *Energy Service Company – This company will be responsible for designing and entering into the EPC with the school and a PPA with the local utility. Critical qualities include a willingness for innovation and an appetite for a certain amount of risk in uncharted territory.*
- *Electric Bus Manufacturer – Must be cost competitive in order to make the EPC viable. Ideally, the manufacturer can be vertically integrated in order to provide other system components to bring down overall project costs.*
- *Utility Provider– This partner is a clear project lynchpin. The ideal provider must be willing to purchase the power and link to the system for emergency situations.*
- *School – The school should be willing to integrate energy curriculum and have staff trained on system operation and maintenance.*

Potential Project Barriers:

The main barrier that needs to be resolved is thoughtfully engineering the system. Since this is a fairly complex system, many hours of engineering will be required. Requirements for purchasing from American providers are also a factor that will need to be addressed if federal funding is sought.

Figure (1): Lyons High School Transportation and Energy System



Despite the high up-front costs, EVSE providers or owners can generate revenue and reap other reputational benefits. As of August of 2012, EVSE providers can sell electricity to PEV drivers without being regulated as a public utility, as per Colorado House Bill 12-1258 (codified at C.R.S § 40-1-103.3). This policy opens a new revenue source for EVSE providers. Other revenue sources include charging more for EVSE parking spaces, increasing parking garage entry fees, or selling advertising space on EVSEs. Many retail stores, such as Walgreens, also project increased sales revenues from PEV drivers shopping longer while charging.[73] Others provide discounts on charging if consumers make a purchase in the store.

Consider a scenario where an EVSE provider installs a public charging station in a well-located site and only generates revenue through the resale of electricity. When gasoline costs $3.58, PEV drivers would be willing to pay between $0.28 and $0.95 per kWh to charge their vehicle at a desirable location. If a Level 1 and Level 2 EVSE supplier charges $0.30 per kWh, they can realize payback periods of less than 6 years.[74] If a DC fast charger provider charges $0.60 kwh, they can realize the same payback period of less than 6 years. These prices are within the consumer willingness to pay.[75]

Considering these financial and non-financial opportunities, government agencies, private companies, and property owners have developed several business models to effectively install and manage public charging stations, three of which are described here:

- <u>One party ownership and management</u>: One entity (either public or private) installs and operates the EVSE on owned property. For example, the City of Boulder installed and now operates a charging station at their South Boulder Recreation Center. This model allows governments to invest in infrastructure that may not be immediately available in the private sector and can provide a high-profile location for the promotion of PEVs. Kum and Go provides a private sector example of installing and operating EVSE alongside gasoline pumps.
- <u>3rd party ownership and management</u>: A third-party company installs, operates and manages EVSE at a property owned by a host entity. The host entity seeks to increase revenue with the increased number of customers spending more time in their store, and may also receive a share of revenue generated from charging events. The third party would realize profits from the sale of charging events or selling advertising space on the EVSE. The CarCharging Group and NRG's EVGO network provide this third party service to commercial businesses and multi-residence units.
- <u>Split ownership and management</u>: An entity would purchase and install an EVSE, but turn over the management and operation to a third party. The City of Boulder intends switch to this model in the future, releasing management of current EVSE to a third party.

While the public charging deployment is somewhat complex, the opportunity for returns and profit may motivate a variety of investors to participate in the market, creating a robust level of public charging access that will make consumers more confident.

The success of this deployment plan hinges on continued stakeholder engagement, education, and action in the next few years. The status report and recommendations throughout the remainder of this report will be crucial to ensuring the EVSE infrastructure is deployed in an efficient, cost-effective, and consumer-friendly manner.

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[73] "Plug In or Power Down? Retailers jockeying for position in evolving electric-vehicle charging race." CSP Daily News. CSP Business Media LLC, 17 October 2011. Web. 2012. <http://www.cspnet.com/news/technology/articles/plug-or-power-down>.

[74] Based on a Level 2 station with $6,000 installation costs, $300 annual O&M and an average usage of 3.5 hours per day (less in the first 3 years). Appendix 9: Public Willingness to Pay for EVSE.

[75] Appendix 9: Public Willingness to Pay for EVSE.

VI. Education and Outreach

Section Summary:

This section discusses strategies for educating both the general public and industry leaders to address information gaps, train key service providers, and increase awareness about the benefits of PEVs. *The Electric Ride* campaign conducted under Project FEVER is a proven, fun, and inspiring means to educate the public. Training plans for service providers, such as first responders, dealerships, and electricians, will ensure that the market is ready to provide PEV consumers with seamless customer service. Finally, strategies to educate elected officials will enable citizens and organizations to pursue more PEV-friendly policies.

Audience:

Policy-makers, Business Leaders, Utilities and Energy Professionals, and the General Public

Despite the growing awareness about PEVs, many questions and misperceptions remain regarding PEV technology, electrical infrastructure, safety, and political support. While some answers will come with further market development, many gaps result from a lack of information and can be addressed through education and outreach.

Raising public awareness of PEVs as a viable and optimal transportation option will be crucial to increasing sales. Building on the success of *The Electric Ride* campaign in 2012, industry leaders will continue to educate the general public and potential PEV consumers about the benefits of PEVs. Simultaneously, training industry participants and service providers ensures that the system is well-equipped to support PEV owners in a seamless user experience.

Public Outreach: The Electric Ride

To motivate the switch from the traditional ICE vehicles to new technology and behavior, consumers need more information about what it means to be a PEV owner. While some may want to know about the environmental impacts, others may want to know if PEVs are "cool." *The Electric Ride* website provides the first step to filling this gap in consumer understanding. The site provides an online resource portal where Coloradans can learn about PEVs, share their user story, and prepare for charging their vehicles at home, work, and in public. The site provides an avenue for all Coloradans to get excited about PEVs.

The Electric Ride is a Colorado-specific education and outreach campaign designed to make PEVs fun and exciting. Under the direction of Project FEVER, a local creative agency, rabble+rouser, conceptualized *The Electric Ride* with a $60,000 budget.[76] Designed to capture the sense of emotion that drivers feel when operating their vehicle, *The Electric Ride* marketing efforts target the public through several avenues: a dedicated website (www.ElectricRideColorado.com), social media,[77] branded PowerPoint presentations, templates for printed materials, and a logo. The retro feel of the logo

[76] Appendix 10 : Request for Proposal process for public relations firm selection.

[77] www.facebook.com/ElectricRideCO and www.twitter.com/ElectricRideCO.

provides a unique juxtaposition to the futuristic element of PEV technology. The logo has created a widely recognized brand for *The Electric Ride* as the premier source for PEV and charging education in Colorado.

The Electric Ride website uses a wide array of advanced content to facilitate conversations about PEVs and charging equipment. The homepage features an interactive scroll of available and emerging PEVs. There are quizzes, video clips, Facebook and Twitter feeds, a dealership map, a photo gallery, and a vehicle cost calculator. The features keep visitors engaged through interaction while providing comprehensive, expert content on PEVs and charging infrastructure. *The Electric Ride* website educates approximately 1,500 users per month. The website also offers stakeholders a secure online portal to view and share program materials. All materials produced for this plan are available in this portal.

The Electric Ride has established a solid base of awareness through outreach efforts in 2012 and is well-positioned to continue to educate in coming years. In 2012, the campaign gained momentum through public forums such as the website launch event, Earth Day fairs, booths at public events, dedicated events such as National Plug-In Day and Electric Avenue, and presentations to industry groups. The Denver Metro Clean Cities staff will continue to update content and will identify and pursue future funding to keep *The Electric Ride* website a relevant information source. Future additions to the campaign website include an EVSE location widget, a "My Vehicle" component, a resources page with downloadable content, additional videos (both from staff and from user-generated content) and an enhanced community garage section.

Industry Outreach

First Responders

While PEVs are not more dangerous than any other vehicle in an emergency situation, additional training will keep first responders actively aware of any unique facets of the technology.[78] This specific training will enhance the ability to respond to emergencies, alleviate misperceptions about safety, and bolster consumer confidence. Among others, training topics would include:

- Direct and indirect vehicle identification methods: Determine the vehicle is a PEV
- Unique vehicle mechanics: Putting in park, turning off ignition, removing key to disable the high voltage system[79]
- Determination that vehicle is turned off despite quieter motor: All OEM PEVs turn off the high voltage battery in the event of a crash or sensor/airbag deployment, indicated by the "Ready"' light being turned off
- Unique PEV characteristics: Battery location, steps to disengage the electrical system, and identification of safe points along the car for extrication.[80]
- EVSE equipment emergencies: Follow same protocol as electrical incidents with some unique facets to disengage equipment

[78] Grant, Casey, P.E., U.S. National Electric Vehicle Safety Standards Summit Summary Report. Michigan: Fire Protection Research Foundation, October 2010. Print.

[79] Grant, Casey, P.E., U.S. National Electric Vehicle Safety Standards Summit Summary Report. Michigan: Fire Protection Research Foundation, October 2010. Print.

[80] Wohciechowski, Charlie, "Electric Cars Pose New Challenges, Risks for First Responders." 5NBC Chicago. 26 August 2010. Web. 2012. <http://www.nbcchicago.com/the-scene/cars/electric-vehicle-safety-101603308.html>.

The major players in promoting PEV safety training throughout Colorado are the Arapahoe Community College (ACC) and the Red Rocks Community College (RRCC). Following content and training models provided in partnership with the National Fire Protection Agency (NFPA), these two colleges educated 83 first responders—including law enforcers, firefighters, and paramedics—on PEV safety in 2012 and have plans to train more. Refer to Appendix 11 for a full list of trainings by responder type. The current training program uses video, classroom instruction, self-paced online programs, and simulation to help first responders navigate the science and components of PEVs and hybrids. The curriculum includes five modules: Basic Electrical Concepts and Hazards; Vehicle Systems and Safety Features; Initial Response: Identify, Immobilize, and Disable; and Emergency Operations, as well as an on-site inspection of the various PEVs.

Based on the Colorado experience to date, the following factors are crucial to implementing a successful first responder-training program.

- Secure funding: Tuition, program fees, and other college revenue streams are often sufficient to fund the programs. Grants may also be available through the Department of Energy (DOE) and National Fire Protection Association (NFPA). In Colorado, Clean Cities Coalitions have also been able to financially support these trainings in the form of scholarships through a partnership with the ACC.
- Establish partnerships: Refer to the Colorado State University Ventures-Systems Solutions Group (Ventures) as an example of successful partnership to implement educational opportunities.[81]
- Work with community colleges and faculty: Faculty expertise can ensure standard NFPA curriculum meets local needs.
- Secure license to trainings: Community colleges can purchase licenses to NFPA modules in order to market and implement trainings independently.
- Tailor trainings to specific audiences: Use specific PEV safety trainings for each group, such as firefighters, EMT/paramedics, and law enforcement.
- Incorporate PEV safety into standard curriculum: Incorporating PEV curriculum into degree programs ensures continued and consistent training.

Building on these success factors, ACC and RRCC will continue to implement first responder training both as a specialized program as well as an integrated curriculum in the degree programs. Further, this training will continue to be spread by other entities now offering on-line trainings. The National Alternative Fuels Training Consortium (NAFTC) now offers a first responder safety training through the Clean Cities Learning Program and Advanced Electric Drive Vehicle Education Program.

Marketing and communication of the trainings will continue to use current outreach methods under the leadership of the ACC and RRCC and the supporting efforts of the three Colorado Clean Cities Coalitions. Outreach will continue to be directed toward participant groups, associations, and first-responder networks using a variety of methods, such as posters, videos, websites, and social media. The videos add a multi-media component to the recruitment of students for ACC's automotive technology program process.[82]

[81] Caille, Gary W. Advanced Electric Drive Vehicle Education. Colorado State University Ventures, 9 June 2010. Web. 2012. <http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2010/technology_integration/tiarravt033_caille_2010_o.pdf

[82] Refer to Arapahoe Community College website for recruitment video examples. <http://www.arapahoe.edu/departments-and-programs/a-z-programs/automotive-technology>.

Electrician Training

Similar to first responders, electricians are already highly trained in installing electrical equipment governed under the same National Electric Code (NEC) and with similar requirements and processes as EVSE. The purpose of specific training in EVSE is two-fold: raise awareness that EVSE are governed by the same NEC as all other electrical installations and bolster the understanding of any nuances specific to EVSE installations. Such in-depth understanding will only further enhance the user experience.

Increasing awareness that EVSE installations follow the same NEC standards as any electrical installation of the same voltage and amperage is important to ensure electricians utilize the resources available to them to provide safe, quick service to new PEV consumers. Resources available to electricians include informational brochures, product-specific instructions, and NEC guidelines.

Industry Outreach	Parties Involved
Safe	Electrician
Appropriately placed	Electrician, vehicle owner, building owner
Low cost to install	Electrician, building owner, utility company
Durability and reliability	Electrician, building owner
Charging Adequacy (level 1 or 2)	Electrician, vehicle owner

This information, which is less technical in nature, can be deployed through more informal channels, such as manufacturers and EVSE distributors. For instance, EVSE distribution centers could distribute educational material when electricians purchase equipment, or a government agency like the Department of Regulatory Agencies (DORA)[83] could distribute materials when an electrician receives a license or renewal. A sample presentation created by Clean Energy Economy for the Region (CLEER) is provided in Appendix 12.

To train electricians in the detailed nuances of PEV and EVSE and technical information, the training developed at the national level can be deployed in Colorado. The "Electric Vehicle Infrastructure Training Program" is a 24-hour course that offers continuing education credits to electricians and covers a range of topics from PEV battery types to Internet connections to demand-shedding controls on buildings with PEV charging. Organizations such as the International Brotherhood of Electrical Workers are good resources for this training.

Dealership Education

As the typical first point of contact with potential PEV consumers, dealerships well-versed in PEV and EVSE have the potential to positively impact sales. Anecdotal evidence from PEV owners and OEMs in Colorado suggests that dealership sales staff at most locations is already adequately trained in PEVs. Some OEMs, such as General Motors, have formed a training program for designated staff to support customer questions outside the dealership experience. Dealerships and OEMs have also taken special measures to educate customers about charging options. Through part-

[83] Electrical Board. Department of Regulatory Agencies, n.d. Web. 2012. <http://www.dora.state.co.us/electrical>.

nerships with EVSE companies, dealers can ensure all consumer questions about charging are answered quickly. Topics that can be handled through these partnerships include EVSE specifications, installations, and communication with the local utility.

However, there can be knowledge gaps when it comes to explaining financing options outside the normal sales process, specifically the tax credits process, as well as leasing options. Cultivating a more knowledgeable sales force on these financial incentives will directly overcome a barrier to widespread PEV adoption. Continuing education on these topics is made difficult due to the high rates of turnover for sales staff and the limited time for training.

Several education strategies will help overcome these challenges to increase sales. First, maximize educational opportunities during regular staff meetings to increase time and interest of the sales team. Second, provide detailed handouts on the tax credit procedure to the finance and insurance offices at dealerships. These are representatives that sit with customers at point-of-sale. Another solution is to work with the Colorado Automotive Dealers Association (CADA) to offer training to long-term dealership staff to create institutional knowledge. Creating an online portal to clearly outline and streamline the process to obtain both federal and Colorado tax credits could further support the training of long-term dealership staff with knowledge of vehicle financing. Lastly, creating more demand from consumers will naturally incentivize dealers to become knowledgeable on the desired product.

Elected and Municipal Official Education

While the trainings described so far will directly enhance the PEV consumer experience, the training of elected and municipal officials is crucial to creating a policy and regulatory environment to support PEV market growth. While Colorado has seen many victories for issues such as renewable energy and alternative fuels, creating legislation to support the PEV and alternative fuel market must now overcome greater fiscal scrutiny due to the difficult economic conditions prevalent since 2007. Building on the commitment of local companies to advanced vehicle technologies, the economic benefits of the emerging PEV industry can be highlighted to attract government attention and pass successful legislation. Efforts can also build on the understanding being developed by the Colorado Public Utilities Commission (PUC) investigatory docket opened in 2011.

Mobilizing grass roots and organizational advocacy to effect change in the legislative process can be accomplished using the following steps and framework. First, these advocates will want to identify public officials who support policy to expand the PEV and EVSE market. The State of Colorado legislative website provides bill sponsorship and voting records that can be used to identify elected officials who are more likely to support the alternative fuels industry. PEV-related businesses can also proactively contact their elected officials to convey industry concerns and make policy recommendations.

With the audience established, one framework for approaching these officials is a strategy designed by action.org called E.P.I.C.: **E**ngaging your audience; stating the **P**roblem; **I**nforming about a solution; and having a **C**all to action. **E**ngaging the audience will require a message that appeals to both the emotional and logical arguments for elected officials and their constituents. Emotional messaging content will focus on myth-busting, story-telling, offering test-drives, promoting *The Electric Ride* campaign, and providing case studies and testimonials. The logical message includes information on the positive impact of PEVs on local green jobs, state economics, international competitive edge, and the spirit of mobility, connectivity, and efficiency. Several other strategies may also help engage an audience of elected officials:

- Work sessions with individual officials or at public meetings
- Use business/private sector partners and allies to get on the agenda for public official meetings
- Letter to local officials signed by FEVER partners
- Use media to cultivate education of officials

Stating the **p**roblem will require research to answer tough questions about the PEV market and benefits, such as:

- What are the true costs of PEVs and infrastructure?
- What is usage potential? (i.e. how much will people use EVSE?)
- What are the differences in EVSE types?
- How do the subsidies in Colorado compare to other markets?
- Major opposition questions: Are PEVs amenable to Colorado geography, climate, and altitude?
- What, if any, is the role of the government in private sector/market?

Informing on the solution will also require some research and may depend on the exact interests and make-up of the advocates. Potential policy solutions are included in the policy section of this plan, but advocates may also want to consider these ideas:

- Focus on factual data
- Explain impact on foreign oil independence and/or climate change
- Explain air quality benefits
- Discuss business opportunity
- Use citizen/private-sector testimonials

Resources at *The Electric Ride* and this Plan can help with the research necessary to State the problem and Inform the solution.

Call to action is the final step of the discussion. The advocate must clearly state exactly what action the elected official needs to take to move this issue forward. Ideas spread throughout this Plan, particularly in the policy section, provide guidance as to “the ask.”

The training and education of all the groups discussed in this section will aid in overcoming barriers across all issue areas by creating a new awareness among consumers, service providers, and elected officials. While the following sections provide recommendations to overcome the more technical and process-oriented barriers, all solutions ultimately rely on a well-educated public and industry to succeed. Building outreach channels, establishing training opportunities, and offering continual education are all inherent to furthering the PEV market.

VII. EVSE Permitting and Multi-unit Installations

Section Summary:

After outlining the permitting and inspection process for EVSE governed under the NEC, recommendations provide insight into how to further streamline the process and ensure EVSE installations are safe, quick, simple, and affordable. For installations at multi-unit dwellings, a framework for collaboration between property managers and residents provides solutions for overcoming installation barriers.

Audience:

Policy-makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

As with any purchase, PEV consumers want to know they can use a new product immediately. For a PEV, this means access to charging. To gain access quickly and easily, customers need to understand their charging options and how to obtain charging equipment that meets their driving patterns. Standard 120v outlets often provide readily-accessible charging options that are less cumbersome to install and often do not require a permit.[84] Customers who prefer faster charging options (level 2 or DC fast charging), can still find easy installation options, but may need to be aware of more moving parts and will likely need to acquire an electrical permit. Tenants of multi-dwelling units can explore a variety of options with relevant building authorities. The key is for PEV customers to know how to gain charging access and what steps will be required.

Permitting Process and Improvements

The permitting and inspection process for EVSE is already well-established and the process itself is not a significant barrier for PEV expansion in Colorado. The installation process is governed under Article 625 of the NEC, following the same requirements for any electrical installation of the same voltage and amperage. After installation, a state or county inspector will need to review the installation for code compliance (See Appendix 13: State Inspection and Permitting Map). While state and county inspections are governed and implemented slightly differently, the general procedure is well-understood and similar across the state.

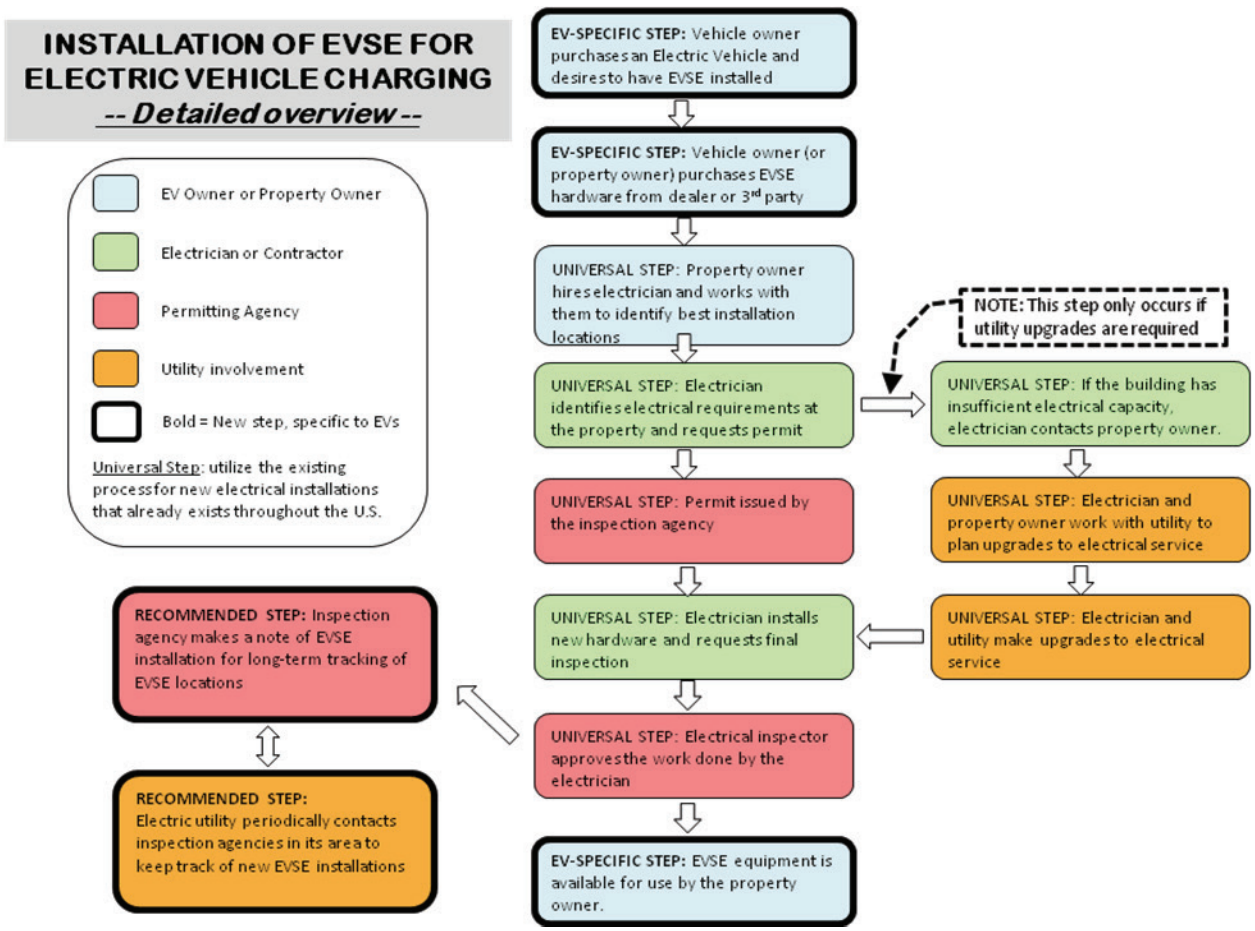
As these processes have been in place for some time, the relevant implementers (electricians, building department personnel, and inspectors) are aware of the requirements and do not anticipate issues from installing new EVSE. Electrical department regulators from urban (Jefferson County) and rural (Archuleta County) areas have indicated that accommo-

[84] A new dedicated 120V outlet may need a permit on some occasions depending on electrical modifications required, such as a new breaker or wiring. Consult a licensed electrician.

dating the growth of level 2 charging is not an issue.[85] While DC fast charging may require some additional education for inspectors and electricians, it will not present significant issues either.[86] Licensed electricians that also gain training in EVSE will be able to assist customers throughout the process.

The basic permitting process discussed here follows relatively simple steps, as per the flow chart below. The bulk of the work (i.e. permit application and installation) is managed by the electrician, while the main responsibility of the consumer is hiring the contractor. The consumer can use resources such as the Yellow Pages, preferred vendors list from the PEV dealership, utility contacts, formal bid processes, or the International Brotherhood of Electrical Workers member list to find a contractor. Beyond this step, the PEV customer can be as involved or disengaged as desired.

Figure 2: Permitting Process Flow Chart, Electrician Perspective



[85] Jefferson County Municipal Building Department representative. Personal interview conducted by Paul Berry. 27 July 2012. Archuleta County representative. Personal interview conducted by Paul Berry. 1 August 2012.

[86] Jefferson County Municipal Building Department representative. Personal interview conducted by Paul Berry. 27 July 2012. Archuleta County representative. Personal interview conducted by Paul Berry. 1 August 2012.

One potentially difficult aspect of this process is the price of the electrical permit. Since local building departments administer the permitting process, pricing varies across jurisdictions. In Colorado, this variation can be quite significant, with fees ranging from $43 to $188, due to the fact that local jurisdictions have authority to establish prices and the factors that are used to calculate the price. Making consumers aware of the price variability and educating them on the factors that determine the price may help avoid perceptions of inequality and alleviate concerns about the process.

Table 18: Permit Fees For Residential And Commercial Evse Installations Across Colorado[87]

	Residential Permit Cost	Commercial Permit Cost
Denver[88]	$43.00	$43.00
Boulder	$36.70	$42.85
Ft. Collins	$143.25	$143.25
Colo. Springs	$186 (if bought locally)	$188.16
Grand Junction	$69	$69
Steamboat Springs	$70	$70
Pueblo	$69.00	$69.00
Breckenridge	$149.50	$149.50
Greeley	$83.25	$83.25
Durango	See DORA	See DORA
Colorado DORA	$130	$130

In addition to price variability, there remains a perception that the process is lengthy, cumbersome, and lacks standardization. Typically, the approval process only takes approximately 48 hours for residential installations, unless there are conditions that require panel upgrades or other electrical planning. In addition ensuring this timeline is well understood by the consumer, some larger concerns exist around the technical specifications for DC fast chargers and tracking mechanisms for EVSE locations and load demand. While these larger concerns are beyond the scope of the local level authority, further streamlining of the current permitting process will enhance the customer experience.

Two cities outside of Colorado, Houston and Raleigh, have actively pursued updates to the permitting process to enable quicker EVSE installations, providing best practices that may be pursued within Colorado according to local needs.

[87] All costs presented were verified with a representative from each jurisdiction. Permit fees are based on an EVSE installation that costs $3,000. This high cost estimate was used to provide the upper range of potential permit fees. Most installations will be significantly less than $3,000 and associated permit fees may be lower.

[88] Additional fees may be applied depending on the complexity of the installation

Table 19: Best Practices for Permitting[89]

	Houston	Raleigh
Wait time	48 hours	24-48 hours
Best Practice process		
Permit submission		
Residential	Over the counter or online in 15 minutes	Over the counter in one day
Commercial	Over the counter or online in 15 minutes	Right-of-way permit for an additional $74 required
Requestor	Electric contractor/installer	Homeowner, installer, contractor
Cost	$35-$45 plus the cost of the plan review, if necessary	$75
Inspection requirement	Yes	Yes
Cost	Included in permit price	Included in permit price
Plan required		
Residential	No	No
Commercial	Yes	Required for multiple units
Working with localities	Localities receptive and positive towards preparing the process, particularly those in or near urban areas	Overcomes difficultly with contractors and inspectors as demand increases
Recommendations and challenges	Consider "bulk sticker" permitting with random inspection process Reduce process to 24 hours, ensuring inspector arrives the next day if installation is completed by noon	Public and internal education and marketing process is key Use Project Get Ready Collaborate with energy companies Create an informational booklet and guidelines on process Create installation how-to videos

[89] Virginia Get Ready: Electric Vehicles Plan Initial Electric Vehicle Plan. Virginia Clean Cities, 13 October 2010: 47. Web. 2012. <http://www.virginiaev.org/wp-content/uploads/2010/11/EV-VGR-FINAL-October-13-2010.pdf>. Modified under partnership with Rocky Mountain Institute's Project Get Ready.

In addition to these two cities, Oregon has implemented two programs that provide examples for other streamlining solutions.

- **E-permitting Process** (Oregon):[90] This program allows contractors to purchase permits online and follow the same inspection process as a regular permit.
- **Minor Installation Label Program** (Oregon): This program is designed to decrease costs of permit inspections by substituting full permits with installation labels for straightforward cases. Currently, installation of branch circuits up to 30 amps at 240 volts can qualify for an installation label.[91] The installation labels are sold at a tenth of the cost of a regular permit, and inspectors only inspect one out of ten installations and ensure load capacity to meet new EVSE demand.[92]

When considering these, and other, best practices and program options, local governing agencies will want to focus on enhancing success across four factors through process improvements:[93]

1. **Safe:** NEC guidelines ensure safety requirements are met, and further exposure of electricians and inspectors to EVSE can enable a quicker response in the rare event of safety issues. Potential actions include:
    - Conduct trainings for inspection staff on EVSE installation standards to ensure universal familiarity with EVSE equipment and inspection processes.
    - Offer educational opportunities through the Rocky Mountain Chapter of the International Association of Electrical Inspectors.
2. **Quick:** Continue to complete entire permitting and inspection process for simple home-based EVSE projects in less than 48 hours, ideally less than 24 hours,[94] so that consumers can use the EVSE in less than one week. Local jurisdictions can adjust this goal according to context. Potential actions include:
    - Require EVSE permit approvals within 1 business-day.
    - Perform EVSE inspections within 1-2 business days of request, potentially prioritizing EVSE requests.
    - Set up online permit process.

[90] Clements, Dennis. Expediting the Permit Process for Installation of EVSE. Oregon Building Code Department, 12 February 2010. <http://www.rmi.org/Content/Files/Oregon%20Expedited%20Permit%20Process.pdf>.

[91] A minor label for the installation of a 40 amp, 240-volt branch circuit and the connection of EVSE in one- and two-family dwellings where the EVSE is in an attached garage is being investigated.

[92] Minor Label Program. Department of Consumer Business Services, Building and Codes Division. State of Oregon, n.d. Web. 2012. <http://www.bcd.oregon.gov/programs/minorlabel/minor_label_programs.html>.

[93] California Plug-in Electric Vehicle Collaborative, n.d. Web. 2012. <http://www.PEVCollaborative.org/>;

Atlanta's EV Readiness. City of Atlanta, Mayor's Office of Sustainability, n.d. Web. 2012. <http://www.cleancitiesatlanta.net/index.php/grants-a-projects/atlanta-ev>.

[94] Toraya, Jules. Electric Vehicle Deployment Municipal Best Practices Study. City of Atlanta Mayor's Office of Sustainability, 11 May 2011. Web. <http://www.plugingeorgia.com/pdf/bppaper05.13.11.pdf>.

3 **Simple:** Make sure the consumer experience is as simple as possible, and set up easy steps for the electricians and inspectors to conduct the full process and keep the number of parties involved minimal. Potential actions include:
- Avoid requiring the electrician to be present at final inspection.
- Develop a permitting checklist with all the steps required for a permit for use by building department and inspectors.
- Avoid special EVSE permits to prevent increase uniformity for electricians, inspectors, and customers.[95]

4 **Affordable:** Keep permit prices consistent and as low as possible since PEV customers are already paying more for the vehicle. Potential actions include:
- Standardize EVSE permit fees across regions or set maximum—preferably done at the local level rather than state-mandated in order to meet local needs.

Installation Plan for Multi-unit Residential Areas

Given the importance of residential charging, the availability of charging options at multi-dwelling housing units determines whether residences of apartment buildings, condos, or other multi-unit arrangements can purchase a PEV. Since tenants do not always have their own parking spot or authority to install charging equipment, multi-unit residential areas present unique challenges to charging infrastructure.

While some cases may be as simple as the resident installing an outlet or charging station, there are examples in Colorado that have not been this simple. Instead, residents have faced complex challenges such as parking spot designations, power supply, data tracking, billing complexity, and legal concerns. These issues can prevent residents from gaining approval from the relevant authority. There is no silver bullet solution; however, collaboration between residents and building managers usually results in a mutually satisfactory solution to accommodate PEV charging.

The most challenging issue in multi-resident dwellings is establishing who should carry the cost burden, the resident or property owner. Property managers may be more inclined to allow installation if the PEV owner pays the full cost of installation and electricity. However, installing EVSE in a multi-unit building is often cost prohibitive for a single user[96] and creates another cost barrier to purchasing a PEV. Furthermore, the property manager could benefit from providing EVSE.[97] Different cost-sharing models between the two parties can be considered on a case-by-case basis.

[95] Danforth, Joel. Municipal Deployment of Electric Vehicle Supply Equipment for Public and Fleet Charging. United States Department of Energy. PDF. 2012.

[96] Peterson, David. Addressing Challenges to Electric Vehicle Charging in Multifamily Residential Buildings. Rep. Luskin Center for Innovation, UCLA, 2011. Web. 2012. <http://luskin.ucla.edu/sites/default/files/EV_Multifamily_Report_10_2011.pdf>.

[97] Appendix 14: How Electric Vehicles Can Benefit Property Developers

To determine the best approach, guide negotiations, and establish the optimum cost-sharing model, residents and property managers can use the framework below to assess the feasibility of EVSE installation.

1 Find a location for the charger(s) that can be connected to a source of power.
- Consider 120v charging options.
- Locate and assess the proximity of an electric panel.
- Use existing conduit near the parking spot to decrease wiring costs.
- Asses need for digging or trenching to connect panel to EVSE.

2 Verify source of power capacity and determine metering method.
- Check the capacity in the chosen electrical panel - even older buildings may have extra capacity built into subpanels that can be used for new loads such as PEV infrastructure.
- Establish a mechanism to track electricity use and recuperate costs of electricity used for charging, such as:
  - Employ a PEV owner's electric meter.
  - Install a new meter: For properties with common outlets available, a simple metering device to record kWh use can be used to determine the cost of energy used by the PEV.
  - Use a charging station with metering capacity.
  - Establish costs of desired tracking mechanism.

3 Contact utility to assess cost of new meters and necessary service upgrades.
- Verify capacity to add meters and assess meter installation costs and space for mounting hardware.

4 Address issues resulting from common parking situations.
- Install a minimum number of 208/240v 40 amp outlets, equal to 5% of the total number of parking spaces.
- Establish policy for new tenants requiring charging.

5 Consider future PEV growth and charging capacity.
- Install electrical panel capacity and empty conduit for the future installation of EVSE, equal to a minimum of 5% of the total number of parking spaces.
- Install additional electrical and transformer service capacity.
- Ensure space for meters, sub-panels and conduit to accommodate future installation of electrical outlets.

During this process, property owners will want to pay particular attention to costs and accommodating future growth. Ideally, EVSE installation will use the lowest-cost strategies that can also accommodate future demand. For example, property owners can decrease costs by assigning PEV charging to the spots closest to a parking structure's electrical panels. Also, installing proper equipment and establishing policies and procedures will preempt obstacles arising from existing parking rules or preferred parking.

Another option is to set up a business agreement with a third party EVSE provider that will operate charging equipment at multi-unit locations at a low, or no, cost to the property owner. For example, the property owner would grant a multi-year lease to the EVSE provider, which would install, own, and operate the EVSE during the lease period. There are some EVSE companies that specialize in providing this service, often uniquely tailoring solutions to multi-unit residential areas.

In the case that on-site charging access is impossible due to costs or curbside parking arrangements, PEV owners will have to find other creative charging solutions. Working in concert with the property owner and government representatives, PEV drivers can look into more unique arrangements that can still meet charging needs, such as:
- Charge at work.
- Locate public charging infrastructure within walking distance to the residence, such as neighborhood public lots or curbside parking.

- Check commercial parking areas nearby (such as businesses with EVSE).
- Consider vehicle (i.e. PHEVs) and charging (i.e. 120v) options.
- Work with local government to provide curbside EVSE.

Solving the charging challenges for multi-unit dwellings will require more creative solutions and collaboration between diverse stakeholders. As evidenced by the story of one Colorado PEV owner below, many individuals and groups are interested in helping residents of apartments and condos to become PEV owners. As more residents of these types of units want to purchase PEVs, property managers will be incentivized to provide charging and solutions will be forthcoming.

Case Study: Finding Charging Access in Multi-Dwelling Units

"Sometimes I can't sleep at night. After growing up in Colorado, the drought, pine beetle infestation, and forest fires make me worry about what we are doing to our beautiful earth. Electric vehicles are a tangible solution that could really make a difference for our environment. In January of 2012, I bought a Chevy Volt.

"Excited about using domestically produced electricity as my fuel, I plugged-in to an electric outlet outside my back door. The outlet was next to my parking place, in the common garage of my multi-unit housing complex. Three weeks later I got a letter from my HOA demanding that I stop charging my car immediately. It turns out the electricity for that outlet comes from an HOA circuit, not my own. Thinking the cost of electricity was the issue, I offered to install a charging option from my own circuit. Neither was this agreeable. Plugging-in would not be as easy as I thought.

"Faced with an HOA that was just saying 'NO' to providing charging access, I decided to fight for regulations that clearly allow for PEV charging for myself and future tenants. In my case, the HOA was afraid that PEVs are dangerous. Despite assurance from the fire department attesting to the safety of the Volt, HOA members were concerned about the risk of spontaneous fire of the Volt (despite the fact that all traditional vehicles are parking there with 15 - 20 gallons of flammable liquid in them). As such, the governing body was asking me to purchase an extra layer of insurance and report all accidents, practically inhibiting my PEV charging.

"Four months and lots of negotiation later, we came to an agreement. While I did purchase additional insurance, I did not have to report my vehicle use or accidents. For a daily cost of $1.50, I now charge my Volt from the outlet outside my door.

"While this is only an interim solution, property managers now have an example of how to provide safe, accessible charging at no cost! In fact, my own property developer is installing charging stations in an apartment building currently under construction. As a development company with 15 properties, providing PEV charging is an important avenue to live up to their brand as a sustainable community committed to preserving Colorado's environment. I am excited that I could be part of the solution.

"To make PEVs a solution for more people, I am also working with elected officials to pass legislation that would restrict HOA's from 'just saying no' to PEVs. The aim is to create an avenue for property managers and PEV owners to work together to find mutually agreeable charging solutions. Thus, all tenants of multi-residential housing can easily and conveniently have access to one more way to help the environment, electric vehicles." —Linda Campbell, Colorado PEV Owner

VIII. Local Ordinances and Codes: Building Codes, Zoning, Parking

Section Summary:

This section establishes guidelines that can be used to develop local ordinances and codes that encourage PEV and EVSE growth in a cost-effective, safe, and efficient manner. A model ordinance is provided as general guidance to develop and implement local ordinances including building codes, parking development and etiquette, and zoning, in a manner that best meets local needs. Combined, these guidelines create an avenue to spur investment at the local level and increase consumer confidence in the PEV charging infrastructure.

Audience:

Policy-makers, Business Leaders, Utilities, and Energy Professionals

Clear, streamlined, statewide planning guidelines will further the EVSE deployment plan and enable strategic and optimized investments in charging infrastructure. Since Colorado is a home rule state and jurisdictions maintain significant local authority, PEV/EVSE-related ordinances vary across jurisdictions. Also, due to the nascent nature of the market, many jurisdictions do not have such ordinances.

The recommendations and models provided here seek to address several gaps in PEV planning. First, clear siting guidelines adapted to the local context can preempt potential conflict due to land-use, right-of-way, and other restrictions. Second, combined with the data and distribution analysis conducted in the deployment plan, ordinances can support strategic planning and help achieve the most effective distribution of EVSE by level and location. Third, as more PEVs demand charging at public attractions, parking etiquette and enforcement procedures will avoid conflict between all drivers. Lastly, local ordinances play a role in incentivizing private sector entities to invest in EVSE infrastructure. Relevant policy-makers, planners, and implementers can apply these recommendations and enable economic development at the local level.

The ordinances discussed include building codes, zoning laws, parking enforcement, and ordinances that encourage EVSE installation. Combined, these guidelines will enable a charging network that meets state, regional, and local needs.

Model Local Ordinances[98]

Model codes, or sample or suggested ordinances, can help local governments achieve a consistent regional PEV framework by replicating or adapting best practices to local conditions. Based on examples from Washington and

[98] County of Sonoma General Services. Department Electric Vehicle Charging Station Program and Installation Guidelines. County of Sonoma, July 2011. Web. 2010. <http://www.sonoma-county.org/prmd/docs/misc/ev_prog_guidelines.pdf>; Draft: Installation Guide Electric Vehicle Supply Equipment. City of Atlanta, June 2012. Web. 2012. <http://www.plugingeorgia.com/pdf/library/EVSE_Installation_Guide.pdf>; Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State. State of Washington, n.d. Web. 2012. <http://psrc.org/transportation/ev/model-guidance>; Ready, Set, Charge California, A Guide to EV Ready Communities. Bay Area Climate Collaborative, November 2011. Web. 2012. <www.ReadySetCharge.org>; Center for Sustainable Energy California. Cities and Governments. The California Electric Vehicle Collaborative. Web 2012 <http://energycenter.org/index.php/outreach-a-education/plug-in-a-get-ready/citiesgovernment>.

California and input from experts in Colorado, a model code to guide the implementation of effective building codes, zoning, parking, and signage ordinances is described here and provided in Appendix 15: Model Code. The model code is not designed as a state mandate, but rather as sample language that local authorities can adapt to encourage PEV adoption in their locality.

Definitions

First and foremost, local ordinances will need to start with specific definitions of key terms related to PEVs. A sample list of key terms and guidance definitions is included in section 3.1 of the model ordinance (Appendix 15). Authorities can select and define the most relevant terms to the local context. The definition of EVSE will need particular attention, as this is a new fueling option and its definition will determine if it is governed under “fueling station” standards. The location, type of ownership, and type of access (public, restricted, etc) will need to be considered when defining EVSE in the local ordinance.

Overall, developing definitions could help enable a common language and understanding of the market at the local level, but can also evolve along with the market. Maintaining a database of terminology across the state could also ensure codes are implemented in an efficient manner.

Building Codes

Adopting building codes that support the provision of EVSE in commercial, public, and residential structures can incentivize cost-efficient EVSE deployment. These building codes would provide language that requires or incentivizes residential or commercial developments to either provide EVSE or pre-wiring for future installations.

Encouraging the adoption of EVSE requirements in building codes can save money, ensure new building stock is EVSE-ready, and indirectly encourage the existing building stock to become PEV-ready too. Pre-wiring or installing EVSE during construction is significantly cheaper than retro-fitting old buildings due to the potential for retrenching, rewiring or upgrades to electric panels. Commercial retrofit installations can cost an additional $1,100 per station for surface lots and $800 for parking garages;[99] residential single-family level 2 retrofit installations cost an additional $900 more than preparing that home during new construction.[100] In addition to the cost savings, EVSE building code requirements would ensure all new buildings are ready to support the increasing demand for PEV charging and population increases. With a 52% population growth expected in Colorado by 2040,[101] new building stock is also expected to house these residents. Thus, building codes represent a great opportunity to expand the EVSE network. Further, if new building stock is EVSE-ready, there will be more competition for existing building owners to offer EVSE charging, thus, incentivizing more installations.

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[99] Olsen, Matt, Patrick Mahoney, Ken Hoffman, and Bread Schoener. Electric Vehicle Charging Infrastructure Recommendations to Fairfax County. MITRE Corporation, 19 July 2011. Web. 2012. <http://www.mitre.org/work/tech_papers/2011/11_2916/11_2916.pdf>.

[100] Electric Auto Association. “EV Infrastructure Costing Worksheet.” Vancouver Electric Vehicle Association, n.d. Web. 2012. <http://www.veva.bc.ca/home/index.php>.

[101] Colorado Department of Local Affairs. Population Totals for Colorado and Sub State Regions. State of Colorado, n.d. Web. 2012. <http://www.colorado.gov/cs/Satellite?c=Page&childpagename=DOLA-Main%2FCBONLayout&cid=1251593346834&pagename=CBONWrapper>.

To implement these building codes, relevant authorities will need to determine the best mechanism and language to encourage adoption in the local context. The three mechanisms that have seen success in other cities include: 1) Capacity level: all buildings must install the electrical capacity for a certain level of charging; 2) Number of Spaces: minimum number of EVSE per parking space must be met; or 3) Business Size: all businesses of a certain size must provide EVSE. Specific examples of these mechanisms are provided below.

Table 20: Building Code Requirement Examples

	Single Family Residential	Multi-Family Residential	Commercial
Vancouver, British Columbia[102]	Conduit for future dedicated outlet for PEV charging in the parking area	Conduit for future dedicated outlet for PEV charging in the parking area; 20% of parking spaces required to accommodate EVSE	
Los Angeles, California[103]	A 240v outlet or sufficient panel capacity and conduit for future installation in parking area	A 240v outlet or sufficient panel capacity and conduit for 5% of total parking spaces	Enough 240v outlets for 5% of total parking spaces
State of California[104]	Conduit from service panel to the parking area	3% of all parking spaces (but not less than one) would have the capacity to support future EVSE	Capacity and conduit for 1-4 future EVSEs, depending on the number of parking spaces
Hawaii[105]			All public places with at least 100 parking spaces will have one parking space near the building entrance equipped with EVSE

[102] "Electric Vehicle Infrastructure Requirements for Multi-Family Buildings." City of Vancouver, n.d. Web. 27 July 2012. <http://vancouver.ca/sustainability/EVcharging.htm>.

[103] New Article 9 to Incorporate Various Provisions of the 2010 California Building Standards Code. Ordinance 181480. Sections 99.04.106.6 and 99.05.106.5.3.1, City of Las Angeles, 2010. Web. 2012. <http://ladbs.org/LADBSWeb/LADBS_Forms/PlanCheck/2011LAAmendmentforGreenBuildingCode.pdf>.

[104] Revision Record for the State of California. California Green Building Standards Code. Sections: A4.106.6, A4106.6.1, A4.106.6.2, A5.106.5.3, and A5.106.5.3. State of California, 1 July 2012. Web. 2012.< http://www.iccsafe.org/cs/codes/Errata/State/CA/5570S1002.pdf>.

[105] Relating to Electric Vehicle Parking. S.B. No. 2747. State of Hawaii, 2012. Web. <http://www.capitol.hawaii.gov/session2012/Bills/SB2747_.htm>.

A sample building code language example from Los Angeles California is available in the Model Ordinance (Appendix 15).

Zoning and Allowed Uses

Establishing zoning regulations that promote EVSE installations and provide guidelines for potential installers will ensure an efficient, safe, and accessible charging infrastructure. Zoning regulations can help set safety and accessibility standards and provide guidance for clear and effective parking and signage. Zoning codes will establish allowable public EVSE locations according to density and land use. The overarching key for successful zoning codes is to allow flexibility to accommodate new technologies, such as DC fast charging or battery swapping, while still providing consistency for planning purposes. Since the future of the EVSE market remains uncertain, local jurisdictions may be able to provide information on the potential impact of various technologies on land use (i.e. noise, setbacks, or other characteristics), rather than establishing mandates.

Jurisdictions interested in implementing zoning codes for EVSE can find more information in the model ordinances (Appendix 15), which provides sample zoning guidelines that can be adapted to fit the context of local jurisdictions in Colorado.

Local Ordinances for Parking

Local ordinances are important to guide PEV parking across three areas: zoning-related ordinances, governing public installations, etiquette and signage. Each of these areas will require specific considerations at the local level.

<u>Parking: Zoning Ordinances:</u> Zoning ordinances amendments can be used as a mechanism to encourage EVSE installations. The City of Sea Tac Washington and the State of Hawaii provide two examples of how to use zoning regulation to promote EVSE. The City of Sea Tac incentivizes EVSE by allowing EVSE parking spots to count towards required off-street parking. Contrastingly, Hawaii established that parking facilities of a certain size must provide a certain percentage of parking be EVSE ready. See EVSE parking section of the model ordinance for more detail (Appendix 15).

<u>Parking: Public Installations:</u> Local jurisdictions can also promote the EVSE market by installing charging options on governmental land. These will either be on-street parking (curbside) or off-street (in parking facilities or garages). For both types of installations, local ordinances provide guidelines on the location, maintenance, lighting, safety, signage, and other installation considerations. These guidelines may help local jurisdictions establish consistency and efficiency in providing public charging. While the model ordinance provides language specifically for public facilities and installations, much of the guidance could be applied to any public or workplace installations.

Local planners can decide between on and off street according to the local context, costs, and locations; however, on-street parking installations may face more considerations, such as snow removal and metered parking.

In addition to the sample ordinance language to govern these parking types, best management practices provide general business considerations to follow throughout any EVSE installation process (public or private). A few best practices are highlighted here and a full list is provided in Appendix 16.

Table 21: Highlights of Parking Best Management Practices

Consideration	On-street Best Practice	Off-Street Best Practices
Fee for EVSE Use[106]	Charge a fee for kilowatt hours (kwhs) used during charging Increase existing parking fees for PEV users Charge a specific fee for ICE vehicle drivers that park in PEV spaces	Free access with purchased "pass card" Add fee to parking entrance fee Charge for kilowatt hours used during charging Overstay fees
Ensuring right amount of EVSE turn-over	Consider metered parking with certain hour limit Enforce fines for overstays under the current system	Use dual-port charging to increase number of EVSE accessible spots Fee-based systems Reservation systems Valet services
Designated versus Preferential parking	Offer designated parking for PEV drivers (preferential parking with caution)	Offer designated parking for PEV drivers (preferential parking with caution)

The best management practices combined with the code language will aid in deploying EVSE parking efficiently and in locations that will be highly used by PEV drivers.

One other important safety and regulation issue for all public or workplace EVSE is that they are all required to comply with Americans with Disabilities Act (ADA).[107] Generally, an accessible parking space must meet certain space and design requirements to allow a person with a disability to make full use of the parking space and EVSE.[108] While the federal ADA guidelines do not currently address EVSE installations, implementers can use the federal parking accessibility requirements for regular parking spaces as guidance for EVSE projects. The most prominent accessibility requirements for accessible EVSE parking is outlined in Table 22.[109] Illustrations of ADA-accessible and EVSE-capable parking designs are available in Appendix 17.

[106] Goal is to charge a fee that is not burdensome to the customer, as this may discourage using public charging, and needs to be competitive with home charging rates.

[107] EV Project: Accessibility at Public EV Charging Locations. Prepared for US Department of Energy. ECOtality North America, 10 October 2011. Web. 2012. <http://www.theevproject.com/downloads/documents/EV%20Project%20-%20Accessibility%20at%20Public%20EV%20Charging%20Locations%20(97).pdf>.

[108] ECOtality North America, 2011, 4.

[109] ECOtality North America, 2011, 4.

Table 22: Summary of Important ADA requirements

Element	ADA/ABA 2004 ANSI A117.1 2003
Number of Spaces	4% of parking spaces, or 1 for every 25 spaces, in any given lot, be designated as accessible; 1 out of every 6 spaces should be van accessible[110]
Parking Stall	8x18 feet for a car and 11x18 feet for a van
Accessible Route Width	Minimum 36 inches wide
Accessible Route Slope/ Cross Slope	Maximum 1:20 (5%) running slope and 1:48 (2%) cross slope; Accessible vehicle spaces 1:48 (2%) in all directions and 90-inch clearance for vans
Reach Range	48 inches front and side to allow reach to all operable parts from a wheelchair
Accessible Controls	Operable with one hand and not requiring grasping, pinching, or twisting of the wrist or force more than 5 lbs. Exception: Gas pumps
Accessible Ramps	A ramp or curb-cut must be accessible in order to allow for operation of charging station
Facility Accessibility	Must be connected by a minimum 50-inch-wide accessible route in proximity (not necessarily adjacent) to the entrance of the building[111]
Side Access Aisle	Side access aisle of 60 inches wide to allow space for wheelchair and equipment in and out of space
Accessible Card Reading Devices	Must be connected by a minimum 50-inch-wide accessible route in proximity (not necessarily adjacent) to the entrance of the building[112]
Other Considerations	Ensure that bollards, wheel stops, or curb do not obstruct use of charging station

[110] Mayfield, David. Electric Vehicle Charging for Persons with Disabilities. Sustainable Transportation Strategies. 14 February 2012. Print.

[111] EV Project: Accessibility at Public EV Charging Locations. Prepared for US Department of Energy. ECOtality North America, 10 October 2011. Web. 2012. <http://www.theevproject.com/downloads/documents/EV%20Project%20-%20Accessibility%20at%20Public%20EV%20Charging%20Locations%20(97).pdf>.

[112] ECOtality North America, 2011, 9.

Due to the highly detailed nature of these requirements and risk of non-compliance, hiring an expert on ADA requirements to consult on site-specific issues is highly recommended. These experts may also be able to help in determining exemptions and identifying opportunities where current ADA parking spots can also serve as EVSE spots.

Parking: Etiquette and signage: Local ordinances will play a role in determining how PEV drivers find and use EVSE parking spaces. The EVSE etiquette and EVSE signage sections of the model code (Appendix 15) highlight the key considerations for relevant authorities to implement local guidelines for parking etiquette and signage. In terms of etiquette, the key considerations are the enforcement of the use of designated spots, plans to mark the spot and notify potential users, and clearly state penalties. Some guidelines for parking etiquette are embedded in general parking considerations. In terms of way-finding, local jurisdictions can determine a set of signage that will allow users to find stations. While the developed Federal EVSE sign has yet to receive final approval, this sign can be useful for way-finding.

Colorado entities interested in pursuing PEV and EVSE local ordinances or codes in any of the described areas (building codes, zoning, and parking) will find further information in the model ordinance (Appendix 15). The following steps also provide a framework to implement the codes and ordinances most likely to spur EVSE and PEV adoption in the local context.

1. Select the appropriate policy tool (e.g. local ordinance) to promote EVSE adoption in the local context.
2. Work with relevant building department and/or local agency to develop code language.
3. Gain appropriate political support.
4. Work with relevant decision-makers to implement new code.
5. Enjoy the new economic, environmental, and social opportunities that EVSE infrastructure will bring to the community.

Overall, creating statewide guidance to inform decisions regarding building codes, zoning regulations, parking etiquette, and local ordinances will empower local jurisdictions to promote PEVs in a way that will grow the entire market.

IX. Fleets: PEV Integration

Section Summary:

Integrating PEVs into fleet operations represents a major opportunity to increase PEV sales. Since fleet operators are highly focused on the economics of vehicle ownership, this section highlights the best fleet candidates for PEV adoption and how these fleets can optimize PEVs to improve performance, achieve lower cost of ownership, meet operational demands, and create return on investment. The final recommendations offer a menu of options for fleets to leverage the many advantages of electrification with viable financial models.

Audience:

Policy-Makers, Business Leaders, Fleet or Operations Managers

Fleet operators represent a key target segment for spurring adoption of PEVs. In the U.S., public and commercial fleets represent only 7% of the total U.S. vehicle stock, but they account for over 35% of transportation fuel consumption.[113] Similarly, Colorado fleet owners and operators account for a significant share of vehicle purchases. While consumers are likely to consider a wide range of features when purchasing a vehicle, fleets are focused on the economics of vehicle ownership, making purchasing decisions more predictable. For fleet operators with significant fuel costs, PEVs may offer opportunities to reduce the total cost of ownership among other advantages.

Electrification Opportunities

Aside from increasing PEV adoption overall, the primary goal of fleet electrification is to enhance the performance of the existing fleet. Understanding the key drivers of fleet operators today will guide the opportunities and challenges for integrating new vehicle technology. Above all, fleet owners strive to purchase and operate vehicles that make financial sense. In a survey of Colorado fleet owners and operators, cost efficiency ranked as the highest indicator of a successful fleet. Considering fleet operators often purchase rather than lease vehicles, upfront capital costs and operational costs play a critical role in vehicle decisions. Fuel costs often represent a significant portion of overall costs. In addition to finances, survey participants identified several other key elements, including:

- Aligned vehicle, job, fuel (i.e., the right vehicle for the right job and fuel usage)
- User friendliness
- Reliability/safety
- Reduced petroleum consumption[114]

[113] "Fleets" Rocky Mountain Institute, n.d. Web. 2012. <http://www.rmi.org/Fleets>.

[114] Project FEVER. Fleet Working Group Survey Results. April 2012.

If PEVs can enhance fleet performance across these areas, decreasing costs and increasing reliability, more operators will consider electrification as a competitive edge worth executing.

Considering these performance drivers, successful fleet electrification depends on employing PEVs towards the most suitable job application. Since PEVs are not the best option for every job, ensuring that early adopters utilize PEVs for a purpose that improves performance will increase consumer confidence and motivate adoption of the technology. Fleets that meet one or more of the criteria listed below are likely to benefit from converting to PEVs:

- Low to medium daily mileage
    - Companies needing regular site visits to monitor work
    - Service industry companies that require each vehicle to cover a limited area
- A central pool or parking facility
    - Companies, organizations, and universities with large campuses
    - Fleets with central pooling facilities and capacity for charging stations
- Regular and local routes
    - Local delivery fleets without heavy cargos to carry
    - Environmentally conscious fleets providing staff vehicles for local use
    - Regular routes that require travel of 50-70 miles
- Light duty vehicle use
    - Fleets with many light-duty vehicles, such as sedans and light pick-up trucks
- Access to tax credits
    - Tax-paying organizations with fleets
- Ability to monetize environmental and public relations benefits of efficient transportation
    - Companies with strong sustainability goals

The use and application of the vehicle are the most important considerations, regardless of organization type. Large companies may see more cost savings due to the size of the fleet, but the modular and scalable nature of EVSE provides a cost-efficient mechanism for smaller companies to engage in this alternative fuel as well.

For fleets that meet one of these criteria, fleet electrification represents an attractive alternative to help fleet operators achieve top priorities, such as:

<u>Total Cost of Ownership:</u> PEVs represent an opportunity for fleet managers to significantly cut operational expenditures. Although the upfront cost of PEVs is currently higher, the total cost of ownership or operational costs provide advantages over ICE vehicles, especially for fleets with high mileage numbers. PEVs have lower maintenance costs and require little to no petroleum fuel. In contrast to the uncertain and volatile petroleum market, electricity provides a stable and low-cost fueling option, especially for commercial or industrial entities paying lower electric rates.

<u>Fueling Infrastructure:</u> Most fleet vehicles return to a central pool or parking facility, making PEV charging attractive compared to other fueling options. For jobs that require 50-70 miles of daily travel, many PEVs can satisfy the fleet operator's needs on just one charge. Once vehicles return to the central pool, they can charge overnight which could further reduce fueling costs if off-peak rates become available. In many cases, these vehicles can utilize standard 120v outlet, obviating the need for any higher level charging equipment. The central charging system also gives the fleet manager full control over fueling expenses. Fleet routes and applications are well suited to work with PEV range and charging patterns.

Sustainability: Since PEVs are environmentally advantageous in comparison to most ICE vehicle counterparts, fleet electrification will help public and private entities achieve their sustainability or environmental targets. For more details on the expected emissions impact of PEVs in Colorado, refer to the Emissions Impact section.

Electrification Challenges

Despite these advantages, fleet managers may still face challenges in fleet electrification, several of which are listed below:

- Financing the higher upfront costs:
  - Since fleets receive a discounted volume price on ICE vehicles, the incremental price difference for a PEV is higher and difficult to justify.
  - Vehicle costs are often on a different budget than operating costs, making it difficult to demonstrate the total cost of ownership.
- Variability of vehicle job requirements, such as duty cycle and range
- Variability of infrastructure requirements, such as number of stations, technology, charge level, and networking capabilities
- Potential for high infrastructure costs due to installation requirements, electric service upgrades (often needed for fleets larger than 20 vehicles), or demand charges (often incurred if multiple cars are charging at once)

As more information is gathered on installation costs and new financing options and other opportunities are leveraged, many of these concerns can be easily alleviated.

Electrification Recommendations

Colorado fleet experts developed recommendations to optimize the advantages of PEVs and overcome these challenges. The considerations are divided across five issue areas (infrastructure, duty-cycle, cost, education, and policy) and range from specific actions to broad policy ideas. A variety of stakeholders can utilize these ideas to participate in fleet electrification across the state.

Infrastructure:

- Map fleet routes to strategically place EVSE.
- Consider all installation costs (see cost analysis in EVSE Deployment section).
- Determine fleet's optimal PEV to EVSE ratio.
- Consider the interface between drivers and charging stations to develop education plan.
- Integrate PEVs into fleet procurement schedule and building contracts (such that the costs/returns are not applied separately to the fleet, but to the building as a whole. Short-term efficiency gains at the building level can pay for project costs).
- Form partnerships with relevant transportation companies interested in green activities, such as DIA, rental car companies, or hotels.
- Consider DC fast charging as costs decrease.

Duty Cycle:

- Find best application of vehicle according to code and fleet requirements.
- Capture data to show business case ($, kwh, VMT) and saving opportunities.
- Measure PEV energy consumption.
- Use software to track parking and charging patterns.

Costs, Incentives, and Demand Charges:

- Bulk purchasing of vehicles: Consider using The Colorado Energy Office "Request for Proposals for Compressed Natural Gas Vehicles" bulk purchases as a model.
- Consider leasing agreements rather than purchases: Many OEMs are offering competitive leasing packages.
- Tap into RAQC funding available for EVSE installations through 2017.
- Conduct pilot projects in partnership with utilities.
- Develop new financing options in coordination with state and local governments and large commercial entities.
- Capitalize on federal and state tax credits: Work with dealerships to ensure public fleets access state tax credits and understand financing options.

Driver Education

- Include fleet maintenance and operations training in the purchase order with the dealership.
- Educate all staff, both office and fleet professionals.
- Place instructional placards on dash boards and charging sites with PEV protocol, including where and when to charge. Clear icons or pictures will enhance this method.
- Implement internal recognition campaign to encourage competition among stakeholders and share lessons learned.
- Form long-term marketing campaign to communicate successes of fleet integration.

Policy

- Frame policy around reducing petroleum dependence.
- Integrate PEV integration as activity to achieve emissions reduction goals.
- Form buying consortium to simplify municipal purchase process.
- Consider options to make vehicle incentives available for non-tax paying entities.
- Aggregate data on all fleet vehicles in the state to share successes and aggregate demand.

While several of these recommendations provide direct action items for fleet managers, many require a broad, coordinated effort among stakeholders. Drawing on a strong consortium of stakeholders, the American Lung Association in Colorado, under the direction of The Denver Metro Clean Cities Coalition, will lead the actions related to information gathering and dissemination. Other items, such as implementation plans, sharing best practices, and policy development, will be led by fleet managers or other entities actively working in fleets.

While more information needs to be gathered and disseminated, initial evidence demonstrates that PEVs offer an opportunity for fleets to create savings, both financially and environmentally. Applied to the right vehicle application, PEVs will enhance the primary goals of fleet operators, creating more successful, cost-efficient fleets.

X. Policy Strategies and Actions

Section Summary:

Section Summary: This section provides a menu of options for strategies that state and local governments, as well as private sector entities, can pursue to promote PEV adoption within the local and state context. Strategies to determine the best role of PEVs in creating a sustainable fuel tax policy to support transportation infrastructure are provided as a menu of options.

Audience:

Audience: Policy-makers, Business Leaders, Fleet or Operations Managers

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Underpinning the success of the strategies outlined in this Plan is a strong policy environment that encourages PEV market growth. States and local government agencies with policies conducive to PEVs and EVSE are more likely to attract investors, OEMs, and consumers. Findings from current Nissan Leaf owners suggest that in states with at least one PEV incentive, consumers are 216% more likely to buy a PEV than a state with no incentives, and 300% more likely in states with two PEV incentives.[115] Policies also serve to incentivize infrastructure development, ease non-financial barriers to purchase, create new financing options, and otherwise enable PEV adoption.

Across the U.S., state and local government action has led the way in creating a PEV-friendly market environment. The majority of states, 35 of 50, have passed pro-PEV legislation, ranging from small perks, such as HOV exemptions to large tax credits for PEV purchases and EVSE installations. Benefits like HOV access for PEVs have proven effective in states with heavy congestion.[116] Of the states with legislation, 18 provide direct financial incentives to PEV drivers to overcome the incremental cost of PEV purchase.[117] State and local policies are an important part of the process for any state or municipality to become PEV-ready.

Through 2012, the Colorado approach has been to decrease the cost of the vehicles, open the EVSE market, and lead by example at the local level. Colorado offers the second highest tax credits in the country, with up to $6,000 available for eligible alternative fuel vehicles through 2015 as per HB09-1331. Colorado is also one of the first states to allow EVSE providers to re-sell electricity as a third-party without being regulated as a public utility, as per HB12-1258 (See Regulatory and Utilities). At the local level, municipalities and counties across Colorado have been promoting PEV and EVSE growth through EVSE installations, fleet electrification, streamlined policy, and incentives such as parking, toll, and other discounts for PEV users. The momentum is tangible. Building on these achievements, new policy strategies will enable state and local policy makers to more effectively address remaining barriers, the primary being PEV and

[115] Nissan. EV Market and Consumer Presentation, EV Conference in Los Angeles. May 2012.

[116] GM's Plug-in Electric Vehicle (PEV) Directional Policy Recommendations. General Motors, n.d. Web. 2012. <http://www.lung.org/associations/states/illinois/indoor--outdoor-air/gm-recommended-pev.pdf>.

[117] "State Electric Vehicle Incentives." National Conference of State Legislatures, Alternative Fuels Data Center. n.d. Web. 2012. <http://www.ncsl.org/issues-research/energyhome/state-electric-vehicle-incentives-state-chart.aspx>.

EVSE incentives and fuel tax strategy. While current tax credits reduce the upfront cost of a PEV, many consumers do not readily understand how to access the credits and no incentives currently exist for EVSE installation. These policies could be adjusted to more effectively address cost and infrastructure barriers. Also, addressing the lost tax revenues for transportation infrastructure associated with PEVs, without adding a significant financial burden to these drivers, offers an opportunity for PEVs to participate in a larger policy solution. The policy environment for PEVs in Colorado is great, but has the opportunity to be even better.

Colorado State Policy Strategy

The Colorado strategy for PEV policy seeks to promote PEV and EVSE infrastructure within the broader alternative fuels industry, including bio-fuels, natural gas and propane. The policy options highlighted in the short- and long-term tables were selected as the ones most politically feasible to implement, the most influential in terms of PEV adoption, and the most desirable to market participants. These policies are simply a menu of options. They do not represent the views, policies, or strategies approved by any state or local agency, organization, or FEVER partner.

Table 23: Short Term State Policy Strategies

Policy Action	Description
Add PEV and EVSE products to State Bid	Adding more PEV and related EVSE models to the State Bid will encourage more fleet managers to purchase PEVs, particularly government agencies required to purchase from this list.
Promote work place charging	With up to 30% of charging expected to occur at the workplace by 2025,[118] encouraging EVSE installations will increase consumer confidence in the charging infrastructure. The policy could either a) require EVSE installations once a certain number of employees drive PEVs, or b) provide tax breaks to workplaces that offer EVSE to employees.
Extend HB09-1331 tax credits	While the cost of PEVs is expected to decrease and tax credits will ultimately be unnecessary, extending the $6,000 tax credits beyond 2015 will further increase adoption of PEVs by bringing the purchase price to a competitive rate.
Point-of-sale tax incentives	Point-of-sale tax incentives, such as tradable tax credits or rebates, will allow consumers to receive tax benefits when they purchase a PEV regardless of tax liability. Consumers will not have to wait until they file their tax return the following year to receive the benefit.
Emissions inspection exemption	Exemptions for the emissions inspections would decrease costs for PEV drivers, providing an added incentive for PEV ownership. Considering PEVs have fewer, if any, tail-pipe emissions, this could increase the efficacy of the system.

Continued on next page

[118] Appendix 6: Charging Station Analysis

Continued from previous page

Policy Action	Description
Encourage air quality planning process to include PEVs	Following the current air quality planning process conducted by relevant authorities, monitoring and evaluating the impact of PEVs on regional air quality as a specific line-item will further enable planning efforts.
Establish energy performance contracting (EPC) financing model for fleets	In EPC models, a third party leverages operational savings to offset incremental capital expenses that a fleet manager would otherwise incur by choosing a PEV over a traditional car. EPC has been used frequently for efficiency improvements in buildings, but has not yet been done for alternative fuel vehicles.

Table 24: Long-term State Policy Strategies

Policy Action	Description
Time of use (TOU) rates or off-peak charging legislation	A TOU rate structure is one mechanism to potentially incentivize PEV owners to charge vehicles during off-peak hours, which could serve to minimize impact of PEVs on the grid. While more consumer behavior information is needed in the short term, the impact of such a policy is not expected until PEVs reach a higher penetration rate in the long term. (See Regulatory and Utilities)
Multiple state Memorandum of Understanding (MOU) for PEVs	By demonstrating an aggregated demand for PEVs, a multiple state MOU would guarantee OEMs a certain level of business and serve as a catalyst to increase production. The existing MOU for natural gas vehicles could serve as a template.
Excise tax system	Once PEVs reach a certain threshold, an excise tax system ensures that PEVs are part of the solution to maintain the transportation infrastructure system. (See Fuel-tax Strategy)
Support development of vehicle to grid (V2G) regulations or standards	Standards to govern the emerging V2G technologies will ensure consistency and dependability in terms of electricity provision and vehicle performance. (See Regulatory and Utilities)
Building codes guidance	Encourage codes for pre-wiring residential and commercial garages. (See Local Ordinances and Codes)

The short- and long-term policy strategies presented above represent options that ranked the highest in terms of feasibility, impact, and desirability according to the current market understanding. However, many other strategies may be appropriate depending on stakeholder and advocacy needs, organizational priorities, or changing market dynamics. Other policy options are also important to consider as part of the policy menu of options.

Table 25: Other Short- and Long-Term State Policy Strategies

Short Term	Long Term
Appropriate funds to state EVSE investment fund established by the legislature.	Support battery technology development in Colorado.
Determine an appropriate mechanism (legislative or otherwise) to implement EVSE deployment plan.	Encourage fleets to replace old vehicles with PEVs.
Avoid ordinances that would disallow charging stations.	EVSE requirement for state-funded buildings.
Include PEVs in Greening Government policies.	Incorporate PEVs as line-item in annual resource planning.
Extend HOV access for single-occupancy PEVs; discounted tolls for PEV drivers.	Establish state organization of building inspectors.
Preempt HOA restrictions that prevent EVSE deployment.	PEV buy-back program in 10 years (e.g. cash for clunkers model).
Offer revolving loan or bank low-interest financing for PEVs and EVSE.	Pass zero emissions state provisions.
Establish quick permitting for EVSE.	Offer tax credit for jobs created in the PEV market.
Limit surcharges by insurance agencies for PEV/EVSE.	Establish Pollution Control Equipment Exemption.

Local Policy Strategy
Action at the local level can spark big change. Local policies play a big role in spurring PEV adoption by providing incentives and removing location-specific barriers. Leading cities also stand to gain significant economic and environmental benefits in doing so. Several leading U.S. cities provide valuable examples of the role of local-level policies, which can be applied to Colorado.

Table 26: Local Level Policies, U.S. Examples[119]

City	Fleets	Ordinances and Financial Incentives	Permitting	Other
Raleigh, NC	Purchased PEVs for city fleet; converted Toyota Prius fleet vehicles			Launched the community vehicle share program
Portland, OR		Uniform building and electrical codes and city ordinances to govern signage, parking, and charging fees	Streamlined permitting/ inspections process for EVSE installation	"Electric Avenue" showcase of PEV infrastructure
Los Angeles, CA		PEV charging rate discount and $2,000 rebate on residential EVSE installations	7-day EVSE installation for single family residences	A dedicated PEV customer service team
New York, NY	Purchased PEVs for fleet	Incentives for the purchase of medium- and heavy-duty PEVs		

In each of these examples, cities are either leading by example with PEV purchases and events or exercising authority to establish a pro-PEV policy environment at the local level. Building on these lessons, local stakeholders and decision-makers in Colorado can consider the following policy actions to motivate the market within the local context.

Case Study:

Mayor Michael B. Hancock and his administration have committed to ensuring Denver is one of the most sustainable cities in the nation, and that means bolstering low-carbon transportation options. Supporting an electric vehicle agenda is not only good for public health and the environment, it also helps create a demand for jobs within Denver's growing clean tech industry. Denver is working to reduce barriers for the EV-traveling public, from permitting to parking. Two new public charging stations are now conveniently located at the Denver Performing Arts Center (Level 4), one of which is ADA accessible. Two additional stations also are located at the Denver Art Museum Cultural Facilities Garage (Level 3).

[119] "EV City Casebook." Rocky Mountain Institute, 2012. Web. 2012. <http://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf>.

Table 27: Local Level Policy Strategies

Fleets	Ordinances and Financial Incentives	Permitting	Other
Install EVSE for city fleet and public use	Offer benefits to service providers, such as PEV taxis and ride-share programs	Establish a quick permitting process to expedite EVSE permits	Establish partnerships with employers in the jurisdiction to enable financing opportunities
Purchase PEVs for city fleet use	Establish appropriate ordinances for parking, zoning, and buildings (see Local Ordinances and Codes)	Develop reporting mechanisms to track EVSE installations	Set up sustainability awards program for businesses with EVSE or PEV projects as a criterion
	Provide parking discounts to PEVs drivers at public parking locations	Waive variances or fees for EVSE projects	
	Offer rebates for EVSE installations		

Several cities in Colorado are already taking the lead across these issues. The City and County of Boulder has taken significant measures towards fleet electrification and EVSE installation; the City of Fort Collins has worked on updating codes and ordinances and removing barriers to PEV-readiness; and the City and County of Denver is proposing EVSE installation in municipal parking lots over 100 spaces and installing EVSE. The cities of Lakewood, Littleton, Aurora, and many others are also thinking strategically as to how incorporate these ideas. Continued collaboration will eventually build a strong statewide network.

Private Sector Policies

In addition to state and local government action, private sector engagement is crucial to ensure widespread adoption of PEVs for several reasons. For one, many private sector businesses own and operate large fleets and perform job functions that are well-suited for PEVs. Second, leadership from the private sector will spur investment and innovation from businesses in the PEV space, such as EVSE manufacturers, battery developers, and auto-manufacturers. Companies that are not directly involved in the PEV space can still play a leading role by raising awareness among employees of the virtues of PEVs. Lastly, the private sector can help in developing the EVSE infrastructure, given that up to 30% of charging may occur at the workplace by 2025.[120]

[120] Appendix 6: Charging Station Analysis.

Companies across the country are promoting PEVs by electrifying the fleet, installing charging stations for employee or public use, joining collaborations,[121] or creating initiatives that support PEVs. Private sector entities or large organizations in Colorado can consider implementing policies and action items that are best aligned with their corporate missions such as:

Fleets

- Integrate PEVs into fleets, including executive or employee vehicles.
- Deploy EVSE to support fleet vehicles.
- Educate fleet drivers about PEVs.

Leadership: Outreach and Innovation

- Collaborate with other sectors to overcome market barriers.
- Provide dedicated parking and/or additional benefits to PEV drivers.
- Showcase PEVs through promotional materials and/or events.
- Include alternative fuels and PEVs in sustainability plans.
- Invest in technology and innovation research.

Infrastructure

- Install employee charging stations.
- Install public charging stations to increase patrons and business.
- Collect and share charging data with relevant industry participants.

By implementing these strategies, companies can not only support the PEV market, but also reap significant benefits, such as higher employee retention, operational cost savings, decreased environmental risk, and improved reputation. In synergy with sustainability and corporate responsibility efforts, PEV initiatives will enhance competitive advantage.

Fuel Tax Strategy

While most of this section has focused on action items for specific policy-makers in state and local government and private sector, the issue of fuel tax requires extensive stakeholder engagement across the entire alternative fuel industry. The discussion is more informational in nature than recommended action.

The options discussed here consider the potential role of PEVs in solving a broader state and national issue: the revenue shortfall to fund transportation infrastructure. In Colorado, drivers pay a gas tax of 22 cents per gallon. The associated revenue is the primary source of funding for the maintenance of transportation infrastructure. In general, this revenue source has been decreasing due to higher fuel efficiency and other factors.

[121] More than 70 companies in the Northeast Atlantic states have signed commitments to further promote PEVs through the Transportation and Climate Initiative.

Addressing the role of PEVs in this issue raises many systematic and policy concerns that have yet to be worked out. Under the current system, since PEVs require no gasoline, PEV drivers are not paying fuel tax that is allocated directly to fund transportation infrastructure (the exception being the gas tax paid by PHEVs using the secondary gasoline engine, but this accounts for a minimal amount of the PEV miles driven). As there is no other mechanism for PEVs to pay for transportation infrastructure, this discrepancy creates some controversy over how PEVS can contribute. The issue is further complicated by the fact that PEVs pay a higher level of tax than comparable ICE vehicles in other areas,[122] the revenue of which is not allocated to fund transportation infrastructure. Furthermore, adding any additional taxes may counteract other policies to lower PEV ownership costs and will not result in significant immediate revenue increases considering there are only 1,300 registered PEVs in Colorado today.

Solving these challenges to create a fair system is important to assuage criticisms in the short term and avoid increasing financial shortfalls as the PEV market grows in the long term. Colorado is in the process of researching potential solutions. To inform this discussion, the list below provides the advantages and disadvantages to potential solutions.

Solution Options	Advantages	Disadvantages
Excise tax on electricity: Apply the "special fuels taxes" definition to include electricity for vehicles using the highways HB12-1167	Applies to PEV highway users Revenue goes to transportation Part of the Highway Users Transportation Fund (HUTF) Equates to the 22 cent gas tax by using a gasoline tax equivalency (GTE) conversion Adapts existing compliance systems Meets security and privacy concerns	PEVs will still pay less than other vehicles because of better fuel efficiency Metering and billing issues As Corporate Average Fuel Economy (CAFE) standards increase, equity with gas powered vehicles will require adjustment, further eroding transportation revenues Tax Payer Bill of Rights (TABOR) concerns

Continued on next page

[122] Sales tax and certain fees for PEVs are higher due to the weight and purchase price, when compared to a similar ICE vehicle.

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Solution Options	Advantages	Disadvantages
Sales tax on PEV electricity consumption: Allocate a portion of the state sales tax attributable to PEV electricity consumption, as determined by a sales tax on utility bills	Short term solution Sets precedence for general fund transfer approach Flexible purpose/distribution Could be used for transit Meets security and privacy concerns	Use of general fund sales tax diverts revenue from other purposes Most electricity consumption is not assessed sales tax by the state Does not address local sales tax share Estimating formula required Difficult to administer at retail locations or for vehicles outside the state
Flat fee on PEV vehicles: Apply a user fee to electric vehicles for highway use	Relatively easy to administer User fee-based approach Could be directed to HUTF Meets security and privacy concerns	Fee amount and basis controversial Does not address local distribution Equity and fairness may be an issue for those driving very few miles Must account for BEVs and PHEVs differently
Mileage-based user fee: Adopt a mileage user fee on all vehicles including PEV's	True use fee Responsive to size, type, urban/rural Technology and costs improving Security and privacy concerns easier to resolve Technology permits public private partnerships, third-party vendors, and value-added services	Perceived security resistance Public education required Change to a new system must overcome higher start-up cost and resistance to change Concern over privacy and TABOR issues
Option for flat fee or mileage-based user fee (MBUF): Offer a choice of a flat fee or MBUF and consider a pilot demonstration to prove the concept and gain public acceptance (pros and cons that apply to each individual choice also apply here)	Offers choice Flat fee offers security choice unconnected to mapping technology Opportunity to test and promote public acceptance	Perceived security resistance Public education required Issues with developing a system that ensures MBUF adequately values and charges for the impact on infrastructure in a statewide context

States and jurisdictions across the U.S. have implemented variations of these approaches. Several examples of flat fee and tax structures implemented in the U.S. are presented below.[123] A report highlighting the mileage based-user fees as a potential model for Colorado is also included in Appendix 18.

- The Energy Content-Based Fuel Tax Approach: Taxes based on a gasoline gallon equivalent; for PEVs, this requires a fuel excise tax of $0.0093 dollars per kWh for electricity.[124]
- Variable Tax Approach: Tax system based on fuel price, percentage of wholesale price, or on a volume per gallon rate.[125]
- Decals: Levies a fee for drivers to purchase a sticker, decal, or annual license for certain alternative fuel vehicles.
    - Alt Fuel Decals: Operators of motor vehicles powered by certain alternative fuels, not including electricity, are required to purchase an annual decal, in lieu of paying a sales or excise tax.[126]
    - Decal or Tax: Operators of motor vehicles can either pay for the decal or pay a sales or excise tax.[127]
    - PEV decals: Drivers of PEVs are required to purchase decals.[128]
- Registration or License Fees: States can levy a one-time fee on registration or annual licensing of alternative fuel vehicles.[129]

Combining all of these actions—including state, local, and private sector strategies, as well as an excise tax plan—into a comprehensive policy strategy will require the alignment of competing interests, changing political contexts, and stakeholder action. Synergizing all of these forces will aid in overcoming the market barriers remaining in all issue areas.

[123] Workman, Simon and Jamie Roll. "Taxation of Alternative Fuels." National Conference of State Legislatures Issues and Research. Web. 2012. <http://www.ncsl.org/issues-research/transport/taxation-of-alternative-fuels.aspx#one>.

[124] Adopted in Pennsylvania, Georgia, Maine, Minnesota, and Oklahoma.

[125] Adopted in North Dakota and West Virginia for several natural gas vehicle types.

[126] Adopted in Alabama, Arkansas, Colorado, Florida, Louisiana, Missouri, Oklahoma, Texas, Utah, and Washington.

[127] Adopted in California, Idaho, Kansas, and New Mexico.

[128] Adopted in Missouri, Utah, and New Mexico.

[129] Registration fees adopted in Nebraska and license fee in Virginia.

XI. Utility, Grid, and Regulatory Strategy

Section Summary:

This section provides a report on current regulatory activities in Colorado, an assessment of potential grid impacts from PEV adoption, and recommendations for preemptively mitigating grid impacts. Building on significant activity to-date, other roles for electric utilities as a transportation fuel provider are considered.

Audience:

Policy-makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

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In addition to the myriad of factors that will drive PEV adoption discussed throughout this Plan, the one underpinning factor is the supply of electricity. As the fuel that powers these vehicles, electricity is the lynchpin for the success of PEVs as a transportation mode and EVSE as a fuel source. Most PEV drivers will rely on the electric grid as their source of electric fuel. Thus, the continued provision of safe, reliable, reasonably priced electricity from the grid, even in the face of increased demand, is required to power the PEV market.

Further, a reliable electric grid will continue to build consumer confidence in electricity as a transportation fuel. There is some perceived uncertainty surrounding the electricity supply in the face of new PEV demand, but a solid understanding of the potential risks and impacts to the grid will enable strategic planning efforts to build on a history of reliability and alleviate those concerns. With this understanding, monitoring the real impacts and communicating these results to consumers will be important to mitigate risk and maintain, if not improve, the system.

In light of the importance of electricity provision, electric utilities and the associated regulators will play a major role in facilitating the PEV market. This analysis focuses on the Investor Owned Utilities (IOUs) in Colorado as well as the state regulatory body, the Public Utilities Commission (PUC), as the major players in the regulatory environment and grid impacts assessments. Municipal utilities and associations are also important players in the Colorado electric industry and are considered in the minimization efforts and role of utilities. The role of each of these players is as follows:

- The PUC Electricity Section has full economic and quality of service regulatory authority over the IOUs and partial regulatory control over municipal utilities and electric associations. The PUC serves the public interest by ensuring Coloradans receive safe, reliable, and reasonably-priced electricity services consistent with the economic, environmental, and social values of the state.
- The major IOUs for Colorado are Xcel Energy and Black Hills, responsible for serving approximately 61% of the state. Xcel Energy and its operating company, the Public Service Company of Colorado, is the largest service provider in the state with 1.38 million electric customers.
- The 29 municipally-owned utilities in Colorado, including jurisdictions such as Colorado Springs, Longmont, and Ft. Collins, provide electricity to approximately 17% of the state.
- The 26 rural electric cooperatives, including Tri-state, Intermountain, United Power, San Miguel Power Association, and Holy Cross, serve approximately 22% of the state.[130] PEV adoption is expected to be slower in these more rural areas and PEV readiness may occur accordingly.

[130] The service territory estimates are an average between 2005 (http://www.dora.state.co.us/puc/energy/ColoradoElectricPowerUtilities.pdf) and 2009 sales (http://rechargecolorado.org/images/uploads/pdfs/2010_Colorado_Utilities_Report_7-26-10.pdf) figures.

These organizations will play key leadership roles in ensuring that the electric grid is well equipped to deal with increased demand from PEVs. Most of these actors have already been active in the PEV discussion and Project FEVER. However, the results and analysis conducted throughout this Plan are not a reflection of the findings of any particular actor, but rather a general understanding of the utility and regulatory issues.

Regulatory Background

In many ways, regulation governing the entire electric industry could impact PEVs in some manner. However, this analysis will focus solely on the activities directly related to the provision of electricity to PEVs through EVSE. The major activity in 2012 in this regard includes the PUC investigatory docket No. 11I-704EG and passage of HB12-1258,

Under investigatory docket No. 11I-704EG, the PUC has been actively researching and gathering stakeholder input on potential PEV impacts. Broadly, the docket will inform the short and long-term challenges and opportunities associated with PEVs and the potential role for electric utilities in facilitating the PEV market. The results of this docket have yet to be released, and are not represented in this Plan.

In 2012, Colorado became one of the first states to enact legislation to de-regulate the sale of electricity for EVSE providers. Colorado House Bill 12-1258 specifies that the purchase of electricity to be stored in vehicles and used as fuel is not subject to regulation as a public utility. As such, EVSE providers are now classified as unregulated services and can charge PEV drivers for the use of charging stations on a per kilowatt-hour basis. HB 12-1258 was passed in April and enacted in August 2012, and is expected to support the development of the EVSE market.

Beyond completing the investigatory docket, no other major regulatory changes are expected with specific bearing on electricity provision for EVSE. More information is needed with regard to the potential grid impacts as well as the outcomes from HB12-1258 to inform any further action. The remainder of the section is devoted to grid impact analysis and the role of utilities, all of which could potentially serve to inform the future regulatory environment.

Grid Impact Assessment

Due to the current PEV penetration rates and the lack of real-world data on grid impact, this analysis used three Colorado-based studies to assess the potential grid impacts due to the increase in electricity demand from PEV charging in Colorado. The major source was a grid impact study conducted by Xcel Energy. Supporting information is pulled from research conducted under Project FEVER, including a grid impact analysis conducted by iCAST and the dispatch modeling performed under the emissions impact study conducted by CU Boulder (see Emissions Impact). Although this evidence is not fully conclusive, these studies give a baseline from which to continually monitor and proactively mitigate impacts. Further, this activity suggests that utilities are working to define system impacts of PEV/EVSE in order to assure grid reliability as well as assuage consumer anxiety.

In the near term, the potential impacts of PEV deployment to the Colorado electrical grid and policies for cost allocation are expected to be minimal. PEV penetration is not likely to affect generation and transmission, but some attention may be required at the distribution level.[131] Existing policies to allocate the cost of system upgrades are expected to be sufficient to handle any upgrades specific to PEVs.

[131] Appendix 19: Analysis of Expected Grid Impacts.

Figure 2:
Diagram of Generation, Transmission, and Distribution Levels of Electricity Delivery.

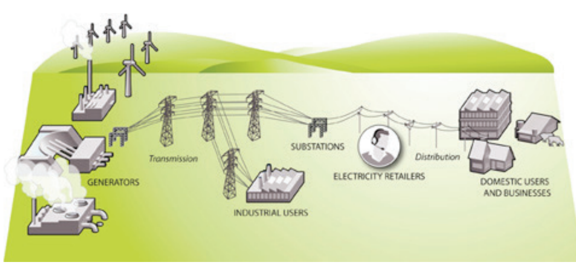
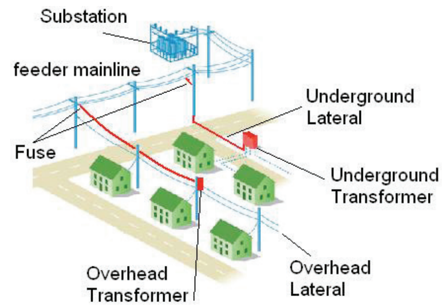


Figure 3:
Diagram Of Distribution Level Of Electricity Delivery.



At the generation or transmission level, the Xcel Energy study found no grid impacts due to PEV demand, even under a PEV penetration scenario more aggressive than the high scenario presented in this Plan (this scenario assumed PEVs make up 15% of all light-duty sales and current electric infrastructure).[132] No grid impacts are expected at the transmission or generation level, at least through 2025. The emissions impact study performed by CU Boulder, which considered the expected electric infrastructure in 2020, also also supported this conclusion.

While grid impacts at the generation and transmission level are not of concern in the short-term, grid impacts are possible at the distribution level. Under this Plan's high penetration scenario for 2025 (PEVs make up 10.2% of LDV fleet), Xcel Energy estimated that 4,300-5,100 transformers would be impacted by incremental PEV demand and the projected cost to replace these between $10-13 million.[133] This cost will be incurred gradually over time and spread across the entire residential rate base.[134] Notably, transformers are replaced, on a regular, as-needed basis by utilities for any failures, so it is difficult to directly attribute these costs to PEV use.

Similarly, lateral conductors (i.e., the power lines that go into a residence) may be impacted by incremental demand associated with PEVs. However, upgrades may be required due to normal load growth, and it is difficult to isolate the impact of incremental PEV demand. These impacts and costs have not yet been quantified by Xcel Energy.

Future Grid Impact Considerations

Despite the extensive research behind the conclusions that PEVs will cause minimal grid impact, several uncertainties in the assumptions will warrant continual monitoring and evaluation as the market expands:

- Clustering effect: It is still unclear whether PEV deployment will be spread evenly across the residential customer base or may be clustered in certain areas. Customers may be more likely to purchase a PEV if their neighbor purchases one, which could lead to multiple vehicles charging on one transformer. This could cause a greater impact at the transformer level, particularly in neighborhoods where load growth could be challenging.
- Commercial customers: While the primary concern for grid impact is currently residential customers, the potential impacts of workplace and DC fast charge stations also exist. Generally, commercial locations have the interconnections already in place to deliver power to the increased load of an EVSE, but the commercial location may need help from their electric utility to understand how the increased load will impact demand charges.

[132] Appendix 19: Analysis of Expected Grid Impacts.

[133] Appendix 19: Analysis of Expected Grid Impacts.

[134] FAQ: Transmission. Xcel Energy, n.d. Web, 2012. <http://www.xcelenergy.com/About_Us/Transmission/FAQ:_Transmission>.

- Variability of EVSE electric demands: common standards covering Level 1, Level 2, and DC Fast Charge EVSE are now complete through SAE J1772 and the NEC (NFPA 70), along with several other safety and performance standards. However, a Level 2 or DC Fast Charge EVSE can still have different electric supply needs, particularly with regards to amperage. Thus, utilities may need to know the location and details of particular electric requirements for EVSE installations to ensure that all EVSE is reliably served.

Grid Impact Minimization Strategies

Avoiding even minimal grid impacts can serve to strengthen the PEV market and assuage consumer anxiety. Proactively implementing minimization efforts will enhance the infrastructure, possibly even enabling opportunities to use PEVs to strengthen the system. Potential minimization strategies are broken into three categories: notification systems, encouraging off-peak charging, and technology solutions. These strategies are presented below as a menu of options for consideration by utilities, regulatory bodies, and interested citizens.

1. <u>Notification Systems</u> Notification systems refer to developing a more robust tracking and communication system between utilities and EVSE installations and PEV purchases. Tracking EVSE installations with a priority on Level 2 and DC Fast-Charging allows utilities to understand the impact on the local grid and plan accordingly. A notification system for PEV and EVSE locations can be extremely effective at minimizing risk at the transformer-level, particularly with clustering or incremental demand increases.

   A notification system will require increased communication between PEV users and utilities as well as between OEMs and utilities. Encouraging PEV users (or the associated electrical contractor) to notify the utility of an EVSE installation will help monitor how many EVSEs are on one transformer. OEM-to-utility communication is already occurring through programs like EVIX that gather OEM sales data and deliver it to utilities. Automakers, such as General Motors, are also communicating directly with utilities on a regular basis. However, this communication could be more comprehensive and streamlined.

   The advantage of the notification system approach is that it provides lead time to preemptively address grid impact and creates a strong signal to consumers that the market leaders are proactively working to ensure reliable electricity provision. The disadvantage is that this approach requires strong coordination across industries that have not traditionally communicated with each other and may require consent to transfer private information.

2. <u>Encouraging off-peak charging</u> Encouraging off-peak charging (plugging-in PEVs at night or during times when the electric load is lower) is estimated to help mitigate grid impacts associated with the utility's distribution system, including transformer failures. Xcel Energy's study indicated that charging impacts were largely attributable to incremental demand at peak times (5pm-10pm). If 95% of PEV charging were to occur off-peak, then no transformer impacts would be expected. Further, off-peak charging can also create short term financial protections for Xcel Energy's entire rate base as well as decrease emissions impact by encouraging charging when wind generation is higher. Thus, encouraging off-peak charging could be a mechanism to avoid added risk or electricity supply issues as PEV charging increases. Increasing off-peak charging of PEVs can be accomplished through two avenues: 1) educational campaigns and 2) rate structures.

   Educational campaigns are a low-cost option and may lead to more voluntary change. Such a campaign would focus on explaining the personal and environmental benefits of charging PEVs at night. This could be as simple as developing and distributing a how-to manual, such as "How to maximize the use of your PEV," that outlines the environmental and energy system benefits of charging at night. Since PEV drivers will already be learning new fueling behavior, they can create off-peak charging habits from the beginning if they are aware of the value associated with doing so. New vehicles also have built-in applications that can be programmed to charge at certain times. The major advantage is that these efforts are simple and would not require the consumer to understand anything about the complex electricity market or its rate design. The disadvantage is that there is no clear incentive for the consumer to act in any particular way.

Rate structures would provide PEV drivers a financial incentive to charge at night by providing lower off-peak electricity rates. These rates structures are called Time of Use (TOU) rates because the price of electricity varies with the time of day. Many states across the country have implemented TOU rate structures, but the success of such programs is highly dependent on the electricity market, prices, and many other variables. In Colorado, a sample rate structure is under development with Xcel Energy, but has yet to be approved due to the uncertainty regarding its effectiveness. Table 28 provides a comparison of TOU rates offered in regions across the U.S. as compared to the sample rate from Xcel Energy.[135]

Table 28: Comparison of Xcel Energy's Sample TOU rate with other utilities

	Off Peak	On Peak	Difference Between Peak and Off Peak		Regular Rates
			In Dollars	Magnitude difference	
Arizona Public Service					
Time Advantage	$0.061	$0.244	$0.183	3.9	$0.097-$0.173
Super Peak	$0.052	$0.494	$0.442	9.4	$0.097-$0.173
Experimental PEV Rate	$0.042	$0.247	$0.205	5.8	$0.097-$0.173
Nevada Energy					
PEV Rate Option A	$0.069	$0.335	$0.266	4.8	$0.117
PEV Rate Option B	$0.056	$0.505	$0.449	9.0	$0.117
Xcel Energy					
Sample TOU Rate	$0.082	$0.206	$0.124	2.5	$0.088-$0.133

[135] Appendix 20: Time of Use Rate Structure Comparative Analysis.

In terms of implementing a TOU rate structure, there are several considerations. First, the rate structure can be mandatory or PEV owners can opt-in to a voluntary program. Also, as seen in service territories outside of Colorado, the rates can be specific to the PEV or applicable to the whole house including the PEV. The financial incentives will also vary by utility depending on how their rates are determined and how aggressively they provide incentives directed to PEV users. The ultimate goal in any TOU rate structure will be to encourage PEV charging at night in a way that provides financial incentives to PEV drivers without negatively affecting the entire rate base.

The advantage of the rate structures approach is that economic incentives may be more likely to create behavior change, as proven in other states. However, the effectiveness in Colorado is still uncertain due to the difficulty of creating a rate structure that provides cost savings since the price of electricity is already so low. In fact, in some cases the TOU option is does not always benefit the PEV owner. Some programs require a monthly fee, which further reduces financial benefits. The administrative fees may be more than the benefits as a whole. Another potential disadvantage is that these rates require the customer to understand rate structures and rate design.

One other difficulty with offering PEV-specific TOU rates (versus a whole house TOU rate) is that participating households would need to install a separate meter. This "sub-meter" would control and measure the power delivery to the EVSE separately from the house, so as to track and bill for electricity used for PEV charging. While this configuration makes it easy to understand PEV charging patterns, sub-meters require additional capital, installation and monitoring costs as well as additional standards and protocols for managing technology, data, and billing. The effectiveness of PEV-specific metering as a solution remains uncertain.

3. Technology Solutions The technology solutions to minimize grid impact discussed here are vehicle-to-grid technologies, demand side management solutions, and smart-grid technologies.

Vehicle to Grid (V2G) technologies: V2G is a system that allows communication between PEVs and the grid whereby vehicles can exchange power with the grid. Through V2G, PEVs have the potential to serve as an asset for mobility and stationary energy applications, such as providing emergency and remote power, contributing to grid stability, and optimizing the costs associated with electricity consumption.

V2G technologies can provide benefits in specific scenarios. For example, in fleet depots where the fleet and building manager operate under a single entity, V2G may be a viable method for lowering utility bills, decreasing electricity demand peaks, and enhancing PEV return-on-investment. Also, in scenarios where PEVs can be integrated with the grid, building operator energy management systems, or renewable energy options, V2G offers a high potential for economic payback. The synergies inherent in the integration of PEVs and grid systems are depicted in Appendix 21.

The disadvantage of this strategy is that few viable business models currently exist for V2G solutions. V2G requires significant financial investment, while the technical feasibility and potential costs to non-PEV users remain uncertain. At worst, misdirected implementation could result in accelerated battery degradation or reduced vehicle functionality. The National Renewable Energy Lab in Colorado continues to lead the way in developing the standard hardware, software, and communications platforms necessary to enable a fully integrated vehicle future.[136]

[136] Ideal Power Converters. "Ideal Power Converters and NREL Achieve Breakthrough Vehicle to Grid Demonstration." Market Wire. October, 2012. Web 2012. <http://www.marketwire.com/press-release/ideal-power-converters-and-nrel-achieve-breakthrough-vehicle-to-grid-demonstration-1713805.htm>.

Demand Side Management (DSM)/Saver Switches: This approach would use technology solutions that can control Level 2 PEV charging during peak load scenarios. This approach is expected to be a notable source of demand savings for utilities. Xcel Energy is currently conducting a pilot program to test DSM savings through technology similar to an air conditioning saver switch on the EVSE equipment. The Xcel Energy EVSE pilot aims to identify devices that are available on the market to monitor charging characteristics and behaviors, understand the coincidence of vehicle charging with system peaks, investigate control strategies that can be used to minimize vehicle charging impact to the distribution grid, and understand customer likelihood to participate in a program that will control charging units.

Customer control of charging and smart grid technologies: Offering PEV owners simple mechanisms to control the time at which their vehicle charges can potentially produce significant impacts at low cost. One solution is offering EVSEs with built-in timers, which can be pre-programmed to preferentially charge overnight. As part of its Boulder Smart Grid - Plug-In / Electric Hybrid Vehicle Project, Xcel Energy sponsored a study with Toyota and CU Boulder to examine the effects of these types of strategies on charging patterns. One key conclusion was that customers who used timers to control charging time had less of a grid impact during peak hours than those who didn't, regardless of participation in a TOU rate or the ability to charge during on-peak hours. Smart grid technology can accentuate these effects by making customers aware of their energy usage and the positive effects of managed charging.[137] These types of technologies are built into many new vehicles so that consumers can easily take advantage of this type of solution.

Current and Continuing Utility Activities and Roles

Beyond the inherent role in the provision of electricity and related grid upgrade and regulatory activities, Colorado's electric utilities have also been enabling the PEV/EVSE market in a variety of other ways. Primarily, utilities are working to build a new reputation as a transportation fuel provider. Doing so requires electric utilities to take on new roles in order to build a new relationship with customers, understand new and different consumer behavior, and implement a related communication strategy.

The following provides options of potential roles for utilities in this market as well as examples of utilities taking action to fill the role.

1. Fleet electrification: Integrating PEVs into a utility fleet provides the opportunity to collect and analyze data on system impacts as well as raise awareness about PEV technology.
    - Xcel Energy owns a PEV Transit Connect that has been used to analyze usage patterns, serve a direct fleet application, and star in many public press events.
    - Black Hills owns a Chevrolet Volt covered in wrap-advertising to create a mobile billboard and established guidelines for vehicle users to report on vehicle performance and user-experience.

2. Strategic planning: Continue to monitor the expansion of the PEV market and make plans to address risk and maximize opportunities.
    - Xcel Energy established a "RePowering Transportation" team charged with developing and implementing a comprehensive strategy to address alternative transportation issues and prepare for the greater utilization of PEVs.

[137] Farhar, Barbara, Dragan Maksimovic, and Alison Peters. The Human Dimensions of Plug-In Hybrid Electric Vehicles in Boulder. Renewable and Sustainable Energy Institute at CU Boulder, 18 September 2012. Web 2012. <https://www.dora.state.co.us/pls/efi/EFI.Run_Document?p_session_id=&p_document_id=3602858>.

3. Invest in EVSE infrastructure: Provide access to charging for employees and/or fund public infrastructure.
   - Xcel Energy is working internally to provide work-place charging for employees.
   - Black Hills Energy is installing a public EVSE on the Pueblo River Walk in Pueblo, Colorado by the end of 2012. The dual-unit 240v station, donated by Schneider Electric, has the capability to charge two vehicles simultaneously and quickly: A fully-drained Chevrolet Volt battery can be recharged in as little as 4 hours. PEV drivers will enjoy dedicated parking spaces, clear signage, and free charging during the pilot period. Black Hills Energy is currently settling insurance, leasing, and other matters necessary for installing EVSE on public access property to be ready for launch by year end.

4. Implement a multi-channel communications plan: Establish a public view of the utilities as market leaders and trusted information sources in the growing PEV market.
   - **Media Relations.** Engage the media through test drives and special events while securing coverage through TV, radio, print, and social media outlets. Include information on requirements to operate a PEV, guidelines for EVSE installations, and how the utility will support this new customer as a fuel-provider.
     - Black Hills issued press releases upon acquisition of two new Chevrolet Volts for the fleet.
   - **Community Relations.** Give consumers "hands-on" viewing experiences of the fleet PEV through public.
     - Xcel Energy showcased the Ford Transit Connect at the St. Patrick's Day Parade.
     - Black Hills has one contact specifically in charge of test drive events.
   - **Employee Communications.** Give employees hands-on test drive opportunities and disseminate information through internal messaging channels, such as employee newsletters, articles, email bulletins, and/or employee focus-groups (e.g., brown bag "lunch-and-learn" meetings). These internal strategies serve the dual purpose of improving customer service communications.
     - Colorado Springs Utilities is developing a comprehensive strategic outreach plan, which includes communications with employees in addition to public and internal audiences.
   - **Customer Communications.** Provide fact-based and neutral information to consumers in an easily-accessible way.
     - Xcel Energy trained its call center staff to be able to answer PEV questions, so that any potential or current PEV customer can easily get information and report a PEV purchase.
     - Develop information sources, such as FAQs, monthly newsletters, online videos or Tumblr websites to reach consumers with information about PEV charging.
     - IOUs have also developed PEV websites: Xcel Energy (http://www.xcelenergy.com/ev) and Black Hills Energy (http://www.blackhillsenergy.com/community/initiatives/electric_vehicle/).

Overall, the activity regarding the regulatory environment, grid impact, minimization efforts, and the role of the utilities as a transportation fuel provider demonstrates a strong electric industry that is ready to facilitate PEV adoption and can proactively address any unforeseen risks.

XII. Emissions Impact Study Findings

Section Summary:

This section outlines the expected emissions impacts of PEVs as compared to traditional ICE vehicles in Colorado in the year 2020. While many scenarios are considered in the full study, this summary of results focuses on a scenario where PEVs reach the 2025 high scenario (outlined in the PEV/EVSE Market Forecast section of this Plan), or 10.2% of light duty vehicles, by the year 2020. The three major findings of the study include: 1. The well-to-wheels emissions of greenhouse gases, carbon monoxide, volatile organic compounds, and nitrogen oxides are consistently lower with PEVs than with the comparison ICE vehicles; 2. PEVs require about 60% of the energy per mile that is needed by ICE vehicles; 3. The extra electricity required to charge the PEVs is projected to come from a generation mix made up of 44% natural gas, 32% wind and 24% coal-fired.

The section was written by the University of Colorado at Boulder Department of Mechanical Engineering. It is an executive summary of the study, "Emissions Changes from Electric Vehicle Use in Colorado," conducted by the Department of Mechanical Engineering at the University of Colorado at Boulder[138] and the National Renewable Energy Laboratory,[139] with research support contributed by the University of Wisconsin at Madison.[140] The report uses the term gasoline-fuel vehicles to refer to the ICE vehicles referenced throughout the rest of this Plan. The full study, including methodology and complete scenario analysis, is available on The Electric Ride and in Appendix 22.

Audience:

Policy-makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

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Compared to vehicles operated on gasoline, PEVs have the potential to reduce petroleum consumption and emissions of several air pollutants. In part, PEVs shift emissions from the vehicle tailpipe to the power plants that produce the electricity needed to charge their batteries. Consequently, the net emissions impact of replacing gasoline-fueled vehicles with PEVs depends on the type of power plants used to produce that electricity.

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[138] Jana Milford and Jennie Jorgenson were the lead researchers from the Department of Mechanical Engineering at the University of Colorado at Boulder.

[139] Gregory Brinkman and Jennie Jorgenson were the lead researches from the National Renewable Energy Laboratory.

[140] Jennifer Detlor was the lead researcher from the University of Wisconsin at Madison.

This study uses "well-to-wheels" life cycle assessment to compare the energy use and emissions of light duty gasoline vehicles with those of PEVs that could be in use in Colorado in the year 2020. The "well-to-wheels analysis" considers energy use and emissions from the stages of production or extraction of the feedstock for vehicle fuel, fuel processing, fuel transport and distribution, and vehicle operation. For gasoline vehicles, this means accounting for impacts of crude oil extraction and refining, delivery of gasoline to the gas station, vehicle refueling, and gasoline consumption in the vehicle. For PEVs, the well-to-wheels assessment accounts for extraction and transport of natural gas, coal or other fuels used to generate electricity, and transmission and distribution of electricity to the vehicle charging station. For PHEVs, both gasoline and electricity pathways are considered.

The well-to-wheels life cycle assessment used Argonne National Laboratory's Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, with key inputs tailored for Colorado in the year 2020. The primary scenarios examined assumed high penetration of PEVs into the vehicle fleet, such that 7.5% of vehicle miles traveled statewide in 2020 would be powered by electricity.[141] The scenario assumed about 56% of PEV vehicles would be plug-in hybrids, split evenly between hybrids with nominal 10 and 40-mile all-electric ranges, and the remainder by battery electric vehicles. PEVs were assumed to use 0.35 kWh of electricity per mile driven in electric mode.

The mix of generating plants used to provide electricity for PEV charging is a critical factor in determining how net PEV emissions compare to those from gasoline vehicles.[142] To address that factor, detailed unit commitment and dispatch modeling was performed for the projected electric power sector in Colorado in 2020. Dispatch modeling uses a least-cost approach to determine which generating units will be used to meet electricity demand on an hour-by-hour basis. This study used the PLEXOS dispatch model with projections from the Western Electricity Coordinating Council (WECC) for the composition and characteristics of the generating fleet available to serve Colorado customers in 2020 and their forecast hourly demand for electricity. The WECC projection of the power plant fleet was altered to reflect current plans for power plant fuel switching and shutdowns and Colorado's renewable portfolio standards.

In order to determine the incremental impact of PEVs, the PLEXOS model was run several times, considering a base case with negligible PEV penetration against cases with added electricity demand for PEV charging. Additional year-long model runs were conducted to examine sensitivity to coal and natural gas prices, the projected level of base electricity demand (before incorporating PEV charging demand), and the profile of PEV charging demand throughout the day. In addition to determining the effects on the power system, the dispatch modeling results were used to estimate the increase in power plant emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide that would result from new demand for PEV charging.

In the high PEV penetration scenario (i.e. 7.5% of light duty vehicle miles traveled are electric-powered),[143] the load on the electric generating system would increase by about 2% compared to the demand in WECC's base forecast. The dispatch model results suggest that the generation mix needed to meet this incremental demand would include 44% natural gas generation, 32% wind, and 24% coal. In a case with lower PEV penetration, such that about 5% of light duty vehicle travel electric-powered, the load on the system would increase by about 1.2%. In that case, the results suggest the extra demand would be met with a roughly even split of generation from natural gas, coal, and wind. In all cases considered, the projected capacity of the power system in 2020 was adequate to accommodate increased demand for PEV charging, with no additional unplanned infrastructure required.

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[141] This aggressive scenario corresponds to the high PEV penetration scenario in 2025 described in the PEV/EVSE Market Forecast section of this Plan.

[142] "Elgowainy, A., J. Han, L. Poch, M. Wang, A. Vyas, M. Mahalik, and A. Rosseau, "Well-to-Wheels Analysis of Energy Use and Greenhouse Gas Emissions of Plug-In Hybrid Electric Vehicles." ANL/ESD/10-1, Argonne National Laboratory, June 2010.

[143] This high scenario corresponds to the high PEV penetration scenario in 2025 described in the PEV/EVSE Market Forecast section of this Plan.

The generating mix used to supply incremental electricity demand for PEV charging shows little sensitivity to the pattern of charging over the day, but is somewhat sensitive to natural gas and coal price assumptions. Of the factors considered, the incremental generating mix was most sensitive to the base-level demand forecast. If base level demand is reduced by 10%, more spare coal capacity exists in the system, and the model dispatches this resource to meet new demand for PEV charging. With a 10% increase in base level demand, little spare coal capacity is available and the extra demand for charging is met mainly with natural gas. This pronounced shift is a consequence of examining the incremental impact of PEVs as a new source of demand for electricity. In contrast, the total use of coal or natural gas is not that different across cases.

Well-to-wheels energy use and emissions impacts of PEVs in Colorado in 2020 were estimated using dispatch modeling results for the high PEV penetration scenario (generation mix above). Life cycle impacts were determined for a "composite" PEV by weighting results for PHEV and BEV based on their assumed share of travel. The PEV impacts were then compared to those for average light-duty gasoline vehicles expected in Colorado in 2020. The PHEVs and gasoline vehicles are assumed to use gasoline blended with 10% ethanol by volume.

Figure ES-1 shows well-to-wheels energy consumption for the composite PEV and average gasoline vehicles, broken down by fuel – coal, natural gas, petroleum or other. The "other" category includes nuclear power and renewables used to generate electricity, and biomass used to produce ethanol. In this case, PEVs are found to be more efficient overall (well-to-wheels), requiring about 60% of the energy per mile that is needed by gasoline vehicles. PEVs are found to offer significant reductions in petroleum use, but do require more coal and natural gas consumption than gasoline vehicles.

Figure 3: ES-1. Well-to-wheels energy consumption for electric vehicles in the high PEV penetration case, compared to that for average light duty gasoline vehicles.

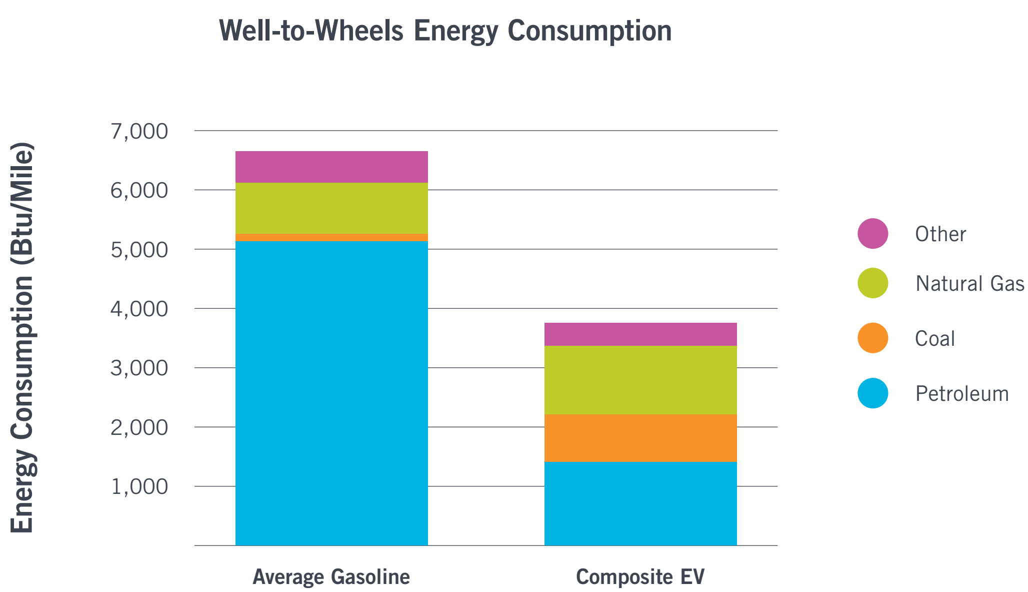
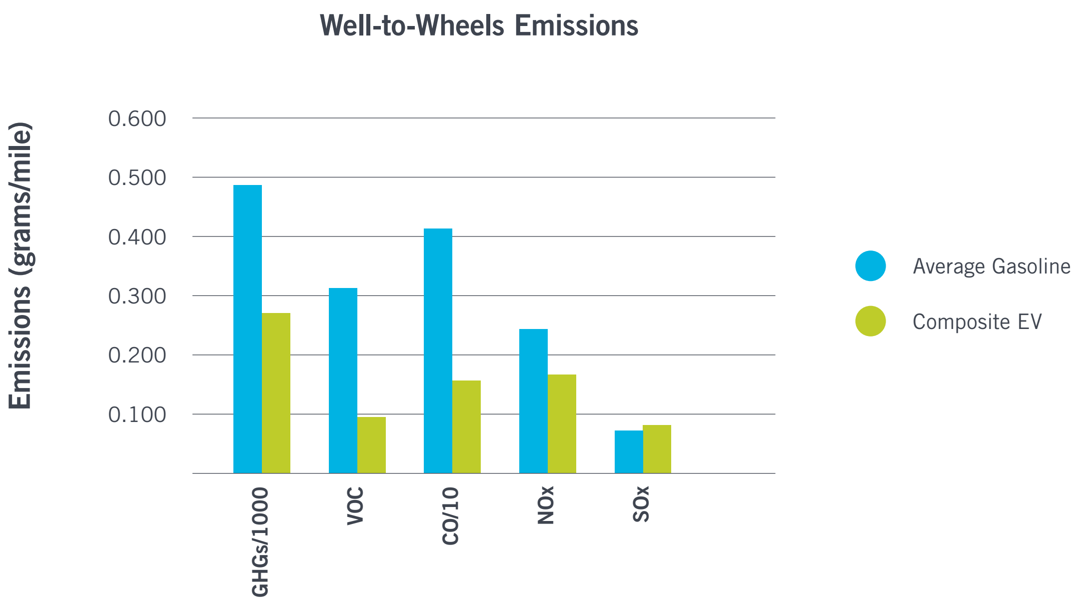


Figure ES-2 shows well-to-wheels emissions rates for the composite PEV and average light duty gasoline vehicles. The estimated greenhouse gas emissions per mile for PEVs are about 55% of those for gasoline vehicles. Emissions of volatile organic compounds, carbon monoxide, and nitrogen oxides are also estimated to be lower with PEVs than with gasoline vehicles. On the other hand, well-to-wheels emissions of sulfur dioxide are about 10% higher for the composite PEVs compared to gasoline vehicles, mainly due to the use of coal to generate a portion of the electricity for PEV charging.

Figure 4: ES-2. Well-to-wheels emissions for electric vehicles in the high PEV penetration case, compared to those for average light duty gasoline vehicles.

For display purposes emissions rates for GHG are divided by 1000; those for CO are divided by 10.



In addition to the main cases shown in the figures, GREET was also used to estimate well-to-wheels energy use and emissions for PEVs with the electricity generating mix for PEV charging determined from the dispatch modeling sensitivity cases with reduced or increased reference demand; for summer conditions (as opposed to year-round); and reduced PHEV mileage during operation on the gasoline engine. Although the magnitude of the estimated energy and emissions impacts varies across these cases, well-to-wheels emissions of greenhouse gases, carbon monoxide, volatile organic compounds and nitrogen oxides are consistently lower with PEVs than with the comparison gasoline vehicles.

XIII. Moving Forward

Section Summary:

From stakeholder commitments to performance assessment tools, this section seeks to create a sense of accountability to carry out the recommendations and strategies considered throughout this plan.

Audience:

Policy-makers, Business Leaders, Fleet or Operations Managers, Utilities and Energy Professionals, the General Public

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The growth of the PEV market relies heavily on the continued action and success of key stakeholders. Taking action to implement any, or all, of the strategies outlined in this Plan will be crucial to overcoming the remaining market barriers and motivating the switch to electricity as a major fuel source. Through a voluntary survey, key stakeholders made commitments to act in the next 5 years. Further, a performance measurement system provides a tool to assess incremental progress towards achieving a first-tier PEV market at both the stakeholder and state level.

Stakeholder Commitments

One indication that the market is poised to grow is that organizations across the state have voluntarily committed to concrete actions to increase PEV adoption. The voluntary nature of these commitments mean that they align closely with the core competencies and mission of the committing organizations and may be more likely achieved. The following demonstrates the actions that key stakeholders have committed to achieving by 2018.

Government Agencies: Commitments

	Top Goals To Promote PEV Adoption In The Next 5 Years	Regulatory	Planning	Permitting	Policy	Education
City of Boulder	Purchase PEVs through a lease-purchase energy performance model Power PEVs with renewable energy sources Complete the Boulder Smart Grid - Plug-In Electric / Hybrid Vehicle Project Share results on smart charging, connectivity to renewable power, battery storage, building automation control ties for demand side management, and car sharing pilot	x	x	x	x	x
High Plains Library District	Provide PEV charging access Promote PEV adoption in the community Add a PEV to fleet		x		x	x
City and County of Denver	Develop policies and programs to cost-effectively lead the PEV market Deploy EVSE in strategic public parking locations in the next year Institute a policy to require all new City-owned, public parking lots and garages with 100 spaces or more to have at least one parking space reserved for PEVs and equipped with EVSE Continue to engage the public Incorporate EVSE pre-wiring requirements into Code for multi-unit and commercial new construction Develop recognition avenues for commercial parking lots or buildings that incorporate public EVSE and businesses that electrify their fleet		x	x	x	x

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	Top Goals To Promote PEV Adoption In The Next 5 Years	Regulatory	Planning	Permitting	Policy	Education
City and County of Denver	See also http://www.greenprintdenver.org/transportation/denvers-electric-vehicle-plan		x	x	x	x
City of Aurora	Adopt PEV codes as part of the city's Comprehensive Plan Educate the public Provide charging access to employees		x	x	x	x
Colorado State Fleet Management	Work to improve adoption of procurement procedures to increase PEV purchases and secure funding to offset the cost of both PEVs and EVSE	x	x		x	x
Mesa Verde National Park	Demonstrate sustainability in vehicle planning, serve as an example for PEV use, and provide charging stations for employees and the public		x		x	x

Private Sector: Commitments

	Top Goals To Promote PEV Adoption In The Next 5 Years	Regulatory	Planning	Permitting	Policy	Education
RunAbout Cycles Inc.	Produce product while encouraging PEV acceptance and legal access rights.	x	x			x
OpConnect, LLC	Deploy technologically advanced EVSE Build user-friendly and smart EVSE to enable successful and efficient PEV charging Champion co-location of PEV charging Provide EVSE to PEV fleets	x	x		x	

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	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
Schneider Electric	Work with cities on adopting PEV infrastructure Work with utilities to develop PEV impact plan Work with businesses to determine appropriate PEV infrastructure to support employee and customer needs	x	x	x	x	x
Fleet Energy Company	Advance utility/grid technology, initiate utility/PEV pilot programs, and integrate PEVs into fleets	x	x		x	x
David J Erb & CO	Promote designated PEV parking in existing commercial properties Assist the PEV community with commercial real estate issues		x		x	x
The Electric Vehicle Information Exchange (EVIX)	Facilitate cross-industry information sharing in PEV market Developing partnerships to promote the adoption of PEVs and PEV infrastructure. Provide data intelligence and use data insights to provide targeted outreach support for PEV industry partners		x			x
General Motors	Increase Chevrolet Volt sales and future PEV models Support Colorado transition towards mass market adoption of PEVs	x		x	x	x
Dietze and Davis	Work with stakeholders to achieve their PEV objectives	x	x	x	x	x
IKEA Centennial	Offer charging stations Conduct pilot development for Solar PEV charging					x

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	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
Zam Energy	Support integration of solar energy with PEV charging utilizing solar incentives Continuously work with collaborations to integrate solar/PEV and develop pilot for Solar PEV charging	x			x	
Eaton Corporation	Work with regulatory approval actions, deploy EVSE, educate audiences, and work with OEMs on EVSE infrastructure and standards	x	x	x	x	x
Spensley & Associates	Educate the public and government officials					x
Synergy Farm	Deploy EVSE to develop a network infrastructure Provide network surveillance/analysis Educate prospective consumers on technology		x			
VIA Motors, Inc.	Build the best Extended Range Vehicles and encourage their adoption Maximize speaking opportunities to the business community to get the word out.					x

Non-profit: Commitments

	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
CSU Ventures Systems Solutions Group & Colorado State University College of Engineering	Implement a multi-linked approach to PEV education aimed at several levels of society and provide trainings through the Vehicle Electrification Education Program (VEEP)				x	x

	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
Regional Air Quality Council (RAQC)	Support policy infrastructure development and PEV adoption Focus on stakeholder education and PEV/EVSE deployment/funding mechanisms.		x		x	x
Energy Efficiency Business Coalition	Increase utility investment and research in charging solutions, customer education, and home/business integration	x				x
Denver Museum of Nature & Science	Expand public and staff PEV charging station access with priority parking Develop and promote public PEV education.		x		x	x
Southwest Energy Efficiency Project	Reform HUTF to fairly include PEVs Maintain tax credit for PEVs, hopefully turning it into a rebate Revise building codes to include EVSE in new construction	x	x	x	x	x
CU Boulder	Purchase a PEV to gather data on GHG emission impacts and demonstrate utility to Colorado consumers	x	x		x	x
The Renewable Energy Initiative (TREI)	Provide 10 corporate and community test drive events per month in Denver and Colorado Front Range cities via the DriveSunShine.org program to increase PEV purchases and leases Expand program to 10 cities. Generate 132,000 EV test drives annually					x

Utilities: Commitments

	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
Colorado Springs Utilities	Create PEV strategy, pilot public charging stations installations, and create PEV rate options	x	x	x	x	x
Black Hills/ Colorado Electric Utility Company, LP d/b/a Black Hills Energy	Integrate PEV into Company fleet Promote PEV additions to customers within company's service territory Inform Colorado PUC stakeholders about PEVs and infrastructure needs	x			x	
Xcel Energy	Support the development of public charging infrastructure Continue PEV integration into our company fleet. Grow role as a trusted advisor for PEV consumers Conduct demonstration projects across service territories Work with stakeholders on exciting PEV projects	x			x	x

Transit: Commitments

	Top goals to promote PEV-adoption in the next 5 years?	Regulatory	Planning	Permitting	Policy	Education
Roaring Fork Transportation Authority (RFTA)	Install EVSE (Level 2) to promote fleet PEV purchasing and usage Receive letters of support from our Board of Directors Share case study information		x		x	x

These voluntary commitments represent exciting progress within a wide variety of organizations across all sectors to further the PEV market.

Performance Metrics

Establishing performance measures that can help define PEV readiness will enable actors to measure progress towards achieving the commitments above and PEV readiness in general. Based on the analysis of the current market and strategies to move forward presented in this Plan, metrics to monitor performance across the key issue areas were developed and are provided in Appendix 23.

Utilizing these performance metrics, two assessment tools were developed to monitor progress at the state and organizational level. The State PEV Readiness Assessment Tool (Appendix 24) provides a framework to gain a high-level view of progress towards PEV readiness in Colorado. DMCCC will utilize this tool to assess statewide progress in 2018, including a report across the performance metrics and a progress report on the stakeholder commitments. This analysis will provide a clear picture of PEV market progress resulting from this Plan. The PEV Readiness Stakeholder Checklist (Appendix 25) allows new or long-standing stakeholders to assess their performance in the PEV space by reviewing current levels of achievement and identifying areas of improvement. This checklist includes a fewer number of performance metrics as pertinent to a smaller, defined jurisdiction or organization.

These tools will enable market participants to judge individual and statewide performance and adjust priorities according to changing market needs. While Colorado stakeholders are obviously committed to becoming a first tier PEV market, ensuring accountability, enabling stakeholders to assess and improve performance, and conducting a statewide review after 5 years will ensure that the strategies and recommendations laid out in this Plan are implemented in a coordinated and effective manner. This continued collaboration is crucial to moving the current 1,300 vehicle PEV market forward to the robust vision for 2020 where more than 471,000 PEVs roam the streets of Colorado.

XIV. Conclusions

The Colorado Electric Vehicle Readiness Plan establishes the vision of Colorado as a first-tier market for PEVs and EVSE. Based on a thorough market analysis, the strategies laid out throughout the Plan seek to help stakeholders achieve this vision. A recap of the findings, commitments, and recommendations is provided below.

Recent Stakeholer PEV Activities

With a solid understanding of the current PEV market, organizations in Colorado across all sectors—including utilities, businesses, government, and transit agencies—have already taken the lead in creating an infrastructure and marketplace that encourages PEV expansion. The highlights of activities in the last 5 years include:

- Integrated PEVs into fleet
- Modeled PEV emissions impacts
- Secured grant funding for PEV activities
- Examined smart grid technologies and applications
- Installed EVSE
- Hosted public PEV events
- Incorporated EVSE policy into sustainability plans
- Assigned a municipal point of contact for constituent PEV/EVSE inquiries
- Increased awareness of PEVs
- Participated in Clean Cities Coalition activities to advance the PEV market
- Conducted research and forecasting of PEV markets
- Implemented PEV pilot programs
- Provided market penetration and EVSE readiness reports to clients nationwide
- Donated PEVs and EVSE to partners
- Hosted “Ride and Drive” events
- Involved fleets with beta testing of new technologies
- Advocated for PEV tax credit legislation and deregulation of electricity sales for transportation
- Presented analysis on economic benefits of EVSE to Colorado

Business Case

Even in the current market, where the purchase price for a PEV is higher than that of an ICE vehicle, PEVs owners can recuperate the additional upfront cost and reap significant savings over the life of the vehicle. However, many potential customers are still reluctant to pay this incremental price difference in the initial purchase. Industry stakeholders can take action to further strengthen the PEV business case and overcome this remaining reluctance. Potential actions include:

- Facilitating battery technology development
- Educating the public on the total cost of ownership and financing options
- Gathering real-world data and examples to demonstrate cost savings
- Creating new applications for PEV batteries to increase re-sale value

For the EVSEs, the financial and non-financial benefits create a strong business case to incentivize property developers and others to invest in EVSE for tenants and consumers. Financially, EVSE providers can see pay-backs of less than 6 years and benefit from other revenue-generating opportunities, such as:

- Revenue opportunities from resale of electricity, advertising, increased parking fees
- Priceless advertising and branding opportunity
- Position as a community and industry leader
- Contribution toward LEED certification
- Attraction of a specific audience interested in sustainable property development
- Furtherance of sustainability plans

Government agencies, private companies, and property owners have developed several ownership and management models to effectively install and manage public charging stations, which include one-party, third-party, or split EVSE ownership and management.

Education and Outreach

As advanced technology vehicles enter the market, education and awareness of key industry leaders and the general public is crucial to overcoming misperceptions, providing a seamless user experience, and raising awareness about the clear benefits of PEVs and EVSE. The key industry leaders include first responders, electricians, dealership staff, and elected officials.

Colorado is already working on training first responders on PEVs, further enhancing a well-established and effective emergency response program. Utilizing national training programs, several community colleges, in tandem with the Colorado Clean Cities Coalitions, demonstrate how to utilize partnerships, grant funding, and expert faculty to provide training tailored to specific responder audiences (i.e. firefighters, EMT/Paramedics, etc.). The PEV safety curriculum has also been incorporated into existing degree programs, which ensures its longevity and continued dissemination.

Licensed electricians are already well trained to successfully install EVSE under the required National Electric Code (NEC). EVSE-specific training will further enhance this process by raising awareness that EVSEs are governed under the NEC and bolster the understanding of any nuances specific to EVSE installations. Electricians are responsible for ensuring that EVSE is safely and appropriately placed, affordable to the customer, durable and reliable over time, and offers adequate capacity to charge the vehicle.

Cultivating a more educated workforce within car dealerships is a priority for ensuring that potential PEV owners get necessary information on vehicle capabilities as well as financing and tax credit options. Dealerships can maximize educational opportunities during regularly occurring staff meetings to increase interest of the sales team. Also, detailed handouts on the tax credit procedure will help the finance and insurance offices interface with consumers. Creating more demand from consumers will naturally incentivize dealers to become knowledgeable as well.

Making sure that elected officials are supportive of PEV and EVSE-friendly policies will also help grow the market through a positive policy environment. Individual and organization advocates can use the E.P.I.C. framework to engage and educate relevant political officials:

- **E**ngage your audience
- State the **P**roblem
- **I**nform about a solution
- **C**all to action.

The Electric Ride has been, and will continue to be, the premier resource for information on PEVs in Colorado to support the education of the general public as well as the specific industry leaders listed here.

Permitting and Installation

With best practices and program options, local governing agencies can focus on enabling EVSE permitting processes that are safe, timely, affordable, and simple.

For multi-unit residences, EVSE deployment will require collaboration between residents and property managers. The following steps help assess the feasibility of EVSE installation and determine best EVSE option and cost-sharing model according to site-specific requirements:

- Find charging location in close proximity to power source
- Verify power capacity and determine metering method
- Contact utility to assess costs and service upgrades
- Address issues from common parking situations
- Consider future growth and charging capacity needs

In the event that an agreement is not possible or EVSE is cost prohibitive, PEV drivers can set up unique arrangements to meet charging needs, such as charging at work or identifying a nearby public site.

Ordinances and Codes

The model ordinances and codes provided to govern the parking, zoning, and other regulations for EVSEs will enable local jurisdictions to promote EVSE development. The guidance is designed to help avoid land-use and parking conflicts while promoting an effective distribution of charging options and spurring economic development.

Ordinances are a cost-effective way to create PEV-friendly communities. Utilizing the guidance and language provided in a sample model code, jurisdictions can follow the following steps to implement codes that will meet local needs:

- Select the appropriate mechanism to promote EVSE adoption (See model ordinance)
- Work with relevant building department and local agencies to develop a code
- Gain appropriate political support
- Work with relevant decision-makers to implement new code
- Enjoy the new economic and social opportunities that result from EVSE

Fleets

Fleet managers conduct a wide analysis of their fleet in order to determine the best placement of alternative fuels vehicles and the appropriate duty cycle for each. Vehicle applications with the following vehicle usage characteristics have been shown to make the best candidates for PEVs:

- Low to medium daily mileage
- A central pool or parking facility
- Regular and local routes
- Light duty vehicles
- Ability to apply tax credits
- Ability to monetize benefits of cleaner transportation
- Easy to implement driver education
- Clear internal policies and procedures

Policy

A strong policy environment encourages PEV market growth. Both financial and non-monetary options were included in this analysis, and can be implemented in all sectors at both the state and local level. A brief summary of policy actions include:

- Add PEV/EVSE products to state bids
- Promote workplace charging
- Extend tax credits
- Move tax incentives to point of sale
- Emissions inspection exemption
- Air quality modeling to include PEVs
- Energy Performance Contracting for PEVs
- Incentivize off-peak charging
- Multiple state MOUs for PEVs
- Update excise tax system
- Establish vehicle-to-grid policies
- Finance EVSE fund at state level
- Extend HOV access
- Set state fleet replacement standards
- Incentivize EVSEs for public buildings

Private sector fleets can utilize internal policies to lead outreach and innovation opportunities in the PEV/EVSE space, integrate PEVs into the fleet, and offer charging infrastructure as an employee benefit.

Solving fuel tax concerns to create a fair system is important to assuage criticisms in the short term and avoid increasing financial shortfalls as the PEV market grows in the long term. Solution options include:

- Excise tax on electricity
- Sales tax on PEV electricity
- Flat fee on PEV vehicles
- Mileage-based user fees

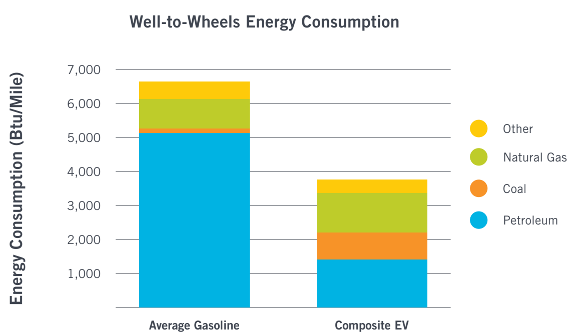
Utility and Regulatory

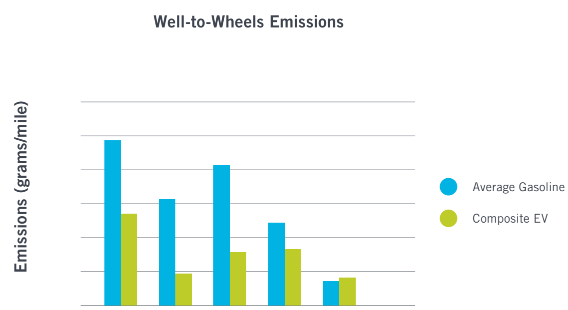
The expected grid impact of PEVs is minimal in the near term, with no impact expected at the generation and transmission levels and minimal impact at the distribution level. Areas that will need continual monitoring and evaluation include clustering of PEVs in neighborhoods, commercial customers, and the variability of electricity demands within each level of charging. Additionally, stakeholders can further minimize any potential for grid impact through three strategies: EVSE notification systems, encouraging off-peak charging, and technology solutions.

Beyond their inherent role in the provision of electricity, related grid upgrades, and regulatory activities, Colorado's electric utilities have played new roles in enabling a reliable grid and robust PEV market through activities such as fleet electrification, strategic planning, EVSE investment, and communication with new audiences.

Emissions Impact

The well-to-wheels emissions impact study found that PEVs require approximately 40% less energy consumption to operate and create fewer emissions (greenhouse gases, carbon monoxide, volatile organic compounds and nitrogen oxides) than average ICE vehicles. The extra electricity required to charge the PEVs is projected to come from a generation mix made up of 44% natural gas, 32% wind and 24% coal-fired. These findings are based on high PEV penetration scenarios and assumptions regarding the provision of electricity in 2020.





Moving Forward

One indication that the market is poised to grow is the voluntary commitment of organizations across the state to actions that will increase PEV adoption. The following list highlights a few of the key commitments for 2018.

- Establish mechanisms and conduct pilot programs to power PEVs with renewable energy
- Complete projects with smart grid technology
- Deploy EVSE, including those with advanced technology
- Promote PEV adoption in community
- Advocate for and institute PEV policies
- Update building codes to include EVSE pre-wiring
- Develop recognition avenues for private sector
- Provide charging access to employees
- Adopt PEV procurement process for fleets
- Demonstrate sustainability in PEV vehicle planning
- Champion co-location of EVSE
- Develop PEV impact plan
- Advance utility and grid technology
- Assist PEV community with commercial real estate issues
- Facilitate sharing of PEV information and program results
- Provide data intelligence on EVSE
- Educate public and elected officials
- Build extended range vehicles
- Provide trainings within the industry
- Obtain grant funding for PEV projects
- Create PEV rate options
- Inform Colorado PUC stakeholders about PEV/EVSE

Glossary

Table of Acronyms

ACC	Arapahoe Community College
ADA	Americans with Disabilities Act
BEV	Battery Electric Vehicle
BMP	Best Management Practices
CADA	Colorado Automotive Dealers Association
CAFE	Corporate Average Fuel Economy Standard
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CO	Carbon Monoxide
CO2	Carbon Dioxide
DMCCC	Denver Metro Clean Cities Coalition
DOE	Department of Energy
DORA	Department of Regulatory Agencies
EEI	Edison Electric Institute
EIA	Energy Information Administration
EMT	Emergency Medical Technicians
EPA	Environmental Protection Agency
EPC	Energy Performance Contracting
EVSE	Electric Vehicle Supply Equipment
GHG	Green House Gases
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model
GTE	Gasoline Tax Equivalency
HB	House Bill
HOA	Home Owners Association
HOV	High Occupancy Vehicle
HUTF	Highway Users Transportation Fund
ICE	Internal Combustion Engine
IOU	Investor Owned Utility
kWh	Kilowatt hour
LDV	Light Duty Vehicle
LEED	Leadership in Energy and Environmental Design
MBUF	Mileage Based User Fees
M&O	Maintenance and Operation
MOU	Memorandum of Understanding
NAFTC	National Alternative Fuels Training Consortium
NCCCC	Northern Colorado Clean Cities Coalition
NEC	National Electric Code
NFPA	National Fire Protection Agency
OEM	Original Equipment Manufacturer
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PUC	Public Utility Commission
RAQC	Regional Air Quality Council
RRCC	Red Rocks Community College
RPS	Renewable Portfolio Standard
RTD	Regional Transportation District
SC4	Southern Colorado Clean Cities Coalition
SWEEP	Southwest Energy Efficient Project
TABOR	Tax Payer Bill of Rights
TCO	Total Cost of Ownership
TOU	Time-of-Use
V2G	Vehicle to Grid
VMT	Vehicle Miles Traveled
WECC	Western Electricity Coordinating Council

Glossary and Definitions

Advanced Electric Drive Vehicle Education Program
A training designed specifically to prepare first responders and public safety officers to respond to incidents involving advanced electric drive vehicles and their supporting infrastructure.

Battery Electric Vehicle (BEV) – also pure electric vehicle. A vehicle that relies solely upon electricity for its propulsion.

Boulder Smart Grid - Plug-In Electric / Hybrid Vehicle Project
A consumer behavior study in Boulder funded by Xcel Energy, Toyota, and CU-Boulder examining the effects of smart grid technologies and time of use pricing on charging patterns.

Carbon Dioxide (CO2)
A by-product of internal combustion engines that acts as a greenhouse gas, which traps heat by reflecting radiation toward the earth's surface and can contribute to the warming of the atmosphere.

Carbon Monoxide (CO)
A colorless, odorless gas produced by automobile engines. According to the U.S. Environmental Protection Agency, CO contributes to the formation of smog, or ground-level ozone, which can trigger serious respiratory problems.

Charging Station
See "Electric Vehicle Supply Equipment"

Clean Cities Learning Program
A program to raise awareness and foster a greater understanding of alternative fuels, alternative fuel vehicles, and advanced technology vehicles through a targeted education and outreach effort. Developed under a partnership between National Alternative Fuels Training Consortium (NAFTC) and the U.S. Department of Energy (DOE) Clean Cities.

Corporate Average Fuel Economy (CAFE) Standard
The Environmental Protection Agency's standard for average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of passenger cars or light trucks manufactured for sale in the United States for a given model year.

DC Fast Charging
High-voltage Direct Current (DC) charging equipment that requires a three-phase electric service. This is the fastest way to recharge PEV, but it is only commercially available in limited locations.

Electricity
Electric current used as a power source. Electricity can be generated from a variety of sources, including oil, coal, nuclear, hydro, natural gas, wind, and solar. In PEVs, onboard rechargeable batteries store electricity to power electric motors.

Electric Vehicle Infrastructure Training Program
This program is a 24-hour course that offers continuing-education credits to electricians and covers a range of topics from PEV battery types, internet connections, to demand-shedding controls on buildings with PEV charging.

Electric Vehicle Supply Equipment (EVSE)
The charging equipment used to obtain a charge for a PEV battery system.

Electric Ride
The public education campaign initiated under the direction of Project FEVER including a website, facebook page, twitter account, logo, and branding material. The campaign will continue to be the premier PEV resource for Colorado.

Energy Performance Contract
A finance model whereby a third party leverages operational savings to offset incremental capital expenses that a fleet manager would otherwise incur by choosing a PEV over a traditional car. EPC has been used frequently for efficiency improvements in buildings, but has not yet been done for alternative fuel vehicles.

E-Permitting Process
A program implemented in Oregon that allows contractors to purchase EVSE permits online and follow the same inspection process as a regular permit.

Extended Range Electric Vehicle
See plug-in hybrid electric vehicle (PHEV)

Green House Gases (GHG)
A gas in the atmosphere that prevents heat from radiating back into space, which consequently results in a warming of the planet (known as the "greenhouse effect"). CO2 is a very common greenhouse gas, but there are also others like ozone (O3), methane (CH4), water vapor, and trace gases that contribute to the greenhouse effect.

HB09-1331 tax credits
A Colorado state House Bill that allows alternative fuel vehicles purchased before 2015 to receive up to $6,000 in tax credits.

HB12-1258
A Colorado state House Bill that allows EVSE providers to re-sell electricity without being regulated as a public utility.

Internal Combustion Engine (ICE)
An engine that uses the combustion of fossil fuels to power the vehicle. Traditional vehicles use an internal combustion engine.

Investor Owned Utility (IOU)
An electric utility owned by private investors, as opposed to one owned by a public trust or agency. In Colorado, IOUs are regulated by the PUC.

Lithium Ion Battery
A type of rechargeable battery in which lithium ions move from the negative electrode (anode) to the positive electrode (cathode) during discharge, and from the cathode to the anode when charged in order to produce electricity.

Level 1 Electric Vehicle Supply Equipment
Also called an outlet, a level 1 EVSE is one-hundred-twenty (120) volt charging equipment that charges a BEV battery from zero to full in about 18 hours, or a PHEV in about six (6) hours.

Level 2 Electric Vehicle Supply Equipment
Two-hundred-forty-(240)-volt charging equipment that charges PEV batteries in no more than eight hours, depending on battery and vehicle type.

Minor Installation Labeling Program
A program implemented in Oregon allows certain installations to receive an installation label in place of a full permit. These labels are less expensive and time-consuming to administer and purchase.

Original Equipment Manufacturer (OEM)
The company that manufactures the parts and final product and sells it under their brand. In this case, it refers to an automotive brand, such as Ford, GM, or Nissan, etc.

Off-Peak Charging
Charging the battery pack during periods of low demand for electricity, usually at night.

PEV City Casebook
A publication that considers the PEV movement in cities across the world.

PLEXOS: A simulation tool that uses cutting-edge data handling, mathematical programming, and stochastic optimization techniques to provide a robust analytical framework for power market analysis. PLEXOS was used for the Emissions Impact study.

Plug-in Electric Vehicle (PEV)
PEV includes any vehicle that draws electricity directly from electrical power sources (grid or off-grid) and uses electricity to power the motor. In this report, PEV includes both battery-electric and Plug-in hybrid-electric vehicles.

Plug-in Hybrid Electric Vehicle (PHEV)
The PHEV has a substantial battery pack that can be charged by an external source other than fossil fuels (i.e. plugged into household electricity) as well as an internal combustion engine. These vehicles can travel in a "pure electric mode" without using any conventional fuels for a limited distance, and then switch to gasoline mode thereafter. Extended Range Electric Vehicles (EREV) are one type of PHEV that utilizes a unique technology. PHEV-10 has a nominal electric range of 10 miles, and PHEV-40 a nominal electric range of 40 miles.

Project FEVER
Fostering Electric Vehicle Expansion in the Rockies is a $500,000 year-long Department of Energy grant awarded to the Denver Metro Clean Cities Coalition to perform stakeholder engagement and write a Colorado PEV Readiness plan.

Project Get Ready
Project Get Ready is a consortium of cities that are leading the transition to electric vehicles. By sharing best practices and lessons learned about integrating electric vehicles into their cities, Project Get Ready cities identify and actively work together to overcome the critical barriers to electric vehicle adoption. http://www.rmi.org/pgr_cities

Public Utility Commission (PUC)
The Public Utilities Commission (PUC) in Colorado has full economic and quality of service regulatory authority over intrastate telecommunication services; and investor-owned electric, gas and water utilities, as well as partial regulatory control over municipal utilities and electric associations.

Pure Electric Vehicle
See Battery Electric Vehicles

Point of Sale tax incentives
These tax incentives, such as rebates or tradable tax credits, allow PEV purchasers to receive financial benefits the day of purchase rather at the end of the year.

Range Anxiety
This term refers to the fear that a vehicle has insufficient range to reach its destination.

Renewable Portfolio Standard (RPS)
A Colorado regulation that requires investor owned utilities (IOU) to provide 30% of retail electric sales from renewable energy sources by 2020.

Smart Grid
Advanced information and communications technology that can be used for managed charging of PEVs.

Tailpipe Emissions
Exhaust emissions released through the vehicle tailpipe. The Environmental Protection Agency publishes allowable emission levels and vehicle certification standards in the Code of Federal Regulations.

Time-of-Use (TOU)
An electricity rate structure that allows consumers to pay different electric rates depending on the time of day that electricity is used. Typically, these rate structures offer lower rates during the night or other times when demand is low in order to encourage off-peak charging. Currently, these rates only apply to commercial and industrial customers in most parts of the country. Also see "Off-Peak Charging".

Volt
A unit of measurement used to determine the potential strength of an electrical current; also the name of the General Motors PHEV.

Kilowatt
A measurement of total electrical energy.

Kilowatt hour
The amount of energy required to power a one-thousand watt load for a full hour.

Wells-to-Wheels
A term referring to the entire amount of energy used in the production and consumption processes of a vehicle. A well-to-wheels analysis considers energy use and emissions from the all stages of vehicle use, including production or extraction of the feedstock for vehicle fuel, fuel processing, fuel transport and distribution, and vehicle operation.