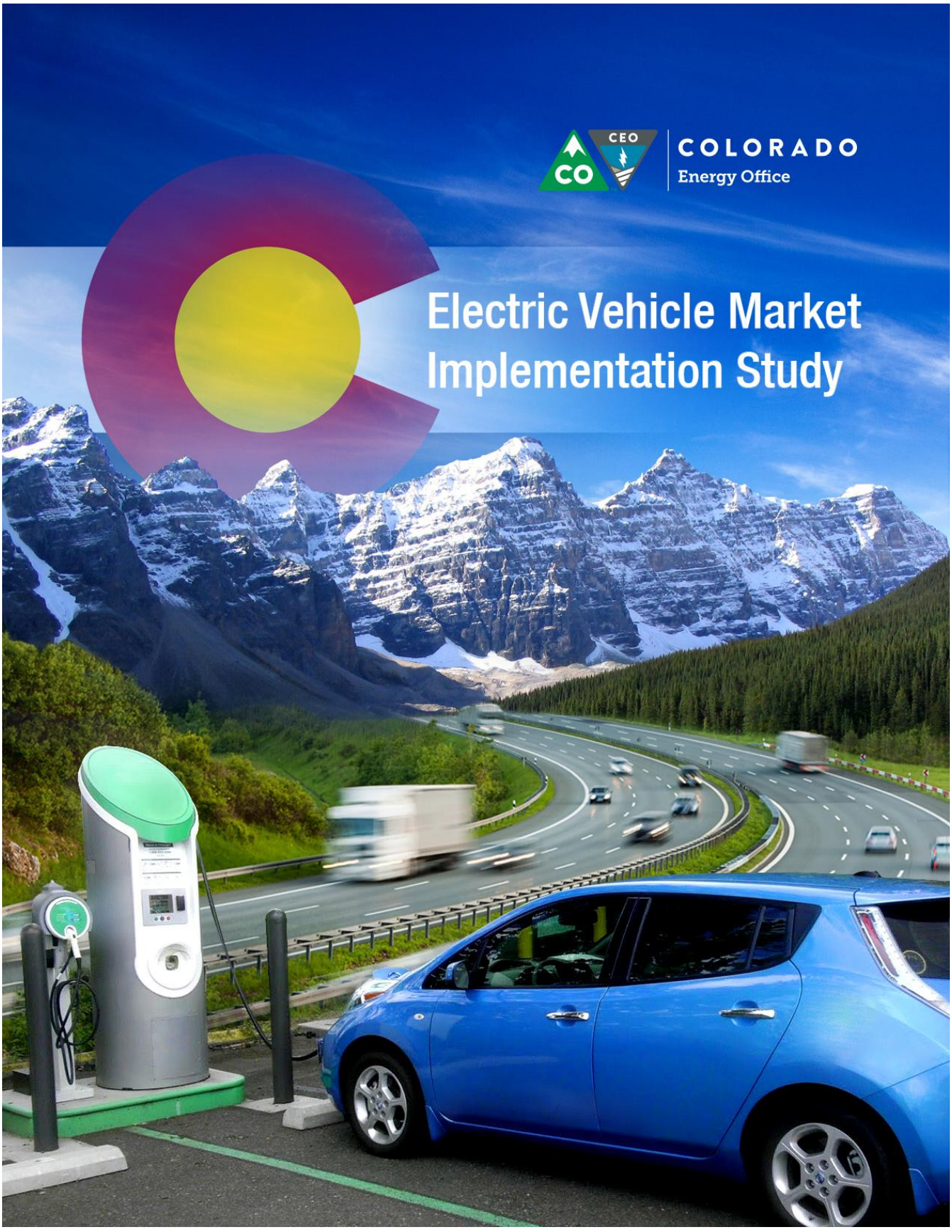
COLORADO
Energy Office

Electric Vehicle Market Implementation Study



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Executive Summary

The Colorado market for electric vehicles (EVs) has grown from 20 vehicles in 2011 to more than 3,100 in early 2014. This growth can be attributed to strong market signals from consumers who demand automobile options that cost less to fuel, unstable gasoline prices, a favorable political climate at the federal level with support from the White House and the U.S. Department of Energy, an unprecedented number of available vehicle makes and models from car manufacturers, mandates for fuel-efficient vehicles, and strong local efforts such as Charge Ahead Colorado, Refuel Colorado Fleets, ALT Fuels Colorado, and Funding Electric Vehicle Expansion in the Rockies (commonly known as Project FEVER). These efforts support the EV market by offering technical support services, as well as by funding vehicles and charging infrastructure. *The Colorado EV Market Implementation Study* indicates that, despite being early in the market adoption phase, EVs are already having a net positive impact on the state's environmental, energy, and economic security—improving air quality, reducing the amount of energy consumed, while mitigating reliance on imported petroleum and saving Coloradans money through reduced fuel and vehicle maintenance costs.

In order to advance continued growth of EVs in Colorado, there are a number of market barriers that must be addressed through strategic policy and programmatic solutions. Some basic obstacles that the EV market faces include driver concerns related to vehicle range, convenience of charging, up-front higher costs, and performance. National studies and a local survey have both shown that consumers are also apprehensive about the availability of charging stations, including the number of publicly accessible locations, the availability of charging opportunities at their places of work, and a lack of EV fast-charging stations that can enable them to drive across Colorado using interstate highways.

Based on the range provided per charging station type paired with dwell times in Colorado, this report offers a general recommendation for the minimum level of charging types for specific location categories. Longer dwell time locations, such as residences, airports, hotels and workplaces, can be well served with Level I charging, which will provide 2–5 miles of range per 1 hour of charging. Types of venues that could accommodate EV owners with Level II charging include libraries, museums, public buildings/courthouses, recreation centers, restaurants, shopping centers, stadiums, and trailheads where 10–20 miles of range per 1 hour of charging is appropriate. The top priority for a Level III charging network is short-term charging, where vehicles can charge 60-80 miles in 20 minutes. This could include an Electric Highway with stand-alone points on Colorado interstates and charging stations located no farther than 50 miles apart and no farther than 1 mile from the highway. This could be incentivized by the state or funded by either host locations or a vendor supplying the charging infrastructure. The recommended option for build out of a more robust EV charging network, with emphasis on the Electric Highway concept, will address the concerns over access to EV charging and range anxiety.

The program recommendations to advance the EV market fall into two categories: (1) enhancing current successful efforts, and (2) finding new ways to reach developing markets. Existing programs, such as the Charge Ahead Colorado funding for vehicles and charging stations, have left an indelible impact on the

growth of EVs in Colorado and may be best served by continued adaptation and evolution as the market changes. With successful outreach to hundreds of fleets and organizations completed, the program administrators, partners, and vendors may wish to selectively target businesses in underserved zip codes. Funding levels offered by Charge Ahead Colorado can also be altered to incentivize investment in faster charging capabilities by doubling incentives for a more expensive Level III infrastructure. New efforts in Colorado could seek to dovetail off of successful efforts happening nationally (such as the EV Everywhere Grand Challenge). For example, program efforts can focus on working more closely with employers that have locations in Colorado. Additionally, CEO can partner with such efforts as the Environmental Leadership Program being run by the Colorado Department of Public Health and Environment to facilitate recognition for leaders in electrified transportation. The program recommendations made in the EV Market Implementation Study are a step toward reducing barriers such as up-front vehicle costs, cost of charging stations, the perceived inconvenience of charging, and vehicle range.

The Colorado Alternative Fuel Vehicle Income Tax Credit is very complex, and by simplifying the process, the State of Colorado could increase uptake of these incentives. A flat tax credit that has two different tiers is one way to change the income tax formula. The higher tier would be to reward those who purchase a battery electric vehicle because they run exclusively on electric power. The lower tier would be applicable to those who purchase a plug-in hybrid electric vehicle, as they have greater range and less risk associated with them. In addition, making "point of purchase" tax credits available to EV buyers is another strategy to be considered. Point of purchase incentives could be particularly effective in the alternative fuel vehicle market, partially because they would allow buyers to finance vehicles at lower monthly rates. Time-of-use rates are also recommended as a strategy to incentivize at-home charging during off-peak grid hours.

Capitalizing off the excellent marketing tools and processes already in place is essential for CEO and partners to lead the EV market. Key groups in this sector are the general public, large employers, the Colorado Automobile Dealers Association, first responders, owners/operators of destinations with longer dwell times, ski resorts, car-sharing services and rental car companies, utility programs, industry leaders and local notable personalities, and electric vehicle supply equipment manufacturers and distributors. Important messaging that CEO needs to convey to the public includes available tax credits and funding programs, content and information on EVs to include in existing auto dealer publications, programs for employees and management at large employers, and mentoring programs to help companies that are new to the EV market. Potential outreach channels include building on existing and developing new social media, continuing strong history of conducting trainings on EVs in conjunction with existing educational opportunities, and assisting stakeholders in promoting their achievements in the EV market. Maintaining focus on these outreach opportunities will allow for key audiences to learn about ways to lower the cost of EV ownership, improve access to charging, and make EV ownership more convenient—all of which are barriers to the market.

Convenient and robust access to charging can be hindered by hard-to-find EV charging locations. Recommendations are contained in this report that highlight national best practices, such as a

combination of way-finding, permissive, prohibitory, and/or regulatory signage. The City of Montrose, Colorado, is a local case study that demonstrates this best practice. This government entity used a combination of way-finding signage in abundance, and permissive signage to direct drivers to the charging station. To serve entities that wish to offer charging to employees and the general public, the *EV Market Implementation Study* offers several recommendations toward a path forward. This includes a sample survey for employers to gauge EV interest in their worker population, a methodology for aggregating the results of the employer survey, as well as a business case with justification for companies to offer charging for patrons. These recommendations will expand access to convenient charging, which is an established challenge in the EV market.

CEO and partners will be able to continue their role in facilitating the market growth of EVs in Colorado through subtle updates to existing efforts, while pursuing new avenues to mitigate driver concerns related to vehicle range, convenience and access to charging, up-front higher cost, and performance. With these barriers being challenged consistently, EVs will continue to positively impact the state's environmental, energy, and economic security.

Introduction

In Colorado, alternative fuel vehicles (AFVs) account for less than 3% of total registered vehicles. According to data from the National Renewable Energy Laboratory (NREL)[1] and Colorado Department of Transportation data,[2] electric vehicles (EVs) made up approximately 0.6% of all light-duty vehicle sales (LDVs) in Colorado's 2013 market. In this study, the term electric vehicle, or EV, will include both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). Despite this relatively low market share, EVs have seen rapid gains in market share throughout Colorado since December 2011 when their market segment was approximately 20 vehicles. With evidence cited below suggesting that the EV market is poised for substantial growth in the next 15 years, it is important that the Colorado Energy Office (CEO) undertake effective planning and implementation efforts, including the formulation of policies and programs that support this emerging transportation area.

CEO's mission is to improve the effective use of all of Colorado's energy resources and to improve the efficient consumption of energy in all economic sectors by providing technical guidance, financial support, policy advocacy, and public communications. Through strategic policy and programs, the State of Colorado is seeking to improve statewide air quality by reducing mobile source emissions and petroleum consumption from motor vehicles. At the same time, Colorado is attempting to reduce consumer transportation costs, encouraging AFV adoption. The purpose of this *EV Market Implementation Study* is to provide a framework for implementing effective policies and programs, as well as to identify other opportunities that the State could pursue to facilitate EV adoption in Colorado. This study is a tool intended for use by program managers, policymakers, and other parties to facilitate discussions on developing an effective statewide EV strategy.

[1] National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014.
[2] Colorado Energy Office provided January 2014 data for total number of vehicles on the road in Colorado.

Economic, Environmental, and Energy Security Benefits of EVs

There is a triple bottom-line benefit to the widespread adoption of EVs: economic, environmental, and energy security. According to the U.S. Department of Energy's Clean Cities program, which aims to reduce petroleum consumption in the transportation sector, 75% of all petroleum consumed in the United States is used in the transportation sector, and 33% of that petroleum is imported from foreign markets.[3] Through higher adoption rates of EVs, Colorado citizens will realize greater economic security with lower ownership costs, reduce greenhouse gas emissions, and empower the United States to utilize domestic sources of energy.

As of February 2014, approximately 3,112 EVs were registered in Colorado, with EVs recently experiencing a period of recognized market growth.[4] Colorado EV sales almost doubled in 2013, with 1,513 sold, from 2012, with 795.[5] As Colorado's vehicles move toward a higher percentage of electric-powered vehicles and its electric portfolio is increasingly generated from cleaner sources, the state is well positioned for EV market growth to provide environmental, economic, and energy security benefits. Colorado has already captured the following environmental, economic, and energy benefits from the adoption of EVs throughout the state.

Environmental Benefits

Findings: Based on the total number of registered EVs (as of February 2014), all of Colorado's EVs would account for an annual reduction of approximately 5,922 tons of carbon dioxide (CO_2) compared to the average gasoline LDV on the road. Each individual EV in Colorado accounts for an average annual reduction in CO_2 emissions by about 37% compared to the typical gasoline LDV on the road.

Since this reduction in CO_2 emissions is directly tied to Colorado's electricity generation mix, the emissions savings for each EV would continue to increase as the electricity generation mix becomes cleaner. For example, Colorado's CO_2 emission rate from electricity generation dropped an estimated 9.5% between 2010 and 2013—from 1,818.17 pounds per megawatt-hour (lbs/MWh) to 1,645.86 lbs/MWh.[6, 7, 8]

Methodology: Data was used from the Southwest Energy Efficiency Project (SWEEP), which seeks to identify and promote the implementation of policies designed to achieve significant energy savings and reductions in greenhouse gas emissions from the transportation sector. IHS Automotive provided total

[3] U.S. Department of Energy, Clean Cities, "About Clean Cities," accessed January 6, 2015, http://www1.eere.energy.gov/cleancities/about.html.

[4] National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014. This data could include approximately 60 hybrid vehicles that could not be filtered out by county due to vehicle identification number (VIN) constraints.

[5] National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014.

[6] U.S. Environmental Protection Agency, eGRID 9th edition Version 1.0 State File, Colorado State annual CO2 total output emission rate (lb/MWh), http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html.

[7] U.S. Energy Information Administration, Net Generation by State by Type of Producer by Energy Source, Colorado, accessed December 18, 2014, http://www.eia.gov/electricity/data/state/.

[8] U.S. Environmental Protection Agency, FLIGHT, 2013 data for Colorado, accessed November 4, 2014, http://ghgdata.epa.gov/ghgp/main.do.

number of EVs and plug-ins by make and model for 2012, 2013, and through February 2014.[9] Carbon dioxide emissions for each year of the specific makes and models were calculated using the tool "Beyond the Tailpipe Emissions" on FuelEconomy.gov.[10] This tool uses the 2010 generation mix for the Rocky Mountain region, though, so the specific make/model emissions were updated in this study to reflect Colorado's current generation mix. With the recent addition of renewable energy to the Colorado generation mix, this 2010 emissions rate provides an artificially high CO_2 emissions rate for EVs. Using U.S. Energy Information Administration (EIA) data for Colorado's 2013 total MWh generation[11] and the U.S. Environmental Protection Agency's (EPA's) facility-level greenhouse gas emissions data for 2013 CO_2 emissions from power plants,[12] a new CO_2 emissions rate (lbs/MWh) was estimated for Colorado for 2013 (1,645.86 lbs/MWh). While eGrid has Colorado's 2010 emissions rate at 1,818.17 lbs/MWh, the tool uses the regional—not state-level—rate. The eGrid's 2010 Rockies sub-region emissions rate used for Colorado zip codes in the FuelEconomy.gov tool is 1,896.74 lbs/MWh. This means the difference between the estimated 2013 emissions rate and the 2010 eGrid regional rate used in the tool was a 13.2% reduction. To reflect the more current, cleaner Colorado generation mix, the 13.2% reduction was applied to all EV emissions rates used in the FuelEconomy.gov model.

The average Colorado vehicle miles traveled (VMT) for 2012, 2013, and 2014 were projected based on the 6-year average annual decline in VMT in Colorado from 2005–2011. Average annual CO_2 emissions from typical vehicle on the road was calculated using the 2014 national average annual CO_2 emissions rate of 480 grams per mile, which assumes a 23-miles-per-gallon average, as provided by FuelEconomy.gov.[13] This is multiplied by the Colorado VMT to calculate total annual tons of CO_2 emissions (assuming 907,185 grams per short ton). The same calculation was performed for each make and model by using the revised CO_2 emissions rate and the Colorado VMT. The average percent reduction in CO_2 emissions for each vehicle was calculated by finding the average of all of the models over all of the years.

Total CO_2 emissions reductions each year in tons was calculated by using the specific reduction information for each make and model for each year, multiplied by the number of units sold. Since there was a certain number of unknown make/model EVs, as well as a certain number of unknown make/model PHEVs, their impact was calculated using the total average for EVs and the total average for PHEVs.

[9] Southwest Energy Efficiency Project, IHS Automotive data for New Vehicle Retail Registrations for Electric and Plug-ins, Calendar Years 2012, 2013 and 2014 CYTD (Data as of February 2014).
[10] U.S. Department of Energy, FuelEconomy.gov, Beyond Tailpipe Emissions, accessed December 18, 2014, http://www.fueleconomy.gov/feg/Find.do?action=bt2.
[11] U.S. Energy Information Administration, Net Generation by State by Type of Producer by Energy Source, Colorado, accessed December 18, 2014, http://www.eia.gov/electricity/data/state/.
[12] U.S. Environmental Protection Agency, FLIGHT, 2013 data for Colorado, accessed November 4, 2014, http://ghgdata.epa.gov/ghgp/main.do.
[13] U.S. Department of Energy, FuelEconomy.gov, Beyond Tailpipe Emissions, accessed December 18, 2014, http://www.fueleconomy.gov/feg/Find.do?action=bt2.

Economic Benefits

Findings: In Colorado, annual cost per LDV is $1,310.66 in gasoline consumption. The average annual cost per EV is $221.03 in electricity costs, which is an 80% reduction in fuel costs—an annual savings of $1,089.63. This is assuming that plug-in hybrids will use electricity to power the vehicle 56% of the time, which is a blend of lower estimates from Argonne National Laboratory in 2010 and higher estimates from the Alternative Fuels Data Center in 2015.[14,15]

Methodology: Using the total number of LDVs on the road in Colorado as of January 2014,[16] with the average 2014 miles per gallon efficiency,[17] the average VMT in Colorado, and the average 2014 price per gallon of gas[18], the annual gasoline cost per vehicle in Colorado was calculated. Similarly, the number of EVs as of March 31, 2014, the current 2014 average cost of energy per kWh,[19] and the average VMT in Colorado were used to calculate the average annual electricity cost per vehicle of EVs.

Energy Security

Findings: As of February 2014, Colorado EVs were displacing approximately 44,926 barrels of crude oil annually. The EIA notes that approximately 33% of the petroleum consumed in the United States in 2013 was imported from foreign countries, which is actually the lowest level since 1985.[20] A reduction in U.S. petroleum demand by EV adoption could help in continuing to lower the need for importing foreign oil.

Methodology: Assuming Colorado EVs drive the average Colorado VMT annually,[21] miles driven annually, along with the 2014 average miles per gallon for a gasoline vehicle, the barrels of crude oil

[14] 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.

[15] U.S. Department of Energy, Alternative Fuels Data Center, Hybrid and Plug-In Electric Vehicle Emissions Data Sources and Assumptions, accessed January 16, 2015, http://www.afdc.energy.gov/data/10303.

[16] January 2014 data from CEO on total number of vehicles on the road.

[17] U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicle, accessed December 18, 2014, http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html.

[18] U.S. Energy Information Administration, Colorado Retail Gasoline and Diesel Prices, Average price from January through October of 2014, accessed November 14, 2014, http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sco_a.htm.

[19] Advanced Energy Economy, Colorado Energy Data, Average retail price of electricity as of May 2014, http://powersuite.aee.net/portal/states/CO#energy.

[20] U.S. Energy Information Administration, Frequently Asked Questions, "How much oil consumed in the United States comes from foreign sources?," accessed December 31, 2014, http://www.eia.gov/tools/faqs/faq.cfm?id=32&t=6.

[21] Colorado Vehicles Miles Traveled for 2012, 2013, and 2014 were projected based on the 6-yar average decline in VMT in Colorado from 2005-2011, page 22, http://www.copirgfoundation.org/sites/pirg/files/reports/COP%20DrivingRpt%20Aug13.pdf.

avoided annually were calculated. This assumes that one barrel of crude oil produces 19 gallons of motor gasoline with the remainder of a barrel producing other refined products.[22]

EV Adoption—Past, Present, and Future

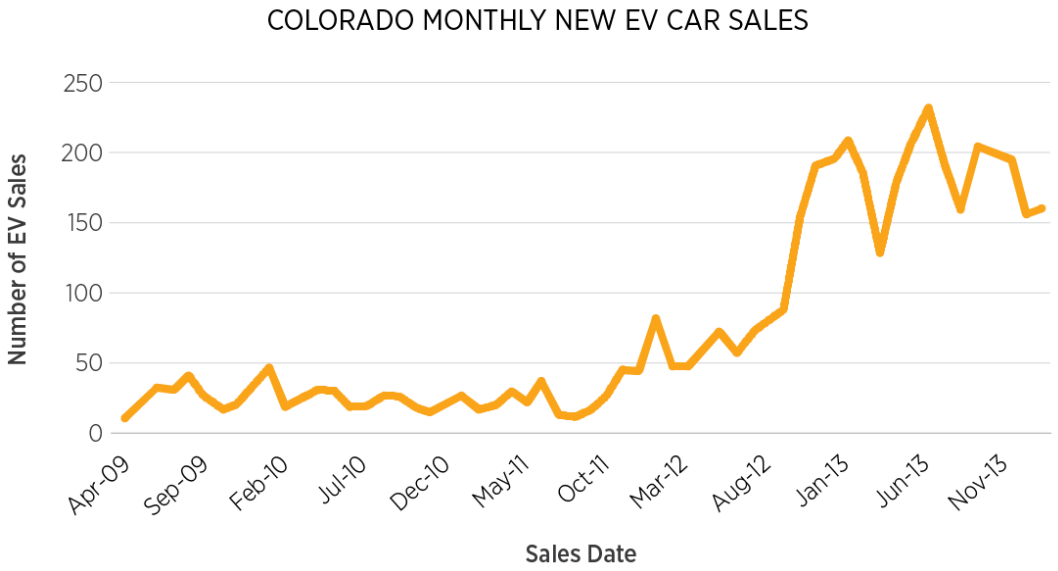
First introduced in the late 1800s, by the year 1900, 38% of all vehicles were powered by electricity.[23] Soon after, interest grew in petroleum-powered cars, and electric vehicles seemingly vanished from the marketplace. Beginning in 2010, EVs began to see resurgence in availability. This is due in part to increasing public concerns about environmental issues, new environmental regulations such as Corporate Average Fuel Economy standards and the Clean Air Act, the commercial success of hybrid vehicles such as the Toyota Prius, and the entry of the Tesla electric sports car into the market.[24] In model year 2014, there were 16 different EV makes and models available for the general public.[25] This figure grew again as of September 2014, with 23 EV makes and models available in the United States.[26] This surge of availability has helped electric vehicles make more driver impressions and gain acceptance.

Past—Colorado EV Sales

Since 2011, Colorado EV sales have shown a pattern of year-over-year growth. In 2013, a new offering of EVs from vehicle manufacturers helped to propel a growth of 90.3% in sales—from 795 in 2012 to 1,513 in 2013.[27] Figure 1 below displays Colorado's monthly EV sales; a sharp incline can be noted beginning after August 2012. A full count of the Colorado EV market for 2014 should be available in the first quarter of 2015.

[22] U.S. Energy Information Administration, FAQs, "How many gallons of gasoline does one barrel of oil make?," accessed December 18, 2014, http://www.eia.gov/tools/faqs/faq.cfm?id=24&t=10.
[23] Hannah Elliott, Forbes, "In Photos: Edison's Electric Cars, Circa 1900," October 11, 2010, http://www.forbes.com/sites/hannahelliott/2010/10/11/in-photos-edisons-electric-cars-circa-1900/.
[24] U.S. Department of Energy, History of the Electric Vehicle. http://energy.gov/articles/history-electric-car.
[25] U.S. Department of Energy, Alternative Fuels Data Center, Light Duty AFV, HEV, and Diesel Model Offerings, By Fuel Type, http://www.afdc.energy.gov/data/10303.
[26] U.S. Department of Energy, History of the Electric Vehicle. http://energy.gov/articles/history-electric-car.
[27] National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014.

Figure 1. Historical EV sales in Colorado, 2010–2013[28]



Current Status – Electric Vehicles and Charging Stations in Colorado

As of February 2014, there were approximately 3,112 EVs in Colorado, which can be broken down into two categories: 1,244 BEVs and 1,868 PHEVs.[29] Appendix A contains additional information on the EV counts by county.

Among Colorado's 64 counties, 57 have at least one registered EV (see Figure 2). The map of Colorado below demonstrates that EVs are most densely clustered in the Front Range region of the state. This can be attributed to a high population and a higher density of individuals that meet the criteria of being a typical EV buyer (according to the Colorado Electric Vehicle and Infrastructure Readiness Plan). This Readiness Plan, funded by the U.S. Department of Energy (DOE) and released in December 2012 as part of the Funding Electric Vehicle Expansion in the Rockies (Project FEVER), identified those earning more than $100,000 annually, having a bachelor's degree or higher, owning two or more vehicles, and aged 38–78 years.[30] Additionally, the locations closer to metro areas could partially alleviate some of the typical concerns by potential EV buyers, such as EV range anxiety, apprehensions over performance in mountainous terrain, and confidence about the certainty of expanding electric vehicle supply equipment

[28] Source: National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014.
[29] National Renewable Energy Laboratory analysis, R.L. Polk, POLK_VIO_DETAIL_2014, October 27, 2014. This data could include approximately 60 hybrid vehicles that could not be filtered out by county due to vehicle identification number (VIN) constraints.
[30] Colorado Electric Vehicle and Infrastructure Readiness Plan, 2012, page 20, http://denvercleancities.org/Colorado%20PEV%20Readiness%20Plan.pdf.

(EVSE) infrastructure. These concerns and barriers are discussed in more detail later in the Assessing Barriers to the Colorado EV Market section, as well as in Appendix B.

Given the current areas with the most EVs, the publicly accessible EV charging stations are also clustered primarily in the Denver Metro and North Front Range areas. Subsequent maps (Figures 3–5)[31] show zoomed-in views of metro areas with high clusters of EVs and charging stations.

[31] The maps for this study were generated using ArcGIS software, Version 10.2 developed by Esri. Copyright© 2014 Esri (Environmental Systems Research Institute), Inc. ArcGIS and all other Esri product or service names are registered trademarks or trademarks of Esri Inc., Redlands, CA, USA.

Figure 2. EVs and charging stations for the State of Colorado by zip code

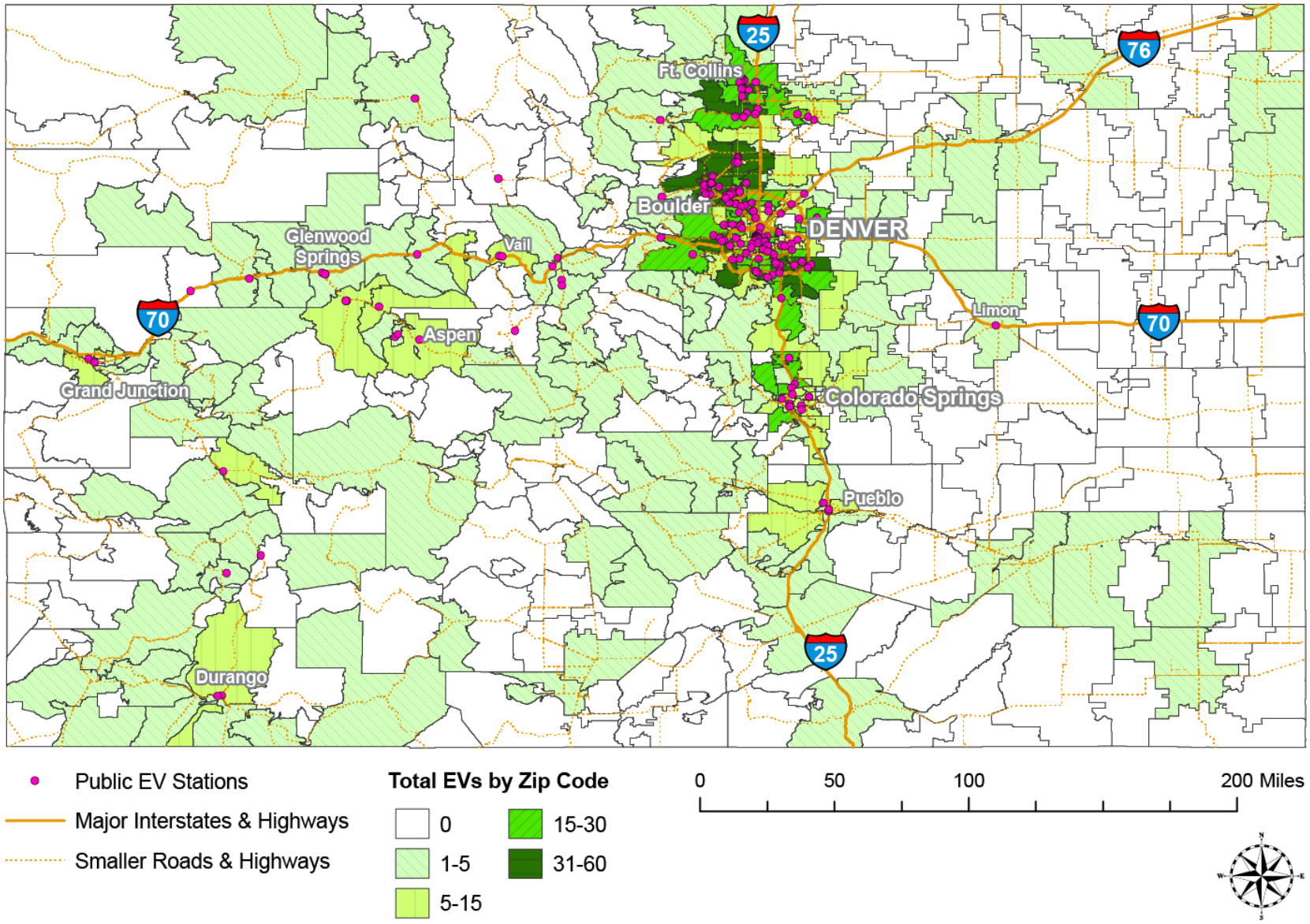


Figure 3. EVs and charging stations in the Denver Metro Area and North Front Range by zip code

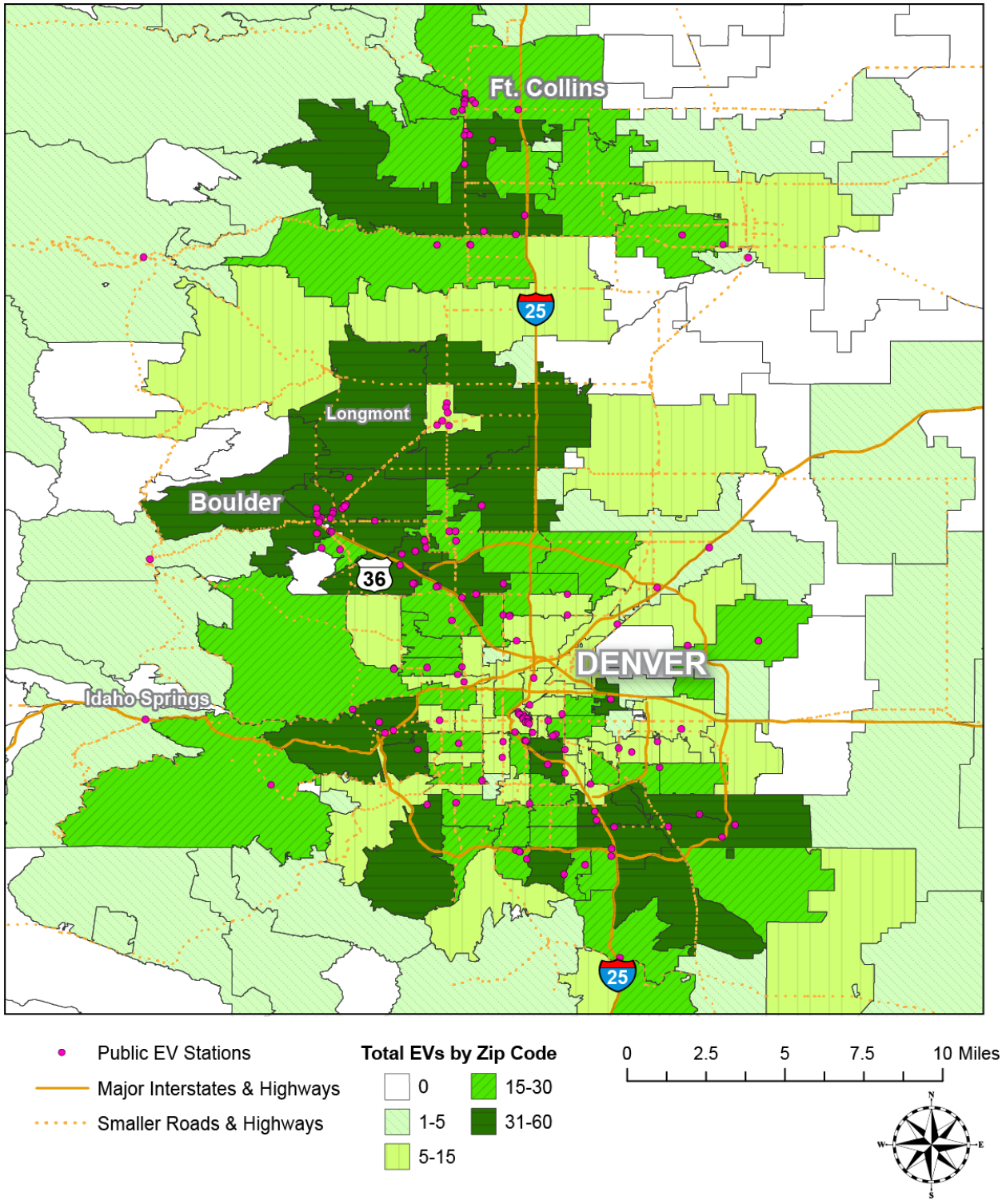


Figure 4. EVs and charging stations in the Denver Metro Area and Boulder Corridor by zip code

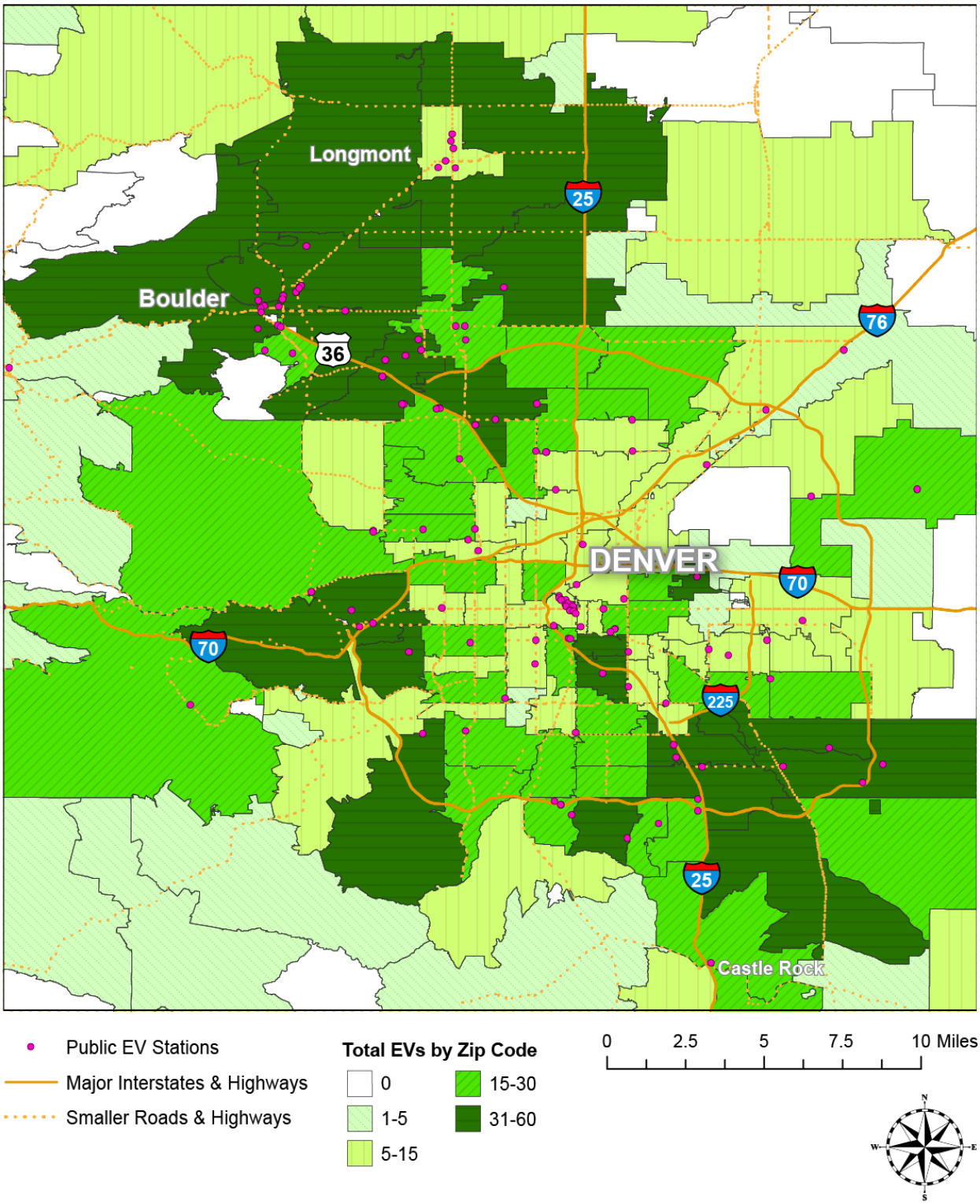
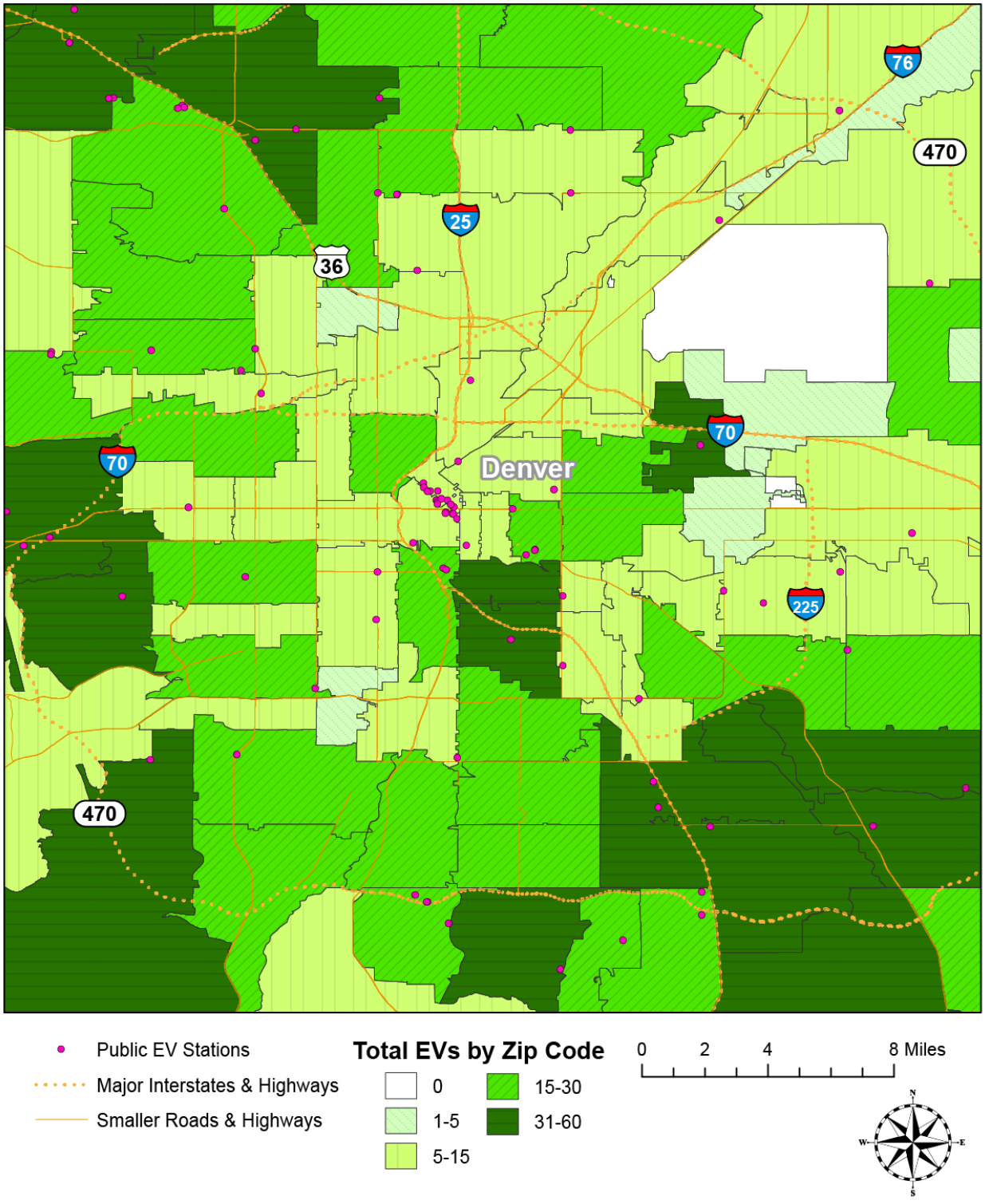


Figure 5. EVs and charging stations in the Denver Metro Area by zip code



Projection of Future EV Adoption Rates in Colorado

After researching existing EV projections and trends, a range of projections were developed for EV sales to 2030. All EV projections for future years assume that an EV will be retired from the current stock after 10 years.

Low EV Growth Scenario

Using Colorado's 2013 number of sales as a starting point, the low scenario utilizes EIA's year-over-year percentage growth of EV sales. This projection uses EIA's reference case scenario, which does not assume constant and consistent growth in EV sales year over year.[32] For example, this scenario estimates a small dip in EV sales in 2020, before beginning to rise again until 2030. These factors can be influenced by EIA's projections of energy prices in 2020, as well as their anticipations of certain legislation or policies expiring without assuming their renewal.

This low-growth scenario projects that Colorado will see EV sales account for 1.85% of all LDV sales in 2030, resulting in approximately 38,056 EVs on the road by 2030. This scenario results in an average 8.7% year-over-year growth in EV sales from 2014–2030. According to this projection, the total number of EVs on the road will account for 0.63% of all LDVs on the road in 2030.

This low scenario resulted in Colorado experiencing a higher percentage of 2030 EV sales than EIA's mountain region as a whole, which resulted from the fact that actual 2013 EV numbers for Colorado were used as a starting point. The results from utilizing these 2013 numbers and assuming Colorado's year-over-year growth would be the same as the mountain region equated to a slightly higher percentage of EV sales compared to all LDVs by 2030. This higher percentage stems from the fact that, in 2013, Colorado's EV sales accounted for a higher percentage of its LDVs than the mountain region as a whole. In 2013, Colorado accounted for a significant proportion (about 36%) of the entire mountain region's EV sales.

Medium EV Growth Scenario

The medium-growth scenario developed for this report assumes that, by 2030, EVs will account for 5% of all LDVs on the road. This is consistent with projections from the National Academy of Sciences, who provides independent and objective advice to the nation on matters related to science and technology, on what is probable for the United States (on average) by 2030.[33] In order to reach 5% of all LDVs on the road by 2030, this scenario assumes that EV sales will increase as a percentage of LDVs each year at a constant growth rate. From 2014–2030, EV sales (as a percent of LDV sales) will increase by 0.77% each

[32] The EIA's reference case in the 2014 Annual Energy Outlook assumes that "current laws and regulations remain generally unchanged throughout the projection period." (http://www.eia.gov/forecasts/aeo/er/pdf/0383er%282014%29.pdf)

[33] American Council for an Energy-Efficient Economy, "Plug-In Electric Vehicles: Penetration and Grid Impacts," 2010, http://www.aceee.org/files/pdf/PHEVfactsheet.pdf.

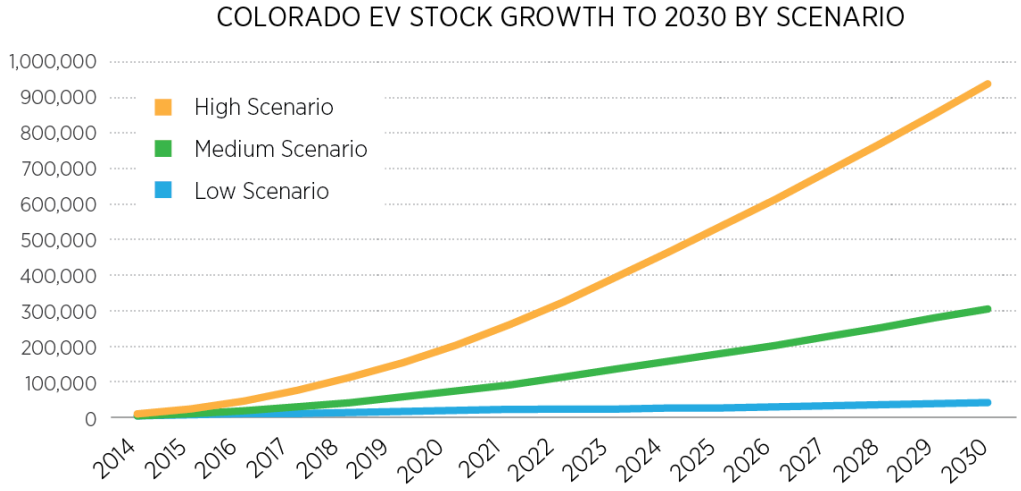
year. This scenario results in about 302,429 EVs on the road in Colorado by 2030. This scenario results in an average 24.4% year-over-year growth in EV sales from 2014–2030.

High EV Growth Scenario

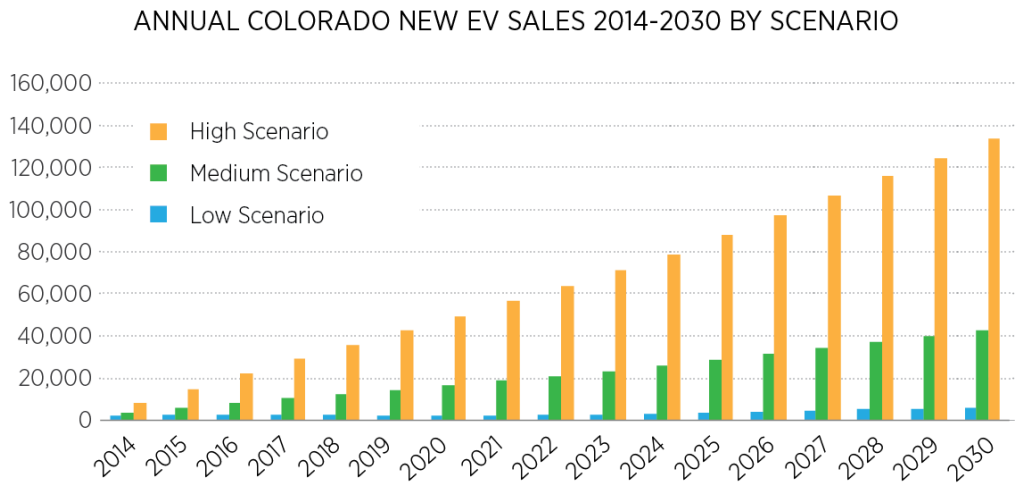
The high scenario developed for this report assumes that, by 2030, EVs will account for 15.5% of all LDVs on the road. This is consistent with the National Academy of Sciences' predictions of the maximum practical scenario for EV adoption in the United States by 2030. This prediction relies upon higher levels of early adoption, as well as strong policy intervention.[34]

In order to reach 15.5% of all LDVs on the road by 2030, this high-growth scenario also assumes that EV sales will increase as a percentage of LDVs each year at a constant growth rate. From 2014–2030, EV sales (as a percent of LDV sales) will increase 2.49% each year. This scenario results in about 937,216 EVs on the road in Colorado by 2030. This scenario results in an average 44.2% year-over-year growth in EV sales from 2014–2030.

Figure 6. Projected EV sales in Colorado



[34] American Council for an Energy-Efficient Economy, "Plug-In Electric Vehicles: Penetration and Grid Impacts," 2010, http://www.aceee.org/files/pdf/PHEVfactsheet.pdf.



Barriers to the EV Market

Many of the common concerns, whether perceived or real, that are preventing widespread EV market adoption include vehicle range, convenience of charging, up-front higher costs, performance, and access to charging. While these issues are consistent across much of the United States, unique regional and local attitudes shape the Colorado EV market. In order to get a better sense of the distinguishable and diverse opinions in Colorado, *EV Market Implementation Study* researchers deployed a survey to in-state drivers and compared the results against the main common challenges identified by industry experts.

Assessing Attitudes of Colorado Consumers

According to a 2013 study conducted online by global firm Navigant Research, which gauged the opinions and attitudes of 1,084 consumers, the environmental benefits of EVs were deemed less important than high-performance and all-wheel drive capabilities.[35] To connect the national attitudes regarding EV attitudes to Coloradans, the Colorado Electric Vehicle Market Survey was administered to Colorado residents in order to gauge their opinions on EVs. The survey consisted of 20 questions and was marketed to the general public via social media by organizations that included ABC's TV station affiliate, Denver 7 KMGH; the Colorado Department of Transportation; and various offices from the City and County of Denver. In addition to these sources for the general public, industry groups were also targeted, including the Denver Metro Clean Cities Coalition, American Lung Association in Colorado, Regional Air Quality Council, and the Electric Vehicle Owners of Colorado. The full results of the survey for all respondents can be found in Appendix C.

The survey received 285 responses out of Colorado's population of 5.27 million. Assuming an accurate sampling of Colorado's population, this response level would result in a 95% confidence level and a 5.8 confidence interval (or margin of error).[36] Nonetheless, the confidence level and margin of error could

[35] Navigant Research, "Electric Vehicle Consumer Survey," accessed December 18, 2014, http://www.navigantresearch.com/research/electric-vehicle-consumer-survey.

[36] U.S. Department of Energy, *A Guide to the Lessons Learned from the Clean Cities Electric Vehicle Community Readiness Projects,* January 2014, http://www.afdc.energy.gov/uploads/publication/guide_ev_projects.pdf.

be slightly over-inflated due to a type of self-selection bias. While the survey received a total of 285 responses,[37] EV owners accounted for 21.75% of responders, and the remaining 78.25% were not EV owners. The survey was available to the general public, and extensive efforts were made to have non-clean energy groups distribute the survey to their networks. Nonetheless, the survey likely experienced a type of self-selection bias, where the groups and individuals most interested in distributing and completing the survey were those already interested in the future of Colorado's EV market. In this case, clean energy groups and current EV owners seemed more likely to respond and distribute the survey. As EV owners are demonstrably over-represented in this questionnaire, it can be noted that this survey may not necessarily be representative of Colorado as a whole.

The Colorado Electric Vehicle Market Survey asked respondents to rank nine pre-identified barriers in order of significance for consideration in purchasing an EV in Colorado. The results from 285 respondents indicate that these common challenges from other states remain relevant to address for Colorado consumers in order to advance the market. The order in which various market barriers were ranked is as follows:

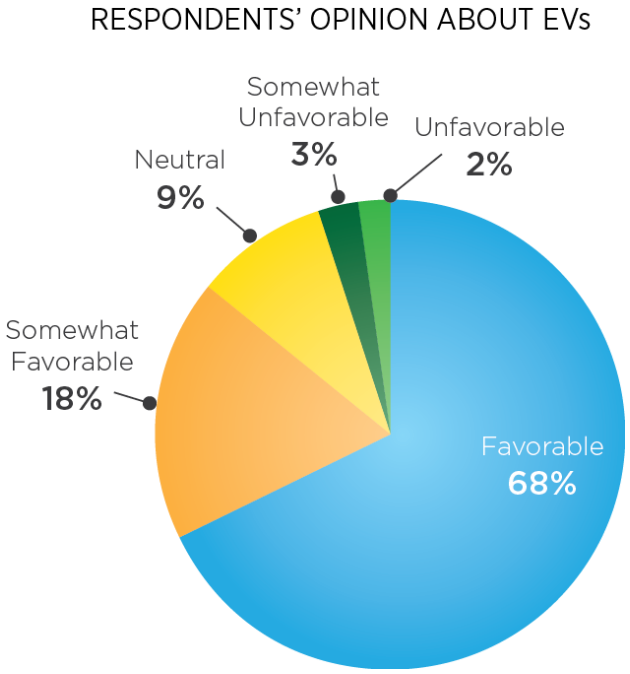
1. Up-front price difference for an EV
2. Limited range of EVs
3. Availability of charging stations
4. The time that it takes to charge an EV
5. Vehicle performance
6. Model availability
7. Consumer knowledge of EVs
8. Elevation impacts and four-wheel drive capability
9. Dealership experience at point-of-sale.

In the survey, respondents indicated the top two barriers involved the issues of cost and range of EVs. The cost of EVs was ranked as the number one barrier by 35.1% of respondents, and range was ranked by 32.6% of respondents as the number one barrier. Other questions in the survey associated with these barriers provided additional insight among consumers for developing policies and programs to address them. Although the cost difference for EVs does represent a primary factor, consumers are generally willing to pay more for EVs up to a point. In terms of up-front price difference for EVs, a significant number, 38.6%, would be willing to pay up to $5,000 more for an EV over another vehicle, and 24.21% would be willing to pay up to $2,000 more. Only 15.79% of respondents would not be willing to pay an incrementally higher cost. Additionally, on the question of comfort with EV range, more than 53% of respondents would require an EV to provide more than 150 miles on a single charge; in fact, more than 32% would not feel comfortable unless a single charge provided more than 200 miles. The other key barriers ranked in the top five by survey respondents include, in order, availability of charging stations, charging time, and performance.

[37] Creative Research Systems, Sample Size Calculator, http://www.surveysystem.com/sscalc.htm.

The results of the Colorado Electric Vehicle Market Survey demonstrate that most respondents (86%) have a favorable or somewhat favorable opinion about electric vehicles. This compares to a 2013 Navigant Research Study, which showed that electric vehicles have a national approval rate of 61%.[38]

Figure 7. Survey respondents' opinions about EVs



EV Market Challenges in Other States

In 2012, DOE awarded grants to 16 communities around the country to help them prepare for EVs and charging infrastructure. Through these awards, local public and private organizations collaborated on plans to deploy electric vehicles, as well as to develop a strategy that helps reduce U.S. petroleum dependency and build a clean transportation future. Depending on local needs, each awardee created a plug-in electric vehicle (PEV) community readiness plan that includes activities such as streamlining permitting processes, revising codes, training emergency personnel, educating the public, and developing incentives.[39]

To assess the barriers of the EV market in other states in the country, researchers conducted a meta-analysis of DOE's summary of the Clean Cities EV Community Readiness grants through the publication entitled, "A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness

[38] Navigant Research, "Electric Vehicle Consumer Survey," accessed December 18, 2014, http://www.navigantresearch.com/research/electric-vehicle-consumer-survey.
[39] U.S. Department of Energy, Clean Cities, "Electric Vehicle Community Readiness Projects," accessed December 18, 2014, http://www1.eere.energy.gov/cleancities/electric_vehicle_projects.html.

Projects."[40] Common barriers identified among states include access to charging stations in multi-resident dwellings, the limitations of fleet managers during the decision-making process, the high upfront cost of EVs, and range anxiety of drivers.

Common challenges that were found from the *Colorado PEV Readiness Plan 2012,* as well as those from other state readiness plans from across the country, can be found in Appendix B. A table is provided in Appendix B that highlights the major barriers for the Colorado EV market identified in 2012, as well as showing where these barriers match with other states with similar barriers identified from the review of Clean Cities EV Community Readiness grants. These other states with similar barriers to Colorado provide avenues for considering other policies and programs that have been implemented to address these barriers. Additional barriers in the table to those listed earlier in this section include the cost burden for a single user to install a charging station at a multi-resident dwelling, common limitations faced by fleet managers in selecting EVs for their fleets, and uncertainty and various standards for the installation of charging stations. In addition to these common barriers shared among multiple states, the table in Appendix B highlights the barrier of a perception that high elevation and mountain terrain will negatively impact EV performance. From the survey conducted for this report and review of the EV readiness plans from 2012, Colorado identified the key challenges that must be overcome in order to facilitate the development of future policies and programs.

EV Charging Station Locations

The Colorado Electric Vehicle and Infrastructure Readiness Plan estimated that for every 100 EVs, there should be 100 residential charging ports, 10 private charging ports, and 20 public charging ports.[41] This would result in 1.3 charging ports for every EV, which aligns closely with the general industry recommendations of 1.5 charging ports for every EV on the road, as provided by Intel PEP stations, an EVSE provider.[42] According to a 2013 Navigant study, 41% of all drivers (not just EV owners) are interested in public charging stations.[43] A single charging station may have more than one port available.

This means a large majority of the appropriate EVSE infrastructure will be comprised of residential charging. In specifically considering future publicly available stations, it means an appropriate EVSE would have 20 publicly available charging ports for every 100 EVs (a ratio of 1 port for every 20 EVs).

Although the installation of home charging offers a clear benefit to EV owners, it is not necessarily an opportunity that requires state funding for success. Most EVs come with a cordset that allows for

[40] U.S. Department of Energy, *A Guide to the Lessons Learned from the Clean Cities Electric Vehicle Community Readiness Projects,* January 2014, http://www.afdc.energy.gov/uploads/publication/guide_ev_projects.pdf.
[41] Based on Appendix 6 of the Colorado Project FEVER Report that states assumes for every 100 EVs are 20 charging stations to public charging stations, page 6.
[42] Intel Corporation and PEP Stations, "Charging Stations Keep Electric Vehicles Moving Ahead," 2012, http://www.hubbell-wiring.com/press/pdfs/PEPStations-IntelCaseStudy.pdf.
[43] Navigant Research, "Electric Vehicle Consumer Survey," accessed December 18, 2014, http://www.navigantresearch.com/research/electric-vehicle-consumer-survey.

charging through a standard, three-prong household plug.[44] Although the charging time is slow (8 hours of charging provide around 40 miles of driving), this setup allows for convenient overnight charging at home at no additional cost.

The availability of EV charging at a workplace is another clear benefit to EV owners. The decision for a business to install workplace charging depends on a number of factors, including building/property ownership, available funding, perceived value to employees, etc. While state and/or local policies and programs that support companies with installing EV charging for employees would help facilitate the everyday driving of EV owners (and potentially incentivize the purchases of EVs by employees), these charging ports would most likely not be available to the general public. This study focuses on using existing EV data to geographically analyze where additional EV stations would support the development of a robust EVSE infrastructure. The data collected for this project does not indicate exactly where EV owners work, but the information could nonetheless be used to support workplace charging programs by geographically identifying where EV owners live and understanding that the average person drives 13.6 miles when commuting to work (according to the recognized clean transportation journal *Green Car Reports)*.[45]

Because this study's main focus is on recommendations for publicly available charging stations, it analyzed where current EVs are registered in Colorado and compared this information to nearby existing EV charging station locations, volume of traffic routes, and locations of points of interest or attractions. The recommendations in this section, in no particular order of importance, focus on three distinct opportunities. The first opportunity is to identify where the largest gaps exist in terms of number of EVs in a zip code and available EV charging stations. The second opportunity focuses on points of interest or attractions in or near these areas where there could be interest in EV charging stations. The last opportunity focuses distinctly on the concept of establishing an "Electrified Highway" in Colorado.

Assessment of Over-Saturated and Under-Saturated Areas by EV and Charging Station Count

Figure 8 displays a statewide map of EV concentration by zip code, along with existing public EV charging stations and traffic volumes. While smaller scales of specific areas are provided in later figures, Figure 8 highlights the density of EVs from Fort Collins to Colorado Springs and begins to shine a light on the areas with the lowest ratio of EV charging stations for every EV. It also outlines zip codes that have the highest density of EVs (>30), but have one or zero EV charging stations within that same zip code. This analysis resulted in 13 zip codes that meet these criteria. These areas are primarily around Denver and Boulder and represent specific focus areas for establishing new EV charging stations.

[44] U.S. Department of Energy, Alternative Fuels Data Center, Developing Infrastructure to Charge Plug-In Electric Vehicles, accessed January 2, 2014, http://www.afdc.energy.gov/fuels/electricity_infrastructure.html.
[45] Nikki Gordon-Bloomfield, Green Car Reports, "95% Of All Trips Could Be Made In Electric Cars, Says Study," January 13, 2012, http://www.greencarreports.com/news/1071688_95-of-all-trips-could-be-made-in-electric-cars-says-study.

Figure 8. EVs and EVSE in Colorado

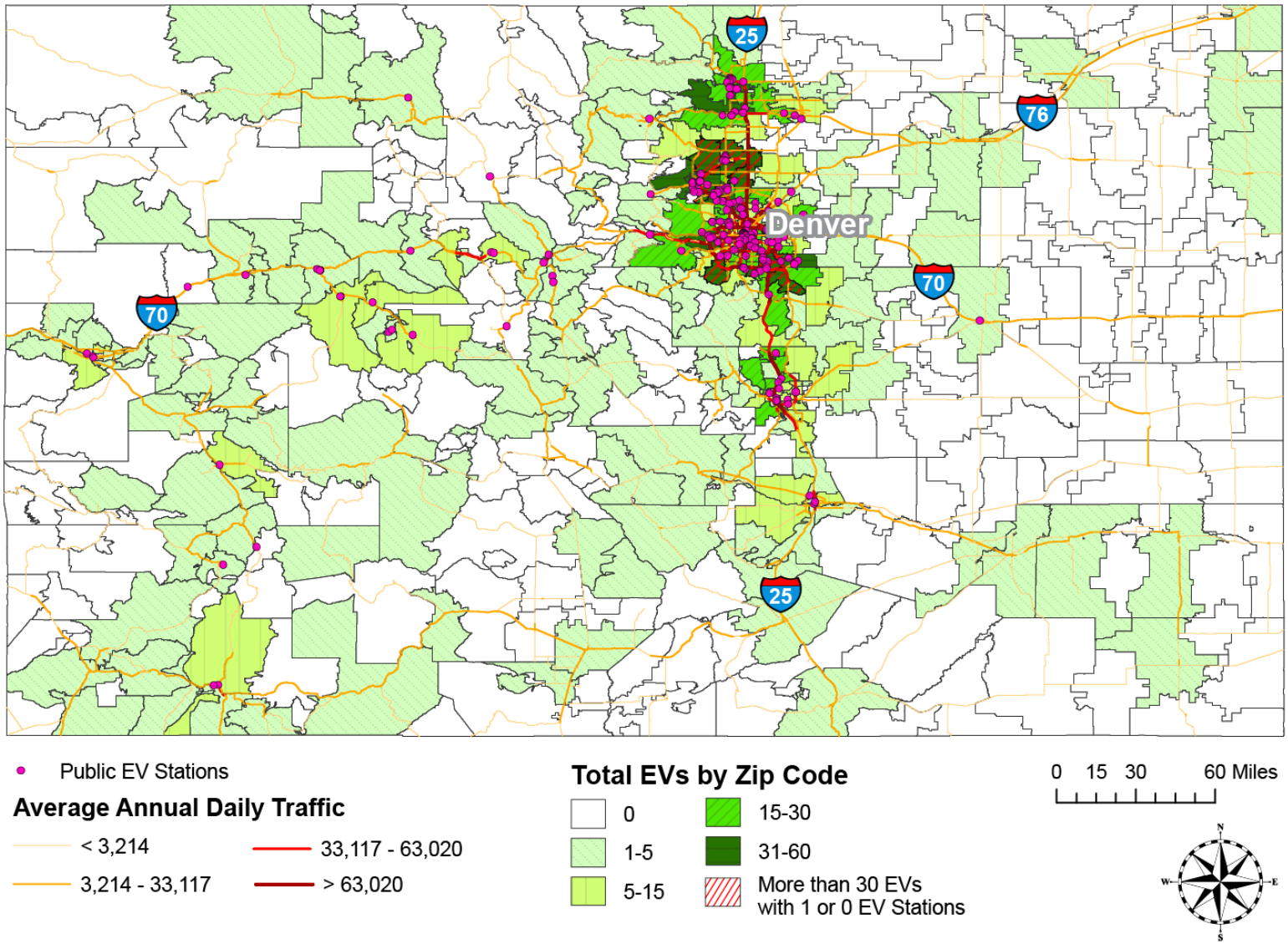


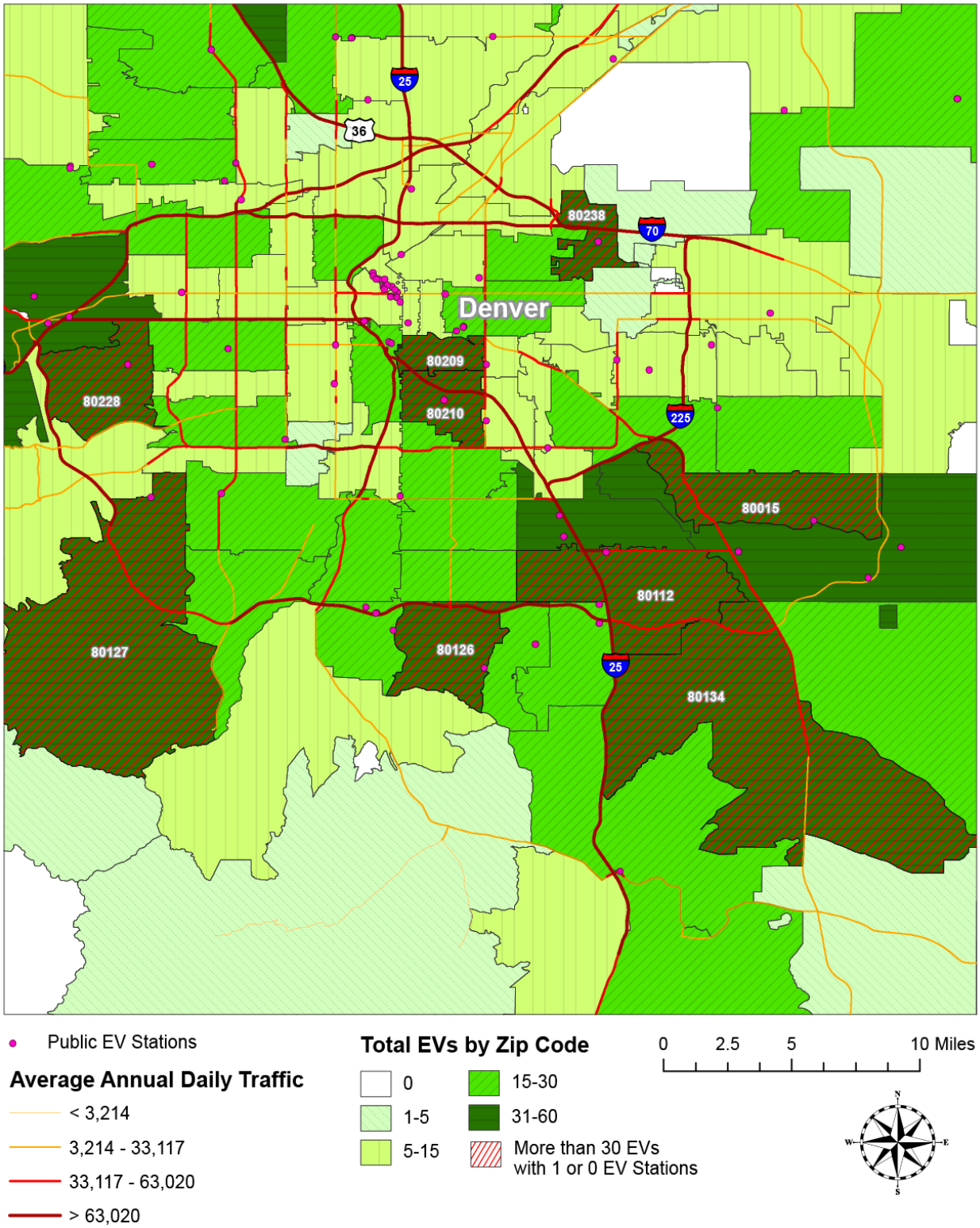
Figure 9 shows an enlarged map focusing on the nine zip codes near Denver where there is a large gap between EV registration and available EV charging stations. A study using data from the U.S. Department of Transportation's 2009 National Household Travel Survey (NHTS) identified that the average single-trip distance in the United States for drivers is only 5.95 miles from their home. In addition, the average distance in commuting to work is 13.6 miles.[46] Because the Department of Transportation conducts NHTS at odd intervals with multiple years in between (the previous survey was in 2001), the 2009 NHTS is the most recent publication.[47] With this in mind, it could be very impactful to focus on initially building up the EVSE infrastructure near where EV owners live and work. Despite having traffic volumes, this report does not provide assumptions on where EV owners work. Nonetheless, looking at existing EVSE infrastructure within and around the areas with the highest densities of EV registrations, it is evident that strengthening the EVSE infrastructure in these areas could be a priority.

This map also indicates roads with the heaviest volumes of traffic. Identifying agreeable businesses or other potential attractions near these more frequented routes in or near the zip codes identified above could be a primary strategy for expanding the Colorado EVSE in critical areas.

[46] Nikki Gordon-Bloomfield, Green Car Reports, "95% Of All Trips Could Be Made In Electric Cars, Says Study," January 13, 2012, http://www.greencarreports.com/news/1071688_95-of-all-trips-could-be-made-in-electric-cars-says-study.

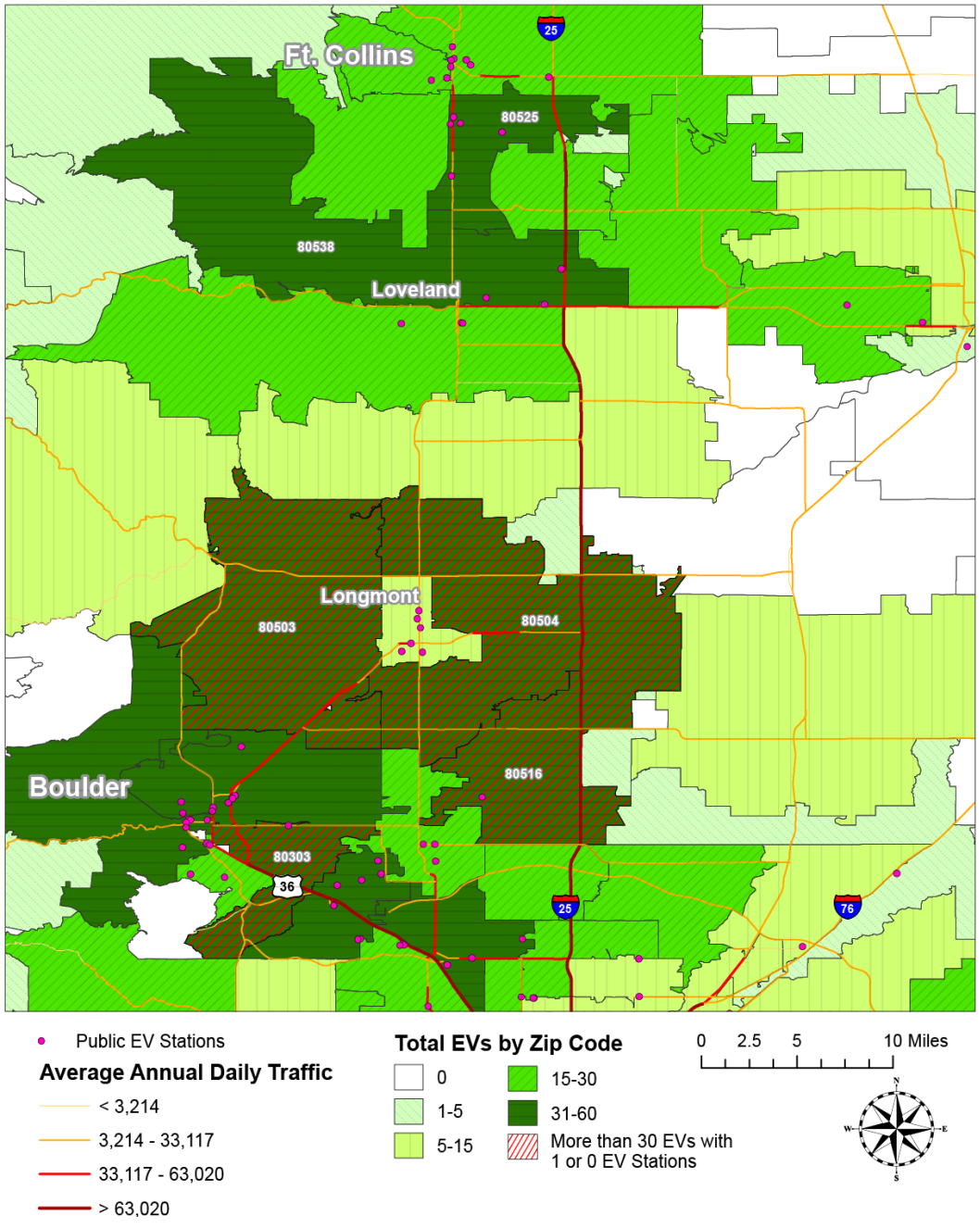
[47] U.S. Department of Transportation, 2009 National Household Travel Survey, accessed December 31, 2014, http://nhts.ornl.gov/introduction.shtml.

Figure 9. EVs and EVSE near Denver



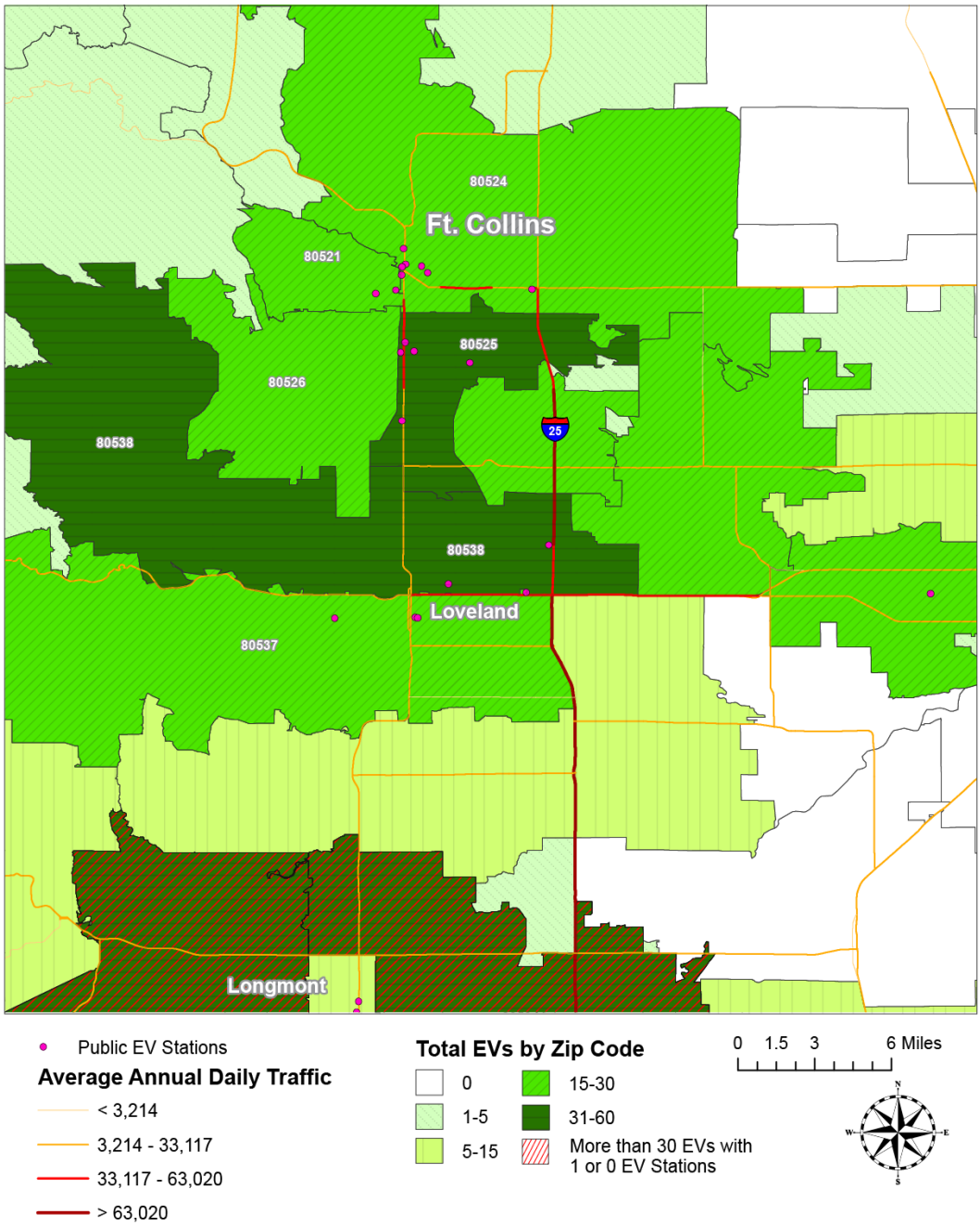
Similarly, in Figure 10, four zip codes near Boulder and Longmont have also been identified as areas with high number of EVs, yet few EV charging stations comparatively. These zip codes include the following:

Figure 10. EVs and EVSE near Boulder



Finally, Figure 11 shows the existing EV and EVSE in and near Fort Collins. Although there were no single zip codes that have more than 30 EVs with only 1 or 0 EV charging stations, there remains a strong concentration and thorough distribution of EVs through nearly all of the zip codes in and around Fort Collins. This concentration results in the publicly available EVSE still falling short of the recommended number of EV charging stations for every EV (per the Colorado Electric Vehicle and Infrastructure Readiness Plan). This map can be used to support the consideration of specific EVSE sites.

Figure 11. EVs and EVSE near Fort Collins



Assessment of Level of Charging Needed at Attractions

According to the 2012 *EV Project* conducted by ECOtality North American and the Idaho National Laboratory, more than 82% of all EV charging was done at the residence of the owner.[48] In this study, researchers collected and analyzed data to characterize vehicle use in diverse topographical and climate conditions, evaluated the effectiveness of charging infrastructure, and conducted trials of various revenue systems for commercial and public charging infrastructure. More than 71 million miles of driving data was collected through this project.

While workplace charging stations for employees would be an internal company-based decision, the other top-ranked locations are more attraction-based decisions. Charging stations can be free of charge or require a fee. Attraction-based locations serve as ideal locations within areas that already need more EVSE infrastructure. To this end, the figures 12–14 have added certain types of attractions to the maps provided in the previous section.

The attractions included in the maps include the following:

- Airports (Level I minimum charging type)
- Libraries (Level II minimum charging type)
- Museums (Level II minimum charging type)
- Courthouses (Level II minimum charging type)
- Recreation Centers (Level II minimum charging type)
- Stadiums (Level II minimum charging type)
- Trailheads (Level II minimum charging type)

This list does not include every potential type of location listed in the previous section because some of these (such as restaurants, hotels, and banks) are so numerous that including every location in a map would be detrimental to the usefulness and readability of the map.

While many of these attractions are typical, this project intentionally included trailheads as an idea. This focus could be a specific way Colorado encourages EVSE deployment, while recognizing and embracing attractions that make the state unique and influence residents' lifestyle. In addition, these are high traffic areas that fit into the promotion of Colorado's high quality of life and outdoor lifestyle. The following maps specifically focus on the Denver, Boulder, and Fort Collins areas, while acknowledging that ski areas are not located in this geographic region. In addition, ski areas and sports venues often have seasonal visitors. In the maps, zip codes are labeled for areas with more than 30 EVs and one or zero EV charging stations. The exception is in Figure 14 as there are no zip codes meeting these criteria. In this case, the most prominent and centralized zip codes around Fort Collins were labeled.

[48] SAE International, Battery Electric Vehicle Driving and Charging Behavior Observed Early in the EV Project". http://www.theevproject.com/downloads/documents/45.%20Battery%20Electric%20Vehicle%20Driving%20and%20Charging%20Behavior%20Observed%20Early%20in%20The%20EV%20Project%20(April%202012).pdf.

Figure 12. Attractions near Denver

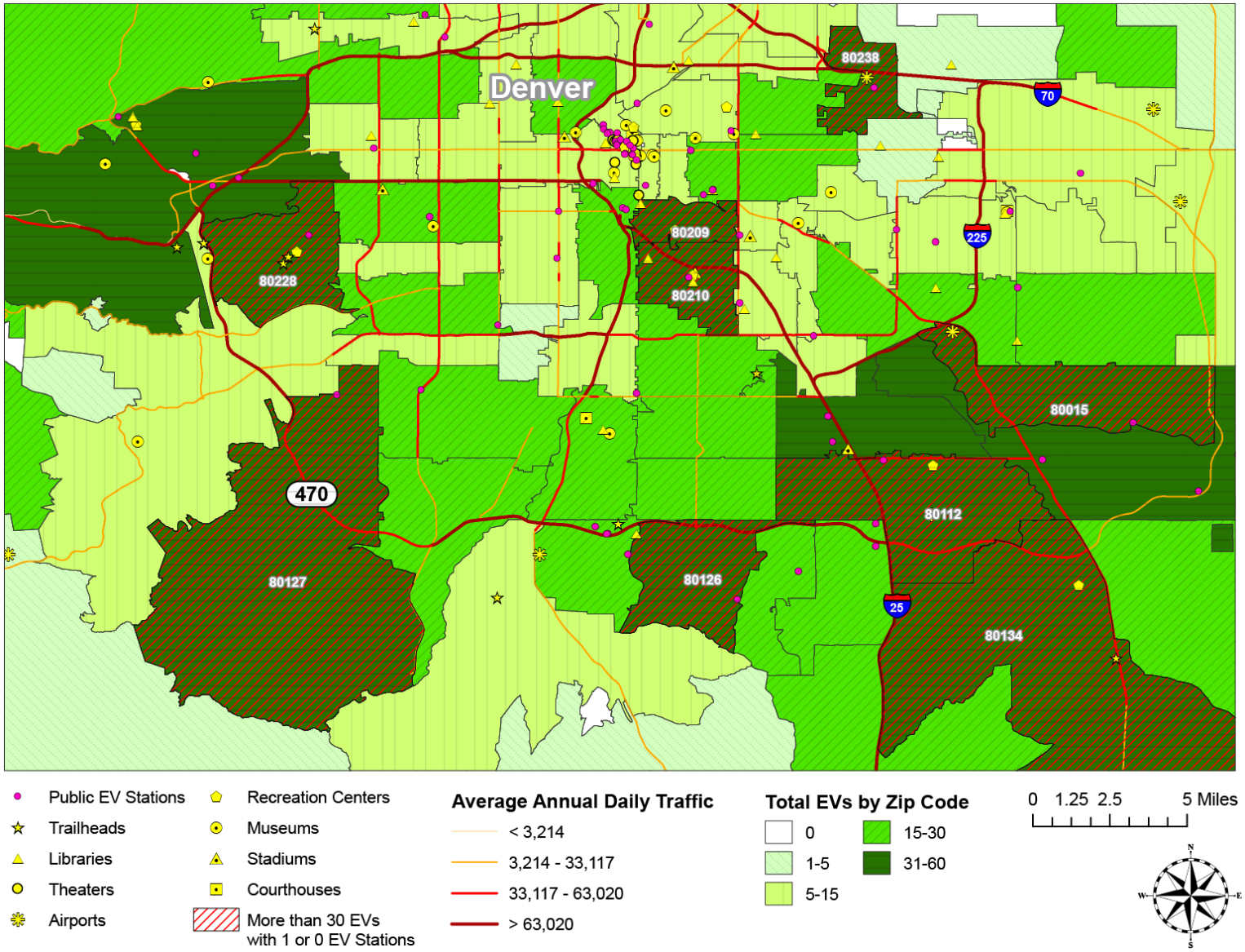


Figure 13. Attractions near Boulder

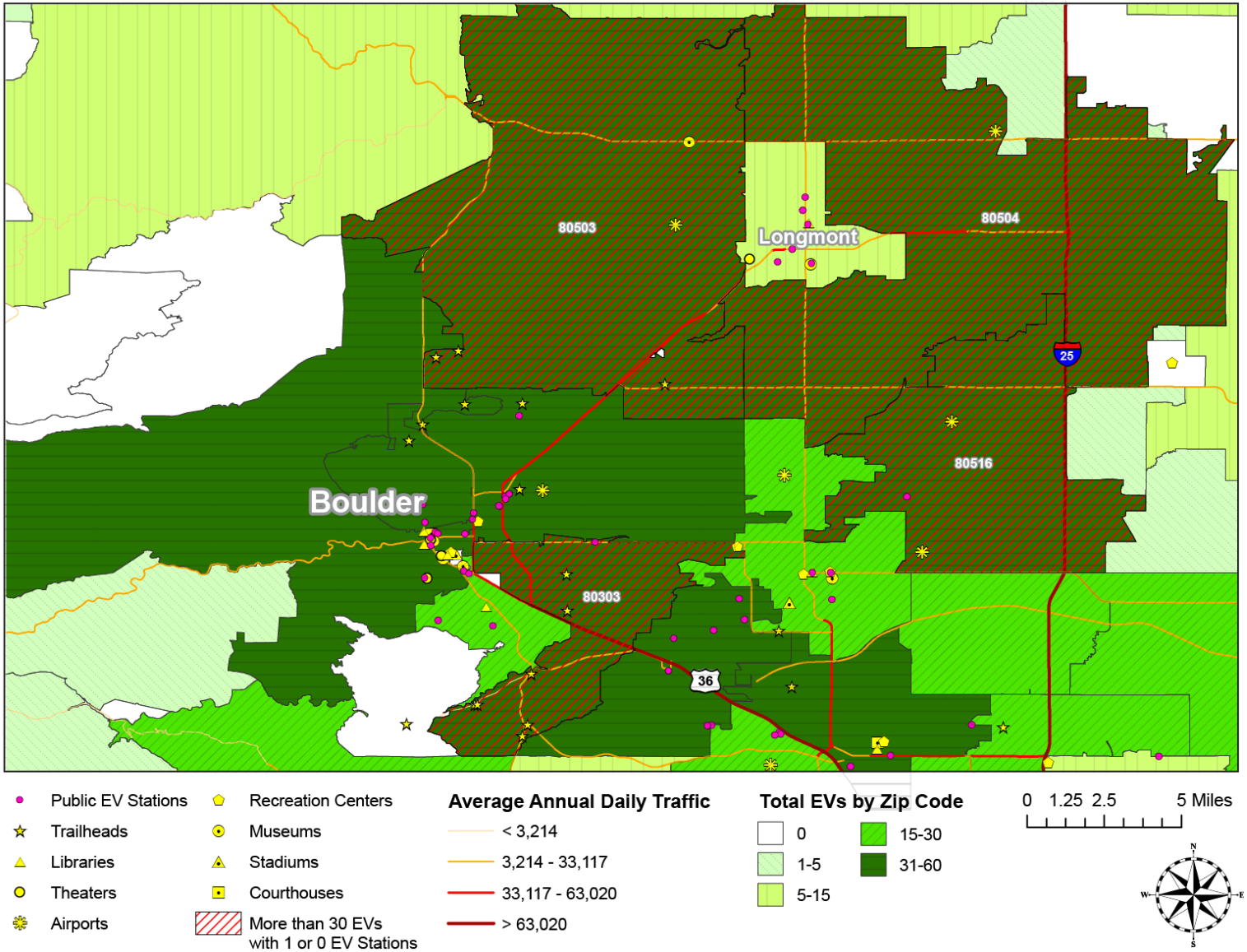
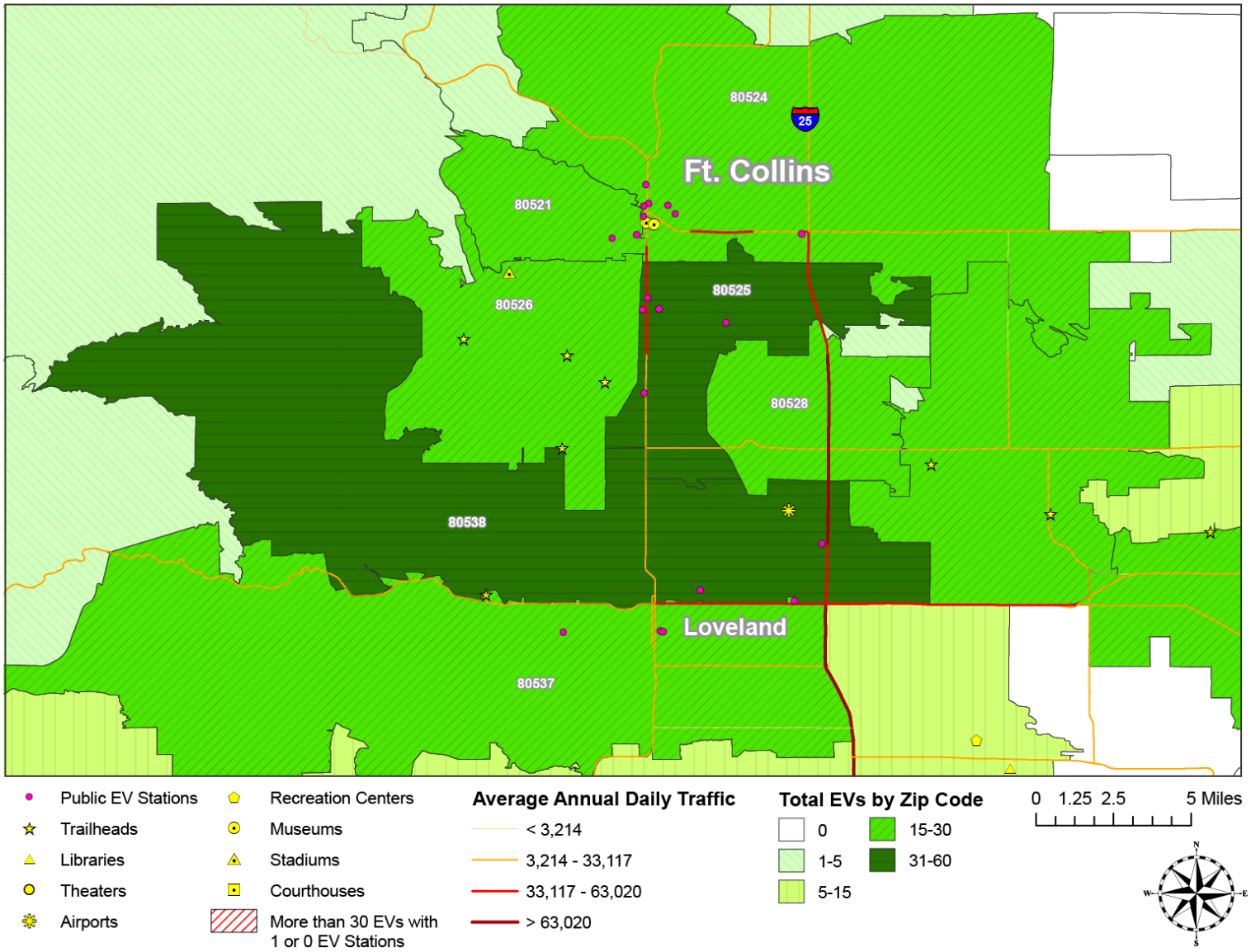


Figure 14. Attractions near Fort Collins



Recommendations for Types of Locations Best Suited for EV Charging

Dwell times, or the length of time spent by drivers at a location, will be the main criteria for which optimal levels of charging are judged. AC Level I EVSE (often referred to simply as Level I) provides charging through a 120-volt (V) AC plug and requires electrical installation per the National Electrical Code. Level I charging adds about 2–5 miles of range to a PEV per hour of charging time. Level II equipment (often referred to simply as Level II) offers charging through 240-V (typical in residential applications) or 208-V (typical in commercial applications) electrical service. Based on the vehicle and circuit capacity, Level II charging adds about 10–20 miles of range per hour of charging time. Direct-current (DC) fast-charging equipment, sometimes called DC Level III (typically 208/480-V AC three-phase input), enables rapid charging along heavy traffic corridors and at public stations. EVs equipped with either a CHAdeMO (which is the trade name of a quick charging method for battery electric vehicles delivering up to 62.5 kW of high-voltage direct current via a special electrical connector and stands for "CHArge de Move") or SAE (which is the charging standard from the Society of Automotive Engineers) DC fast charge receptacle can add 50–70 miles of range in about 20 minutes.[49] For example, while an airport might consider it valuable and cost effective to only install Level I charging, other attractions might recognize that their visitors do not stay more than eight hours. Restaurants, shopping centers, theaters, and recreational areas would be more suited to install Level II or Level III chargers.

In terms of charging equipment types and charging times, DOE provides the following information.[50]

Charging Type	Range Provided by Charging Time
Level I	2 to 5 miles per 1 hour
Level II	10 to 20 miles per 1 hour
Level III (or DC Fast Charging)	60 to 80 miles per 20 minutes

The *EV Project* results showed that while most EV charging is done at homes, 70% of the vehicles still took advantage of away-from-home charging opportunities.[51] This indicates the need for both publicly accessible and workplace charging stations, as the majority of EV drivers are taking advantage of their availability. With such a high number of drivers seeking charging outside of their residences, it indicates that workplace and public charging can break down the barriers of EV range anxiety and access to charging. The following is a chart from SWEEP, which used data from the Denver Regional Council of Governments to determine the public attractions in Colorado that have the longest dwell times.[52]

[49] U.S. Department of Energy, Alternative Fuels Data Center, "Developing Infrastructure to Charge Plug-In Electric Vehicles." http://www.afdc.energy.gov/fuels/electricity_infrastructure.html.

[50] U.S. Department of Energy, Alternative Fuels Data Center, "Developing Infrastructure to Charge Plug-In Electric Vehicles," http://www.afdc.energy.gov/fuels/electricity_infrastructure.html.

[51] SAE International, Battery Electric Vehicle Driving and Charging Behavior Observed Early in the EV Project". http://www.theevproject.com/downloads/documents/45.%20Battery%20Electric%20Vehicle%20Driving%20and%20Charging%20Behavior%20Observed%20Early%20in%20The%20EV%20Project%20(April%202012).pdf.

[52] SWEEP, "Policy Brief: Expanding the Electric Vehicle Grant Fund to the Private and Non-Profit Sectors," February 2014, http://www.swenergy.org/data/sites/1/media/documents/legislation/documents/EV_Infrastructure_Fund_Policy_Brief_Feb_2014.pdf.

Destination	Dwell time (minutes)
Ski Resorts	281
Pepsi Center/Stadiums	228
Universities	174
Outdoor Museums (Zoo, Botanical Garden)	161
Music/Theater Venues	158
Casinos	155
Bowling Alleys	154
Movie Theaters	135
Golf Courses/Tennis Courts	131
Museums	112
Ice Rinks	109
Soccer Fields	103
Churches	101
Recreational Centers	77
Yoga/Dance/Gymnastic Studios	77
Community and Senior Centers	76
Baseball Fields	75
Gyms	74
YMCA	72
Hiking Trailheads (State or National Park)	67
Hospitals	65
Martial Arts Studios	65
Swimming Pools	63
Bars	61
Sit down Restaurants (not fast food)	60
Local Parks	60
Health Facilities	55
Malls (shopping centers and department stores)	50
Hair and Nail Salons	45
Big Box Grocery Stores (Costco, Sam's Club)	40
Wal-Mart/Target	33
Government offices	32
Bookstores	30

Based on the charge provided per charging type, paired with dwell times in Colorado, the following is a general recommendation for the minimum level of charging type for specific types of locations listed in no order of priority. Level I or Level II may be best situated for workplace charging, depending on employee needs. Appendix I below provides more information about best practices for workplace charging.

Level I Charging

- Airports
- Home
- Hotels

Level II Charging

- Libraries
- Museums
- Public Buildings / Courthouses
- Recreation Centers
- Restaurants
- Shopping Centers
- Stadiums
- Trailheads

Level-3 Charging

- Banks
- Fast Food Restaurants
- Gas Stations
- Grocery stores
- Pharmacies
- Rest stops
- Stand-alone points on heavy traffic corridors (e.g. stations at strategic intervals as part of an "Electric Highway")

Recommendations for Colorado Electric Highway

Other regions of the United States have already developed electric highways through state-level planning and involving key partnerships with private entities within the highway corridors. The I-5 Electric Highway that has been developed with collaboration among the three West Coast states began with the State of Washington taking the lead in planning for EV fueling infrastructure.[53] Evidence of the success of the I-5 Electric Highway is seen in the usage of the charging stations. In the period between July 2014 and November 2014, the charging stations were accessed more than 1,400 times in Oregon alone.[54] In addition, the EIA recently reported in December 2014 on the progress of the I-5 Electric Highway. The agency stated that "Washington and Oregon now have about 5% and 4%, respectively, of the nation's total public charging stations, despite having only about 2% and 1% of the nation's total light-duty vehicles. From March 2012 through April 2014, PEV drivers recharged 17,917 times in Washington and 18,522 times in Oregon, mostly using fast chargers. Total kilowatt hours consumed were also similar: 154,881 in Washington and 153,256 in Oregon."[55]

The Washington State Department of Transportation (WSDOT) commissioned a study to determine how the state could support the selling of alternative fuels along the I-5 corridor in Washington, as this highway system was designated as a "Corridor of the Future" by the U.S. Department of

[53] West Coast Green Highway, "Electric Highways Project FAQs", http://www.westcoastgreenhighway.com/electrichighwayfaq.htm.

[54] "West Coast Electric Highway keeps cars humming along"; Russo, Edward; The Register-Guard, January 4, 2015. http://registerguard.com/rg/news/local/32603476-75/story.csp.

[55] U.S. Energy Information Administration, December 11, 2014, "Several states are adding or increasing incentives for electric vehicle charging stations", http://www.eia.gov/todayinenergy/detail.cfm?id=19151.

Transportation.[56] The study found that EV charging was an economically viable option due to the region's inexpensive electricity and the fact that capital requirements were relatively low.[57] WSDOT determined that the most effective approach for the installation of DC fast chargers was through retail locations to support local businesses and allow drivers to visit businesses while waiting for their cars to charge. WSDOT then helped to secure DOE funding from the State Energy Program (SEP) to begin what is now the "Electric Highway." The Washington State Department of Commerce has provided $1.6 million in SEP grants as seed funding for the project.[58] As the State of Colorado has successfully implemented multiple projects from SEP funds in prior years, future SEP programs could provide an avenue toward paying for the costs of an Electric Highway. WSDOT has developed partnerships with private business to support the implementation of the DC fast-charging network. With this initial groundwork in place, WSDOT began collaborating with the Oregon Department of Transportation's Innovative Partnership Office to develop standards for equipment and signage to ensure a consistent driving experience throughout the West Coast.

The ability for the three West Coast states to collaborate on the Electric Highway was aided by a tri-state memorandum of understanding involving Washington, Oregon, and California signed in September 2008.[59] In the memorandum, the three states agreed to collaborate on the development of an alternative fuel distribution network on the I-5 corridor.

More recently, an expanded EV charging infrastructure for the State of Washington has been supported by Executive Order 14-04 (Washington Carbon Pollution Reduction and Clean Energy Action), which was signed by Governor Jay Inslee on April 29, 2014. The Executive Order noted that "The Department of Transportation, in collaboration with federal, state, regional, and local partners, will develop an action plan to advance electric vehicle use, to include recommendations on targeted strategies and policies for financial and non-financial incentives for consumers and businesses, infrastructure funding mechanisms, signage, and building codes. The Department will continue to build out the electric vehicle charging network along state highways and at key destinations, as funding and partnerships allow."[60]

In addition to the I-5 corridor, Tennessee has developed an electric highway with a restaurant chain taking the lead in its implementation. Beginning in 2011, Cracker Barrel Old Store restaurants began the installation of 12 fast-chargers and additional Level II chargers at locations "in 'The Tennessee Triangle,' the 425-mile stretch of interstate highway that connects Nashville, Knoxville, and Chattanooga."[61,62]

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[56] 2008 Alternative Fuels Corridor Economic Feasibility Analysis, Parsons Brinkerhoff, January 23, 2009. http://www.wsdot.wa.gov/NR/rdonlyres/5C14E610-713A-4600-A88D-C567AF49D096/0/AltFuelsFinalReport.pdf.

[57] West Coast Green Highway, Electric Highways Project FAQs, http://www.westcoastgreenhighway.com/electrichighwayfaq.htm.

[58] West Coast Green Highway, Electric Highways Project FAQs, http://www.westcoastgreenhighway.com/electrichighwayfaq.htm.

[59] West Coast Green Highway, Partners, Tri-state agreement http://www.westcoastgreenhighway.com/partners.htm.

[60] State of Washington's Website, Office of the Governor, http://governor.wa.gov/office/execorders/documents/14-04.pdf.

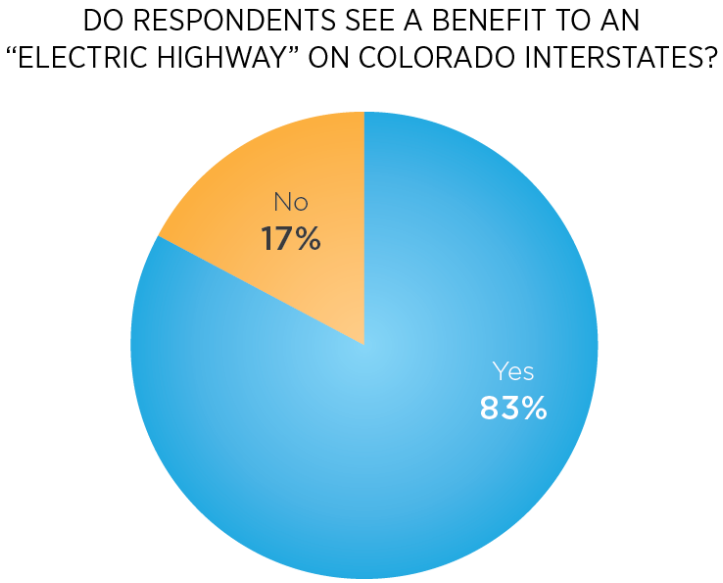
[61] Barnard, Jeff, Associated Press, in *Product Design & Development*, "First big piece of 'Electric Highway' gets juice', March 16, 2012, http://www.pddnet.com/news/2012/03/first-big-piece-electric-highway-gets-juice.

[62] Cracker Barrel Old Country, Press Release 10/31, 2011, " Popular Family Restaurant Chain Installs First of 12 Fast Chargers at Select Tennessee Locations Along the State's Main Highways," http://newsroom.crackerbarrel.com/article_display.cfm?article_id=3130.

Cracker Barrel has stated that the installation of charging stations is consistent with the company's roots of providing both food and gasoline fuel for guests that lasted up to the early 1970s.[63] In addition, Cracker Barrel believes that its customers will be interested in learning more about the stations and will look favorably upon their installation as helping the environment and strengthening the economy. The charging stations are part of the Blink Network, which requires applicable fees for members and non-members to access the stations.[64] More recently, Cracker Barrel has continued to support an expanded fast-charger network with the installation of chargers at four of its store locations in the Dallas-Ft. Worth area of Texas.[65]

Colorado is uniquely positioned in the Rocky Mountain region, with a growing market of EV adoption near both the I-70 and I-25 corridors that would suggest the State, along with private partners, could take the lead in developing a network of fast-charging stations that would involve planning with surrounding states. Through the collaboration with other states along these major interstate corridors, through both state energy offices and local Clean Cities Coalitions, Colorado's EV drivers would find traveling to other major regions of the United States possible without current concerns about the lack of convenient fast charging-stations.

Figure 15. Survey response on a Colorado Electric Highway



The survey administered to Colorado residents as part of this project asked, "Do you see a benefit to an "Electric Highway" on Colorado interstates, with fast-charging stations every 50 miles that would charge a battery to 80% in 30 minutes?" Of the 285 respondents, 83% answered "Yes," while only 17% answered "No." The opinions of the respondents combined with programs in other states support the importance of EV charging on highways in Colorado. An Electric Highway in Colorado could include both

[63] Cracker Barrel Old Country, , " Popular Family Restaurant Chain Installs First of 12 Fast Chargers at Select Tennessee Locations Along the State's Main Highways," Press Release 10/31, 2011 http://newsroom.crackerbarrel.com/article_display.cfm?article_id=3130.

[64] U.S. Department of Energy, Alternative Fuels Data Center, Electric Vehicle Charging Station Locations, accessed January 12, 2015, http://www.afdc.energy.gov/fuels/electricity_locations.html.

[65] Cracker Barrel Old Country, "Electric Vehicle Charging Stations – Texas", http://newsroom.crackerbarrel.com/press_kits.cfm?presskit_id=3.

I-25, running North-South across Colorado, and I-70, running East-West across the state. This concept could be similar to the "West Coast Electric Highway," which is a network of EV DC fast charging stations along I-5 in from Baja, California, through the Pacific Northwest, to British Columbia. This project involved coordination among WSDOT, the Oregon Department of Transportation, and a Governor's Office interagency group in California.[66] The West Coast Electric Highway established criteria for its DC fast-charging station locations to foster a consistent EV driving experience along the highway. The criteria included the following:[67]

- A station located every 25–50 miles
- All stations within ½ mile of the highway
- Safe and convenient access
- Parking spaces
- Restrooms and drinking water
- Shelter and lighting
- 480 volt 3-phase electric power supply
- Amenities (e.g., food and traveler information)

This study looked into the potential of developing an Electric Highway on both interstates in Colorado, as well as where EV charging stations could be located based on an established set of criteria. The criteria set for an Electric Highway included the following:

- Level III EV charging station
- Charging stations located no further than 50 miles apart
- Charging stations located no further than 1 mile from the interstate.

The length of I-25 across Colorado from the Wyoming border to the New Mexico border is approximately 299 miles. The length of I-70 across Colorado from the Kansas border to the Utah border is approximately 453 miles.

Using the above criteria and analyzing interstate exits with existing services and amenities, this report has identified an initial set of proposed station locations for consideration. The stations required to establish a full Electric Highway on both interstates resulted in the following:

- Proposing 9 level-3 charging stations along I-25
- Proposing 12 level-3 charging stations along I-70.

The map in Figure 16 below provides recommendations for locations for all 21 Level III charging stations across the state. The tables in figures 17 and 18 provide the location/exit number, distance from the previous station, and other notable businesses within that same 1-mile radius of the interstate exit. The recommended stations for both interstates have been numbered 1–21, without overlap, to facilitate discussions about specific stations.

These station locations were identified through an analysis identifying exits that have existing amenities within 1 mile of the interstate and within the 50-mile range of a station within either direction. If more

[66] West Coast Green Highway, West Coast Electric Highway, accessed December 30, 2014, http://www.westcoastgreenhighway.com/electrichighway.htm.

[67] Washington State Department of Transportation, "Pacific NW Collaboration to Develop the West Coast Electric Highway," page 13, September 19, 2012, http://wstc.wa.gov/Meetings/AgendasMinutes/agendas/2012/September19/documents/2012_0919_BPI_WSDOTEV.pdf.

than one location met the criteria, then the analysis looked into the locations that had more amenities and nearby attractions that could make for a better charging environment.

The first step was to identify existing Level III charging stations that could be incorporated in the Electric Highway concept. Only four Level III stations were included, with three located in Denver and one in Centennial. While the three stations in Denver were just over 1 mile from I-25, they were included as existing stations that could be used. These were included in the tables in Figure 17 as Station 3 and Station 4.

This means that 19 of the 21 stations needed to develop a full Electric Highway do not exist. Assuming each Level III charging station would cost $50,000,[68] it is implied that it could cost approximately $950,000 for full implementation. It could cost around $350,000 to develop the remaining stations on I-25, while it could cost around $600,000 to develop the 12 stations across I-70.

The cost to private businesses or cities interested in installing a station as part of the Electric Highway could potentially be subsidized by the Colorado Charge Ahead program or another separately created grant or revolving loan program. Additionally, the state could coordinate with Level III/DC fast-charging equipment providers and payment platform companies that would be interested in being involved in the development of an Electric Highway in Colorado. These companies could assist in outreach and marketing to businesses. The market case for private businesses exists, as many have already elected to do so around the country. For example, the Kroger grocery chain announced in 2013 its plans to add 200 Level II chargers and 25 DC fast chargers to store locations around the country.[69] McDonald's has also added more than 30 DC fast charging stations to stores around the country.[70] Involving third-party equipment producers and payment platforms providers in this process could act in a similar business model as Redbox (the standalone movie rental units), allowing businesses to install equipment and conduct business onsite for a regular fee or a portion of the profits. This would reduce the risk and upfront capital required by the business or landowner.

When considering building out an Electric Highway, it might be most valuable to begin with the most traveled portions of the interstates that could have high value—regardless of the completion of a full Electric Highway. This would include focusing on stations 1–6 on I-25 between Fort Collins and Colorado Springs and stations 14–18 on I-70 between Denver and Edwards. The level of average annual daily traffic on these, and other, portions of the interstates was previously shown in Figure 8.

Figure 16 displays the locations of the recommended stations, as well as the city names in which they are located. This map also displays the existing Tesla stations along I-70 and in Centennial, but these chargers are Tesla-specific, which means they are not able to fast charge other EV brands. Nonetheless, these existing Tesla locations could be considered for potential locations for adding Level II chargers.

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[68] Rocky Mountain Institute, "Pulling Back the Veil on EV Charging Station Costs," April 29, 2014, http://blog.rmi.org/blog_2014_04_29_pulling_back_the_veil_on_ev_charging_station_costs.

[69] Plugincars.com, Jim Motavalli, "EV Charging at Supermarkets: Shoppers Double Browsing Time, ECOtality Says," April 17, 2013, http://www.plugincars.com/case-supermarket-chargers-shoppers-double-their-browsing-time-ecotality-says-126998.html.

[70] Green Car Reports, Antony Ingram, "Fast Food & Fast Charging For Electric Cars: The Perfect Combination Meal?," April 23, 2014, http://www.greencarreports.com/news/1083714_fast-food-fast-charging-for-electric-cars-the-perfect-combination-meal.

Figure 16. Recommended Level III EV charging station locations for an Electric Highway

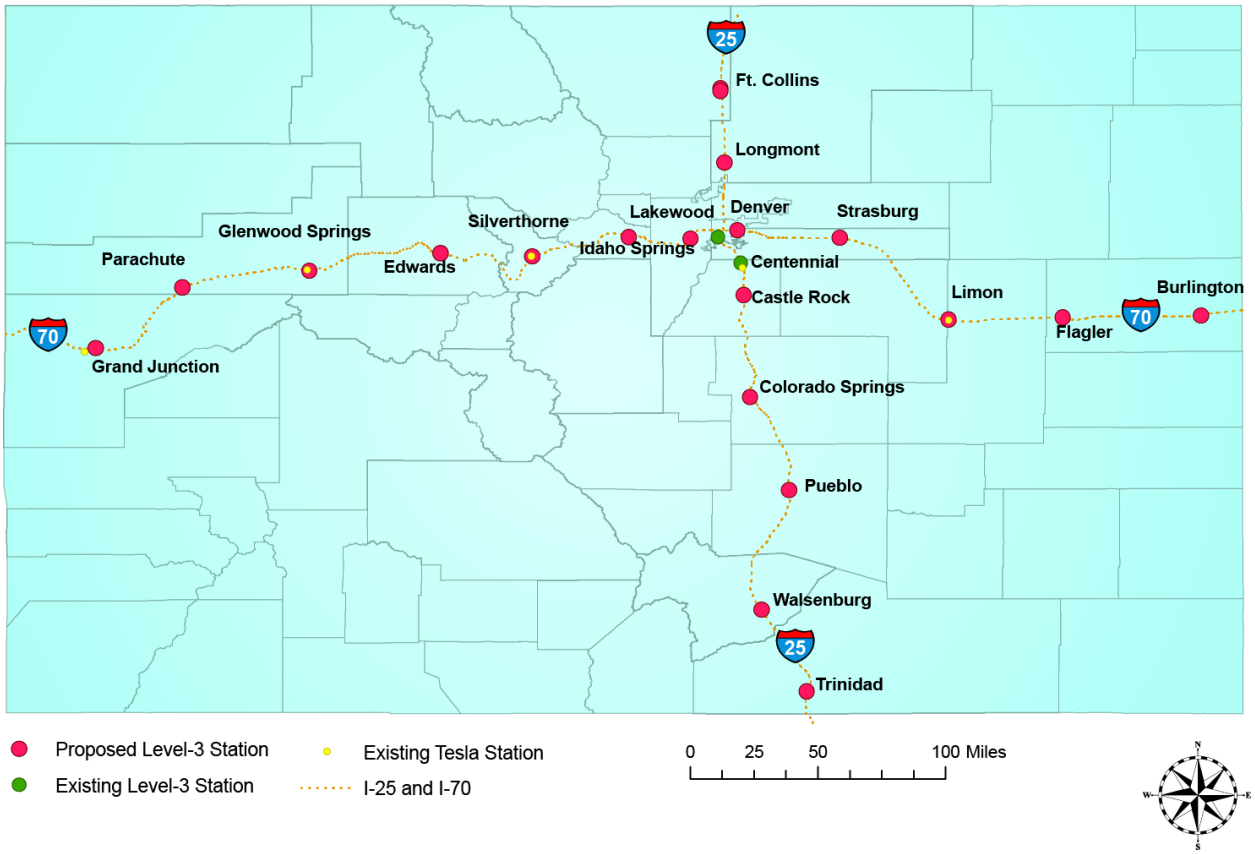


Figure 17. Recommended Electric Highway EV charging station locations along I-25 from north to south

Station	Exit / Location	Distance from Previous Station	Other Notable Businesses within 1-Mile Radius
Station 1	Exit 269 at Mulberry St. in Fort Collins Alternative option could be Colorado Welcome Center at Exit 268	About 41 miles from Cheyenne, Wyoming and 29 miles from the Wyoming border	• Multiple hotels • The Edge Sports Center • Restaurants (e.g., Hacienda Real Family Mexican) • Shopping (e.g., American Furniture Warehouse) • New Belgium Brewing
(Optional) Station 1.5	Exit 257/The Promenade Shops at Centerra	12 miles from Station 1	The Promenade Shops at Centerra
Station 2	Exit 240 near Longmont	29 miles from Station 1	• Multiple fast food restaurants • Shopping (e.g., American Furniture Warehouse and Home Depot) • Hotel
Station 3	Denver	19–40 miles from	Denver already has three Level III

Station	Exit / Location	Distance from Previous Station	Other Notable Businesses within 1-Mile Radius
		Station 2	charging stations within 1–2 miles of I-25: • AutoNation Nissan at Exit 221 • Denver Performing Arts Center at Exit 210 • Cultural Center Complex at Exit 210
Station 4	Exit 197 at Centennial	3–24 miles from Denver / Station 3	• AutoNation Nissan already has a Level III charging station within 1 mile of I-25 • Multiple fast food restaurants
Station 5	Exit 184 at Castle Rock	About 30 miles from Denver / Station 3	• The Outlets at Castle Rock • Multiple restaurants • Grocery stores
Station 6	Colorado Springs (any exit)	About 43 miles from Station 5	• Multiple options depending on the exit
Station 7	Exit 101 at Pueblo	About 43 miles from Station 6	• Pueblo Mall • Movie theater • Shopping (e.g., Barnes & Noble, Hobby Lobby, and Home Depot) • Grocery stores • Multiple fast food restaurants
Station 8	Exit 50 at Walsenburg	About 51 miles from Station 7	• Walsenburg Mining Museum • Walsenburg City Hall • Restaurants • City park (Fiesta Park) • Grocery store
Station 9	Exit 13 at Trinidad	About 31 miles from Station 8 and about 14 miles from the border of New Mexico	• Multiple fast food restaurants • Restaurants • City parks (Central Park and Cimino Park) • Grocery store

Figure 18. Recommended Electric Highway EV charging station locations along I-70 from east to west

Station	Exit / Location	Distance from Previous Station	Other Notable Businesses within 1-Mile Radius
Station 10	Exit 437 at Burlington	About 13 miles from the Kansas border	• Multiple restaurants • Multiple hotels • City park (Parmer Park)
Station 11	Exit 395 at Flagler	42 miles from Station 10	• Diner • Flagler Town Park

Station	Exit / Location	Distance from Previous Station	Other Notable Businesses within 1-Mile Radius
Station 12	Exit 359 at Limon	35 miles from Station 11	• Multiple restaurants • Hotel
Station 13	Exit 310 at Strasburg	49 miles from Station 12	• Restaurants • Comanche Crossing Museum
Station 14	Exit 278 at Denver	31 miles from Station 13	• Shops at Northfield • Restaurants • Movie Theater • Northfield Pond Park
Station 15	Exit 262 at Lakewood	17 miles from Station 14	• Colorado Mills Mall • Restaurants • Movie Theater • Hotels • Grocery Stores
Station 16	Exit 240 at Idaho Springs	22 miles from Station 15	• Restaurants (e.g., BeauJo's and Tommyknocker Brewpub) • Shopping • Clear Creek Ranger District Center
Station 17	Exit 205 at Silverthorne	34 miles from Station 16	• Outlets at Silverthorne • Hotels • Restaurants • Rainbow Park • Silverthorne Recreation Center
Station 18	Exit 163 at Edwards	43 miles from Station 17	• Restaurants • Shopping • Coffee Shops • Movie Theater • Breweries
Station 19	Exit 116 at Glenwood Springs	47 miles from Station 18	• Restaurants • Shopping • Hot Springs • Brewery • Two Rivers Park
Station 20	Exit 75 at Parachute	41 miles from Station 19	• Restaurants • Golf course • Hotel
Station 21	Exit 31 at Grand Junction	About 44 miles from Station 20 and 31 miles from the border of Utah	• Multiple hotels • Grand Junction Visitor Center • Multiple restaurants

Electric Vehicle Programs, Policies, Marketing, and Outreach

Researchers conducted a policy inventory to determine the applicable laws, programs, and incentives that are in place to further the EV market. It is important to have an understanding of the existing policy network to identify gaps, address common concerns using best practices from other states, and determine the impact of these current and future strategies.

Assessment of Colorado Programs and Policies

This section covers the established programs and policies throughout Colorado that encourage or incentivize EV adoption and establish a unique fee for EV owners. The tables attempt to identify ongoing, formal efforts, rather than "one-off" decisions by state agencies or cities to purchase EVs or fund charging stations. Appendix D shows a timeline that illustrates the implementation progression of these laws at the state level.

Figure 19. Inventory of policies and programs in Colorado

Policy/Program	Agency	Overview	Barrier(s) Addressed
Colorado Innovative Motor Vehicle Tax Credit	Colorado Department of Revenue	Tax credits for new EVs and PHEVs are "equal to the actual cost incurred to purchase or lease the vehicle, multiplied by the battery capacity, and divided by 100. That amount must be multiplied by a factor to determine the credit amount, as follows: 1.0 for 2014–2018, 0.75 for 2019, 0.50 for 2020, and 0.25 for 2021."[71] "In general, the amount of credit that can be claimed for a vehicle purchase, lease, or conversion is limited to $6,000."[72] Annual credit caps exist for each technology type and vehicle weight class, as well as for cumulative annual credits.	Vehicle cost

[71] U.S. Department of Energy, Alternative Fuels Data Center, "Alternative Fuel, Advanced Vehicle, and Idle Reduction Technology Tax Credit," http://www.afdc.energy.gov/laws/5246.
[72] Colorado Department of Revenue, Taxpayer Service Division, "Income 67: Innovative Motor Vehicle and Alternative Fuel Vehicle Credits," May 2014, http://www.colorado.gov/cms/forms/dor-tax/Income67.pdf, p. 2.

Policy/Program	Agency	Overview	Barrier(s) Addressed
Charge Ahead Colorado Program	CEO and the Regional Air Quality Council (RAQC)	Outside of the seven-county Denver metro area, CEO funds 80% of EVSE cost up to $6,260 per installation. Within the seven-county Denver metro area, RAQC funds 80% of EVSE costs up to $6,260 per installation. RAQC also funds up to 80% of incremental cost differences for an EV up to $8,260 per vehicle for those excluded from state tax credits.	Range anxiety Vehicle cost Charging access Cost of charging station
ALT Fuels Colorado Program	CEO, RAQC, the Colorado Department of Transportation, and Colorado Department of Local Affairs	Grant funding for both alternative fueling infrastructure (via CEO) and alternative fueling vehicles (via RAQC) that will total approximately $30 million from 2014–2017.[73] Vehicle grants will focus on areas in Colorado's ozone nonattainment and carbon monoxide maintenance areas.	Range anxiety Vehicle cost Charging access Cost of charging station
Refuel Colorado Website and Refuel Colorado Fleets	CEO, Clean Energy Economy for the Region, Clean Cities and 4CORE	Refuel Colorado is an effort by CEO to encourage the adoption of alternative fuel vehicles in Colorado to lead a cheaper, cleaner, domestic transportation future. Refuel Colorado is an effort to provide businesses and consumers the technical information they need to assess the pros and cons of alternative fuel vehicles.	Information regarding vehicle costs and benefits Communications
Low-Emission Vehicle Sales Tax Exemption	Colorado Department of Revenue	Alternative fuel vehicles that weigh more than 10,000 pounds are exempt from Colorado sales and use tax. City and local sales tax exemptions vary.[74]	Vehicle cost
HOV Lane Exemption	Colorado Department of Transportation	A regulated permit process issues 2,000 permits to applicants with hybrids, EVs, and other alternative fuel vehicles allowing them to travel	Air emissions

[73] Clean Air Fleets, "ALT FUELS COLORADO: Fact Sheet," August 2014, www.cleanairfleets.org/wp-content/uploads/2014/08/Alt-Fuels-Colorado-Fact-Sheet-2.pdf.

[74] Colorado Department of Revenue, "FYI Sales 91: State Sales and Use Tax Exemption for Low-Emitting Heavy Vehicles," February 2013, https://www.colorado.gov/pacific/sites/default/files/Sales91.pdf.

Policy/Program	Agency	Overview	Barrier(s) Addressed
		in HOV and high-occupancy toll lanes.	
EVSE Multi-Unit Dwelling Installations and Access	Colorado Department of Revenue	Tenants are allowed to install Level I or Level II EVSE at a leased premise at their own expense. The landlord may require reimbursement for the cost of electricity, as well as the cost of installation or upgrades to existing equipment. The landlord can charge a fee for use of parking space if EVSE is placed in a parking area otherwise accessible to other tenants.[75] These actions will make charging accessible to key demographics for the EV market, such as wealthier and older citizens that may have downsized their home into a downtown condo.	Charging access Convenience of charging
Plug-In Electric Vehicle Fee	Colorado Department of Revenue	Beginning January 1, 2014, an annual $50 fee is collected at the time of registration on every PEV, $20 of which goes to funding charging stations with the rest supporting the highway users tax fund.[76]	Charging Access
Alternative Fuel Resale	Colorado Public Utilities Commission	The resale of electricity is allowed for alternative fuel vehicles (e.g., from charging stations) without the provider being regulated as a public utility.[77]	Charging access Convenience of charging
Lifecycle Performance Contracting for Government Fleets	Colorado Department of Revenue	Colorado government agencies can finance or lease alternative fuel vehicles through energy performance contracts, where the savings from fuel and maintenance costs pay for	Initial vehicle cost Cost of charging station

[75] LexisNexis, Colorado Revised Statutes, C.R.S. 38-12-601 (2014), http://www.lexisnexis.com/hottopics/colorado/?app=00075&view=full&interface=1&docinfo=off&searchtype=get&search=C.R.S.+38-12-601.

[76] LexisNexis, Colorado Revised Statutes, C.R.S. 42-3-304 (2014), http://www.lexisnexis.com/hottopics/colorado/?app=00075&view=full&interface=1&docinfo=off&searchtype=get&search=C.R.S.+42-3-304.

[77] U.S. Department of Energy, Alternative Fuels Data Center, "Alternative Fuel Resale and Generation Regulations," http://www.afdc.energy.gov/laws/10014.

Policy/Program	Agency	Overview	Barrier(s) Addressed
		the capital investment over the life of the vehicle.[78]	
State Agency Alternative Fuel Use and Vehicle Acquisition Requirement	The Colorado Department of Personnel and Administration	State agencies are required to purchase plug-in electric, natural gas, or other alternative fuel vehicles for the state fleet whenever the life-cycle cost is 10% less than the cost associated with a conventional counterpart.[79]	Initial vehicle cost
Alternative Fuel Vehicle (AFV) Registration	Colorado Department of Revenue	Upon registering, the vehicle owner must fill out the appropriate form to report the type of alternative fuel used to operate the vehicle.[80]	Communication/ Information gathering

Municipal-Level EV Policies and Programs

Policy/Program	Agency	Overview	Barrier(s) addressed
SmartGrid Plug-In Vehicles Project	City of Boulder	This project provides a $500,000 grant from DOE to increase EVs, study how smart grid can be used in charging EVs, and collect/report data to measure and share findings and results. Project included installing 12 charging stations.[81]	Communication/Information gathering Charging access
Registration Rebate	City of Aspen	Provides a $100 registration rebate for EVs and hybrid vehicles.[82]	Vehicle cost

[78] U.S. Department of Energy, Alternative Fuels Data Center, "Vehicle Fleet Maintenance and Fuel Cost-Savings Contracts," http://www.afdc.energy.gov/laws/11490.
[79] U.S. Department of Energy, Alternative Fuels Data Center, "State Agency Alternative Fuel Use and Vehicle Acquisition Requirement," http://www.afdc.energy.gov/laws/5619.
[80] U.S. Department of Energy, Alternative Fuels Data Center, "Alternative Fuel Vehicle (AFV) Registration," http://www.afdc.energy.gov/laws/5887.
[81] City of Boulder, "SmartGrid Plug-In Vehicles Project," https://bouldercolorado.gov/public-works/electric-vehicles-and-charging-stations.
[82] The City of Aspen and Pitkin County, Traffic and Motor Vehicles, page 27, http://www.aspenpitkin.com/Portals/0/docs/City/clerk/municode/COAspenT24.pdf.

Utility-Level EV Policies and Programs

Policy/Program	Agency	Overview	Barrier(s) addressed
Electric Vehicle Charging Station Pilot Program	Xcel Energy	A special pilot program that closed enrollment in September 2014. The participating EV owners can earn a bill credit in exchange for allowing Xcel to interrupt their vehicle charging for a limited number of hours throughout the year.[83]	Charging access
Public Use Charging Stations	Fort Collins Utilities	As a partner in the Drive Electric Northern Colorado initiative, Fort Collins Utilities has installed three Level II charging stations and one Level III charging stations for public use with assistance from Charge Ahead Colorado. [84]	Charging access

Other EV Policies and Programs

Policy/Program	Agency	Overview	Barrier(s) addressed
Drive Electric Northern Colorado	A partnership of Electrification Coalition, the City of Fort Collins, the City of Loveland, and Colorado State University	Holding test drive events and performing educational outreach.	Information regarding vehicle costs and benefits
Project FEVER	Statewide collaboration across industries and stakeholders	Provide research and analysis to identify market barriers to EV penetration, as well as strategies to overcome them.[85]	Vehicle range Vehicle cost Charging Access Communications

[83] Xcel Energy, "Electric Vehicle Charging Station (EVCS) Pilot Program," http://www.xcelenergy.com/Save_Money_&_Energy/Rebates/Electric_Vehicle_Charging_Station_Pilot_Program_-_CO.
[84] City of Fort Collins, "Electric Vehicles," http://www.fcgov.com/utilities/sustainability-leadership/EVs.
[85] The Electric Ride, "About Us," http://www.electricridecolorado.com/about_us/partners.

Policy/Program	Agency	Overview	Barrier(s) addressed
			Convenience of charging
Denver Clean Cities Coalition	DOE	Works with vehicle fleets, fuel providers, community leaders, and other stakeholders to reduce petroleum use in transportation.[86]	Vehicle range Vehicle cost Charging Access Communication
Northern Colorado Clean Cities Coalition	DOE	Works with vehicle fleets, fuel providers, community leaders, and other stakeholders to reduce petroleum use in transportation.[87]	Vehicle range Vehicle cost Charging Access Communication
Southern Colorado Clean Cities Coalition	DOE	Works with vehicle fleets, fuel providers, community leaders, and other stakeholders to reduce petroleum use in transportation.[88]	Vehicle range Vehicle cost Charging Access Communication

Recommendations for EV Programs

Through an assessment of Colorado's current EV policies and programs, this section proposes practical recommendations for the State of Colorado to consider modifying existing State programs and developing new initiatives. These recommendations provide an effective blueprint to guide the State in continuing cost-effective strategies that will overcome EV adoption barriers and ensure that it is on a solid path to achieve economic development and environmental benefits through near-term planning of EV adoption. This section also suggests new programming and policy solutions based on a review of other regions and states in the nation, along with a review of other countries with effective EV adoption policies and programs.

In Figure 20, a summary of the key recommendations for modifying Colorado's current EV programs provides important context for new policy and program recommendations (which are evaluated later in the section).

[86] U.S. Department of Energy, Clean Cities Coalitions, accessed December 18, 2014, http://www.afdc.energy.gov/cleancities/coalitions/coalition_locations.php.
[87] U.S. Department of Energy, Clean Cities Coalitions, accessed December 18, 2014, http://www.afdc.energy.gov/cleancities/coalitions/coalition_locations.php.
[88] U.S. Department of Energy, Clean Cities Coalitions, accessed December 18, 2014, http://www.afdc.energy.gov/cleancities/coalitions/coalition_locations.php.

Figure 20. Recommendations to enhance current Colorado EV programs

Current Program	Recommendation	Barriers(s) Addressed
Charge Ahead Colorado	As of January 2015, the Charge Ahead Colorado program has funded 100 charging stations and 19 electric vehicles. This is a significant achievement, as there were only approximately 70 EVSE locations in place when the program began in 2013. In addition to existing outreach efforts, the program (with resources from both staff and members of the steering committee) could target applications from businesses and organizations in areas it determines to be a priority. The successful program model uses minimal staff resources and leverages partnerships to see results. In order to keep costs low and maximize the limited bandwidth of staff, Charge Ahead Colorado team members can partner with EVSE vendors to target strategic regions as part of their marketing efforts—as EVSE vendors specialize in sales and customer service. Possible entry points into this market could include local Chambers of Commerce or management companies that own and operate retail/business space. The maps provided within the *EV Market Implementation Study* offer guidance to zip code, type of attraction, or highway exit number. Figure 9 shows an enlarged map focusing on the nine zip codes near Denver where there is a large gap between EV registration and available EV charging stations. These zip codes include 80015, 80112, 80126, 80127, 80134, 80209, 80210, 80228, and 80238. Figures 17 and 18 also recommend specific highway exits and nearby businesses by name that could be approached for Level III charging as part of a future Electric Highway. These recommendations could result in a more effective, rapid, and strategic EVSE deployment.	Vehicle range Vehicle cost Cost of charging station Charging access Communications Information gathering Convenience of charging
Charge Ahead Colorado	The current incentive level is no greater than $6,260, regardless of charging type. Given the cost disparity between developing a Level II charging station (~$10,000) and Level III charging station (~$50,000), it could be effective to differentiate the incentives for specific types of charging stations. For example, the incentive could be tiered—increasing with each progressively more expensive charging station type (e.g., continuing to offer $6,260 for Level II and offering $12,520 for Level	Vehicle range Cost of charging station Access to charging Convenience of charging

Current Program	Recommendation	Barriers(s) Addressed
	III). Alternatively, the funds could be divided into separate use categories, where Level II projects are competing against other Level II charging programs, and Level III fast chargers were being evaluated against other Level III charging operations. CEO could also analyze incentives to install EVSE that offer a pedestal with more than one charge point. Staff should find a way to determine the amounts that make fiscal sense for the program while properly weighting and incentivizing different levels of risk and investment.	Communications
Refuel Colorado	Refuel Colorado began in the first quarter of 2013 and will conclude successful operations in the third quarter of 2015. CEO may see the benefit in using the Refuel Colorado Fleets element of this program as a mechanism for providing technical assistance and information to fleets in Colorado who wish to transition to the use of alternative fuels and vehicles. The templates and formulas used for the fleet portion of the program should be updated when new data is available to stay relevant. The website portion of the program has a great deal of value and should be kept current for consumers.	Cost of vehicle Cost of charging station Communications/ Information gathering
Coordination of Programs via Websites	The different organizations in Colorado need to increase coordination in promoting EVs. Many programs, such as Refuel Colorado, the Regional Air Quality Council, Drive Electric Northern Colorado, Project FEVER (Electric Ride), various Clean Cities coalitions, and others, have very similar goals and interests. While the efforts of these groups working together have been successful, it can be unclear to the non-industry audience what each group's role is in the market. This "stove-piping" of efforts can be confusing for uninformed Coloradans trying to navigate the various websites for information on EVs.	Communications
HOV Lane Exemption	As the number of EVs grow each year, this program's cap of 2,000 permits annually could increasingly become an issue and cause frustration among EV and hybrid owners. However, existing contracts between vendors and the Colorado Department of Transportation will make it difficult to grow the program in the future. If the program is not able to expand the number of available permits to include all or most EVs, an alternative could be	Convenience

Current Program	Recommendation	Barriers(s) Addressed
	considered. For example, the program could be revised so that an HOV lane decal is only valid for three years and then revoked in order for other alternative fuel vehicles to have the opportunity to participate.	

In the near term, the recommendations for existing programs provided in Figure 20 will be important to implement to ensure that the State is a leader in EV adoption and is making progress in overcoming barriers. However, in the long-term, Colorado may reach a point where key factors align and will see strong growth in EV adoption. This may be achieved without incentives and with a healthy environment that meets all federal and state requirements. This longer-term alignment for a State "exit" would involve three key factors: (1) Colorado consumer choices for long-range EVs at competitive prices, (2) adequate public EV charging infrastructure in place along major highway routes and new installations increasing with demand, and (3) all regions of the state being in or on the path toward attainment of environmental standards, including EPA's proposed ozone rules.

Aside from passing and implementing sound policy to advance the Colorado EV market, CEO can also use existing staff time and resources to overcome challenges to EV ownership. By rewarding and recognizing those who enable and facilitate the EV Market, CEO can offer high-value, low-cost support to those groups. Colorado is the eighth largest state in the country geographically, and it faces some unique challenges by the variance in elevation, meteorological events, and topography. By presenting information to drivers that shows the performance of EVs in this state, CEO will be meeting the needs of the population.

Figure 21. Recommendations for future EV programs

Proposed program	Recommendation	Barrier(s) Addressed
Statewide EV Everywhere Grand Challenge	While the EV Everywhere Grand Challenge is most focused on the production of EVs, light-weighting, and bringing down vehicle and battery costs, the workplace charging and resulting partners network are the elements most applicable to Colorado. DOE launched the EV Everywhere Workplace Charging Challenge with a goal of increasing the number of employers in the United States that offer workplace charging by tenfold in five years, with 500 partners in 2017.[89] Colorado should work more closely with the partners that have locations in the state. For example, national partners with locations in	Vehicle range Access to charging Communications Convenience

[89] U.S. Department of Energy, *EV Everywhere: Grand Challenge Blueprint*, January 31, 2013, http://energy.gov/sites/prod/files/2014/02/f8/eveverywhere_blueprint.pdf.

Proposed program	Recommendation	Barrier(s) Addressed
	Colorado include Cisco Systems (Centennial), Coca-Cola (Denver), DirecTv (Centennial), GE (Longmont), and Google (Boulder). In alignment with national goals, CEO is also advised to set a goal of increasing the amount of workplace charging available to employees in the state and to identify a date by which to do so. Funds from the Charge Ahead Colorado program could be used to help increase available charging stations, and members of the Steering Committee and their associated organizations could each be responsible for recruiting and advising potential employers on how to navigate this process.	
EV Employer Recognition Program	In conjunction with a statewide EV Everywhere Grand Challenge, Colorado should start a public rewards program to recognize state businesses that participate in this endeavor. An EV employer recognition program can be modeled after, or held in conjunction with, the Colorado Department of Public Health and Environment's Environmental Leadership Program (ELP). ELP offers benefits to members who have voluntarily gone above and beyond basic compliance with state and federal regulations and are committed to continuous environmental improvement.[90] The program has provided the following resources to recognize community partners. • **ELP Profile Book** (produced electronically)—lists the parameters of the program, participating organizations, and partner accomplishments, and it thanks program sponsors.[91] • **ELP Directory**—lists companies and contact information for program participants. Membership is listed alphabetically and categorically so	Access to charging Convenience

[90] Colorado Department of Public Health and Environment, Environmental Leadership Program, accessed December 18, 2014, https://www.colorado.gov/pacific/cdphe/environmental-leadership-program.

[91] Colorado Department of Public Health and Environment, Environmental Leadership Program, 15th Annual Awards Event, October 2, 2014, https://www.colorado.gov/pacific/sites/default/files/DEHS_ELP_ProfileBook_Nov2014.pdf.

Proposed program	Recommendation	Barrier(s) Addressed
	that community members can choose to do business with companies who are environmental leaders.[92] • **ELP Program** (two-page document)—details the program and lists all members by name only.[93] • **ELP Program Handbook**—provides a central reference for policies and procedures associated with Colorado's Environmental Leadership Program. The Handbook summarizes information on current aspects of program implementation, including eligibility requirements and member incentives.[94]	
High Altitude and EV Impacts	There are regions in the State of Colorado to target for more widespread adoption of EVs, such as mountain communities that may have perceived issues with performance. Drivers in Colorado have indicated that performance at high altitudes is a potential barrier that influences their next vehicle purchases. CEO could meet this concern by researching and publishing information in one document on the following topics: • Vehicles that offer four-wheel or all-wheel drive • Vehicles that have mountain mode or other similar driving settings • Effects of cold weather and battery range • Vehicle and battery performance at high altitudes—both driving and charging • Charging needs and access in mountain communities and ski resorts. CEO could also support or work in conjunction with NREL on vehicle testing or	Vehicle performance

[92] Colorado Department of Public Health and Environment, Environmental Leadership Program Directory, October 2, 2014, https://www.colorado.gov/pacific/sites/default/files/DEHS_ELP_Directory2014.pdf.
[93] Colorado Department of Public Health and Environment, Colorado Environmental Leadership Program Brochure, October 2, 2014, https://www.colorado.gov/pacific/sites/default/files/DEHS_ELP_Brochure2014thru2015.pdf.
[94] Colorado Department of Public Health and Environment, Colorado Environmental Leadership Program Handbook, October 6, 2014, https://www.colorado.gov/pacific/sites/default/files/DEHS_ELP_Handbook2014.pdf.

Proposed program	Recommendation	Barrier(s) Addressed
	put EVs to the test at the Annual Pikes Peak International Hill Climb.	
Electric Highway Program	While case studies, funding mechanisms, and successes of Electric Highway programs have been identified in other states, including prime locations in Colorado, more research is needed to determine exactly what a statewide program would look like and the benefits of community-based charging compared to corridor-based charging. CEO could support a research project to identify cost estimates, specific locations, and immediately accessible funding opportunities to support a future program in Colorado.	Access to charging Convenience Vehicle range

Recommendations for EV Policy

Colorado offers some of the richest tax incentives and grant programs in the United States to support and drive the EV market. However, there are many policy endeavors that could be pursued through the Colorado General Assembly, which could continue to make EVs accessible for more drivers in our state. Other states have seen great success with simpler tax credits, point of sale rebates, and/or time of use rates to incentive night time vehicle charging.

Simplifying Colorado EV Tax Credits

(Barriers addressed: Vehicle cost, convenience with simplicity of calculation)

The Colorado Alternative Fuel Vehicle Income Tax Credit is very complex and needs simplification. One revision that could be made is changing from refundable tax credits to tax credits that are made available at the point of sale of the vehicle. This would function similarly to leases with the federal tax credit, where the original engine manufacturer collects the tax credit and provides reduced monthly payments to the lessee. With leases or dealer/bank financing, this concept alleviates the financial pressure on lessee's monthly payments. With cash purchases, it reduces the amount of liquid funds that the buyer would need to purchase an EV in the first place. In either case, the arrangement could be optional to the buyer. In that case, the buyer would be protected by the ability to reject the dealer or bank offer and wait to personally file the tax credits.

Another method for achieving simplicity would be to change the income tax formula to a flat tax credit that has two different tiers. The first tier would be to reward those who purchase a battery electric vehicle. The second tier would be applicable to those who purchase a plug-in hybrid electric vehicle. Over time, as the market gets more of a foothold, the tax credits will decrease in value and slowly be phased out entirely by 2030. While 2030 is a longer period of incentives than the currently existing structure that expires in 2021, there are a lot of parameters that need to be met before these can be phased out entirely, which is unlikely to occur by 2021. The table below does not include tax credits for other types of alternative fuel vehicles.

Figure 22. Proposed alternative fuel vehicle tax credits structure

Vehicle type	Calendar year		
	2016–2020	**2021–2025**	**2026–2030**
BEVs	$5,000	$4,000	$2,500
PHEVs	$3,500	$2,500	$1,000

Time of Use Rate Reduction

(Barriers addressed: Access to charging, cost of charging)

Time of Use (TOU) rates have been identified in other states such as Alabama, Alaska, Arizona, California, Georgia, Hawaii, Indiana, Kentucky, Maryland, Michigan, Minnesota, Nevada, Texas, and Virginia. These rates are used as an incentive to encourage EV owners to plug in their cars during off-peak hours to minimize impacts on the electrical grid. It allows consumers to save money, and it helps electric utilities to better manage their grids by encouraging people to shift electrical usage away from peak demand periods. According to *Charged EVs Magazine*, an industry publication, this provides yet another incentive to drive electric—it's easy to schedule charging to happen late at night, or whenever rates are lowest.[95]

Xcel Energy is the largest of 54 electric utilities in Colorado that—together with Black Hills Energy—represents one of only two investor-owned utilities in the state. Xcel Energy also has a large presence in Minnesota, which, in June, became the first state in the nation to mandate that investor-owned utility companies offer a special low-cost tariff exclusively for EV owners that should effect in early 2015.[96] Currently, Colorado residential utility consumers are paying approximately 11.7 cents per kWh for electricity at all hours of the day.[97] If consumers were offered a reduced TOU rate option, they would be able to charge their cars at home with off-peak rates. In 2012, those rates were less than half of the standard residential rate.[98] In the case of Minnesota, Xcel Energy has provided TOU rates as low as 1.92 cents per kWh during off-peak periods.[99]

Figure 23 demonstrates a process that could be undertaken in order to develop a pilot program for Colorado investor-owned utilities to offer TOU rates for EV customers. This is an exceedingly complex issue, and this flow chart is meant to illustrate the high-level tasks and milestones associated with such a project.

[95] Charles Morris, Charged Electric Vehicles Magazine, "Minnesota mandates special electricity pricing for EVs," June 18, 2014, http://chargedevs.com/newswire/minnesota-mandates-special-electricity-pricing-for-evs/.
[96] Stephen Edelstein, "Minnesota Leads Nation, Mandates Off-Peak Electric-Car Charging Rates", Green Car Reports, June 23, 2014, http://www.greencarreports.com/news/1092842_minnesota-leads-nation-mandates-off-peak-electric-car-charging-rates.
[97] U.S. Energy Information Administration, Electric Power Monthly, data for October 2014, available at http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a.
[98] Xcel Energy, http://www.xcelenergy.com/staticfiles/xe/Marketing/Managed%20Documents/Res-Time-of-Day-Info-Sheet.pdf.
[99] Xcel Energy, http://www.xcelenergy.com/staticfiles/xe/Marketing/Managed%20Documents/Res-Time-of-Day-Info-Sheet.pdf.

Figure 23. Process for program and policy development of TOU rates

Point of Sale Rebates

(Barriers addressed: vehicle cost, convenience in recouping tax credit earlier)

This section examines existing programs in other states that could be used as a model or template for future programs in Colorado. Currently, the Massachusetts Offers Rebates for Electric Vehicles program is funded by the Massachusetts Department of Energy Resources and administered statewide by the Center for Sustainable Energy in order to promote the production and use of zero-emission vehicles, including electric, plug-in hybrid electric, and fuel cell vehicles.[100] This model could serve an excellent case study for a potential State of Colorado program. The following descriptions explain what qualifies as eligible under Massachusetts' program:[101]

- In fiscal year 2014–2015, $1.86 million has been reserved for this fund.

[100] Massachusetts Offers Rebates for Electric Vehicles, Frequently Asked Questions, accessed December 18, 2014, https://mor-ev.org/frequently-asked-questions.

[101] Massachusetts Offers Rebates for Electric Vehicles, Implementation Manual for the FY 2014-15, September 2014, https://mor-ev.org/sites/default/files/docs/Implementation%20Manual%20for%20MOR-EV.pdf.

- Rebates are capped at $2,500 per vehicle contingent upon availability of funds.
- Purchased vehicles are eligible under the program.
- Leased vehicles are required to have lease terms of at least 36 months to be eligible for the program.
- Rebates must be reserved after the sale takes place online at https://mor-ev.org/eligible-vehicles-list. This reservation must take place within three months of the sale, after the customer is in receipt of the vehicle, and before funds are allocated. Payments are received by the owner/leaser within 75 days.
- The following vehicles are eligible:
    - Battery Electric Vehicle (BEV)—fully electric, zero-emission vehicles that have an onboard electrical energy storage device that can be recharged from an external source of electricity.
    - Fuel Cell Electric Vehicle (FCEV)—zero-emission vehicles that run on compressed hydrogen fuel that produces electricity to power the vehicle.
    - Plug-in Hybrid Electric Vehicle (PHEV)—hybrid electric vehicles that have zero-emission vehicle range capability and an onboard electrical energy storage device that can be recharged from an external source of electricity. In general, PHEVs are vehicles that can be driven using electricity, gasoline or both.
    - Zero-Emission Motorcycles (ZEM)—either a two- or three-wheeled electric vehicle meeting the Massachusetts definition of a motorcycle (MA General Law Chapter 90 Section 1), is freeway capable, and has sealed batteries.
- Aftermarket conversions are not eligible for tax credits. This differs from Colorado's policy.
- Businesses and fleets are not eligible to apply.

Assessment of Electric Vehicle Marketing and Outreach

The electric vehicle market in Colorado has seen sharp growth over the past three years, due in part to strong tax incentives and beneficial programs such as Charge Ahead Colorado, ALT Fuels Colorado, www.RefuelColorado.com, Refuel Colorado Fleets, and Project FEVER. In order to continue to grow the market, an increased amount of focus and effort must be put toward further deployment and adoption of electric vehicles and charging stations. Comprehensive market and outreach activities must continue to be coupled with policy strategies to assure drivers that EVs are a viable transportation option. With nearly one-third of all *Colorado EV Market Implementation Study* survey respondents unaware of the tax credits available for EVs, the State of Colorado needs to focus efforts on increasing awareness of financial incentives. An October 2014 report by the International Council on Clean Transportation ranked Colorado as the number one state in the country in terms of offering incentives and benefits for EV purchases.[102] Nonetheless, customers must know that these policies exist to ensure their effectiveness through high utilization rates.

The survey administered through the *EV Market Implementation Study* found that 68% of respondents were aware of the Colorado state refundable tax credit that is available when purchasing an EV. When only non-EV owners' responses were examined, the percentage of respondents aware changed to 62%.

[102] The International Council on Clean Transportation, "Evaluation of State-Level U.S. Electric Vehicle Incentives," by Lingzhi Jin, Stephanie Searle, and Nic Lutsey, October 2012, page 20, http://theicct.org/sites/default/files/publications/ICCT_state-EV-incentives_20141030.pdf.

The combination of favorable opinions of EVs, combined with the same population being somewhat unaware of available refundable tax credits, represents a huge opportunity in Colorado for marketing and outreach programs.

Recommendations for Continued Marketing and Outreach

Continued outreach is critical to supporting the State's investment in EVs and charging infrastructure, and groups such as CEO, RAQC, and Clean Cities are leveraging their resources on a daily basis to achieve a market stronghold. A targeted and specific outreach and marketing strategy to supplement successful ongoing efforts can be found in Appendix F. Continuing to share information with these groups will help overcome communications challenges and break down the barriers of vehicle range, convenience of charging, up-front higher cost, access to charging, and vehicle performance. Below are some of the key groups that can continue to play a role in supporting the EV market in Colorado when facilitated by industry stakeholders:

- Colorado Automobile Dealers Association
- Large employers
- The general public
- First responders
- Owners/operators of destinations with longer dwell times
- Ski resorts
- Car sharing services and rental car companies
- Utility programs
- Industry leaders and local notable personalities
- EVSE manufacturers and distributors.

Ideas for reaching these groups include:

- Continue to spread the word on available tax credits and funding programs
- Provide content and information on EVs to include in existing auto dealer publications
- Continue to co-host and build a stronger portfolio of events with strategic partners
- Work with employees and management at large employers
- Set up mentoring programs to help companies that are new to the EV market
- Build on existing and develop new products and outreach materials for audiences
- Continue conducting trainings on EVs in conjunction with existing educational opportunities
- Assist stakeholders in promoting their achievements in the EV market.

Publicly Accessible Charging

The United States has developed a specific road sign for EV charging stations that looks like a standard liquid fuel pump, with the letters "EV" and an electric cord and plug replacing the typical liquid fuel

nozzle.[103] It is important to use consistent signage so that the EV symbol becomes recognizable to both EV drivers and the general public. According to a June 2013 memo from the U.S. Department of Transportation's Federal Highway Administration,[104] the federal government intends to include standard regulatory signing for EV purposes in the next Notice of Proposed Amendment to the Manual on Uniform Traffic Control Devices. No timeline has been set for this update.

Best Practices for EV Charging Signage

It is important for entities that provide EV charging to develop a clear internal policy that governs access, security, usage, and other issues.[105] Signs are particularly important for public charging stations. Colorado should mark PEV parking/charging areas clearly with distinctive patterns on the ground and signs that can be seen over parked vehicles.[106] General service signs also are needed to direct motorists to charging stations. There are approved advanced directional arrows that can be posted in combination with one of the identification signs for charging. There are generally four types of signage for EV charging stations:

- *Wayfinding* with arrows to point drivers in the correction direction
- *Permissive* (such as signs that allow parking for a certain amount of time) that are green and black on a white background
- *Prohibitory* (such as no parking signs) that are red and black on a white background.
- *Regulatory* used for electric vehicle charging, which are needed to restrict access to charging stations and parking areas, or to limit the time of use.

It is recommended that all EVSE owners and operators adhere to all federal, state, and municipal regulatory guidelines. To comply with these policies, guidance documents with detailed information and visual aids are available online:

- 2009 Edition of the Manual on Uniform Traffic Control Devices: http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm
- Accessibility and Signage for Plug-In Electric Vehicle Charging Infrastructure: http://www.evcollaborative.org/sites/all/themes/pev/files/PEV_Accessibility_120827.pdf
- U.S. Department of Energy, Plug-In Electric Vehicle Handbook for Workplace Charging Hosts http://www.afdc.energy.gov/uploads/publication/pev_workplace_charging_hosts.pdf
- U.S. Department of Energy, Plug-In Electric Vehicle Handbook for Public Station Charging Hosts http://www.afdc.energy.gov/pdfs/51227.pdf.

[103] Argonne National Laboratory and the U.S. Department of Energy, "Harmonization of Road Signs for Electric Vehicle Charging Stations," November 2012, http://www.afdc.energy.gov/uploads/publication/ev_road_signage_final_feport.pdf.

[104] U.S. Department of Transportation, Manual on Uniform Traffic Control Devices, (MUTCD), June 17, 2013 Memo, http://mutcd.fhwa.dot.gov/resources/policy/rsevcpfmemo/index.htm.

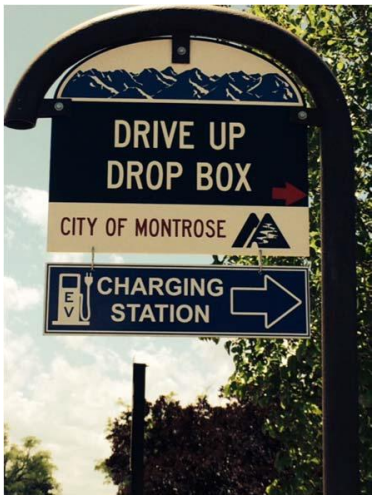
[105] U.S. Department of Energy, Plug-In Electric Vehicle Handbook for Workplace Charging Hosts. August 2013. http://www.afdc.energy.gov/uploads/publication/pev_workplace_charging_hosts.pdf.

[106] U.S. Department of Energy, Plug-In Electric Vehicle Handbook for Public Station Charging Hosts, April 2012. http://www.afdc.energy.gov/pdfs/51227.pdf.

Colorado EV Signage Best Practices—City of Montrose

In June 2014, the City of Montrose, Colorado, obtained funding from the Charge Ahead Colorado program to install a Level II charging station in the Centennial Plaza that offers free charging to EV drivers. One of the city's goals is that EV owners will spend 3–4 hours dining or shopping in the city in order to power their car battery to full charge.[107]

In order to direct Montrose visitors to the charging station, city officials used a variety of signage to help drivers charge their vehicles. The signs below are good examples of how multiple way-finding signs with directional arrows are used to help drivers navigate city streets for access to charging stations.

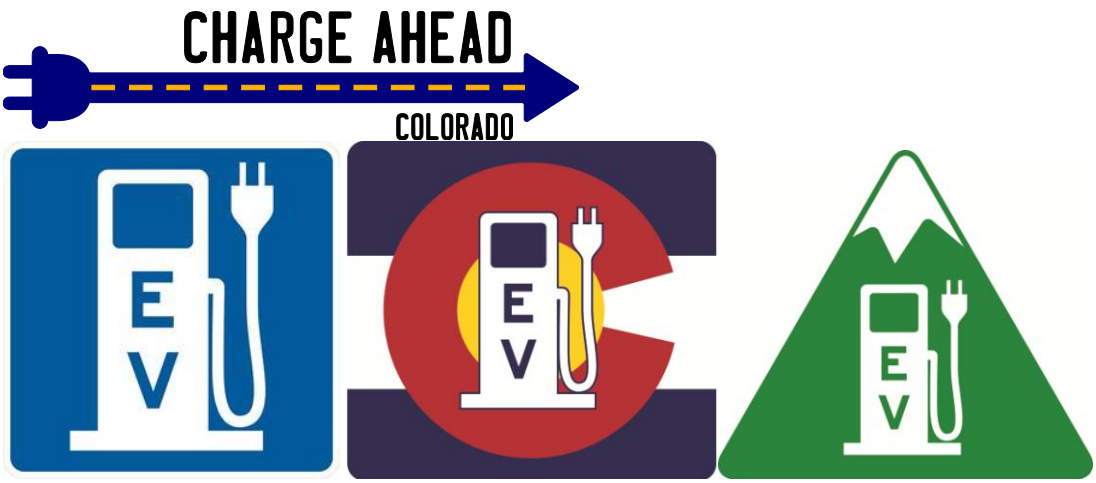


In the photo below, the City of Montrose deployed a methodology similar to what is recommended by the EV Collaborative. The municipality used permissive signage to set the rules for their charging stations, which are governed by a 2-hour stay between 8:00 a.m. and 5:00 p.m. and the fact that parking spots are exclusively for electric vehicles. Arrow signage also helps the city clearly delineate the two spots that are available at each of the ports on the charging pedestal.

[107] KJCT8, accessed January 7, 2015, http://www.kjct8.com/home/headlines/267093061.html.

Continuing to share information on best practices for EV signage will overcome communications challenges and break down the barriers of convenience and access to charging. While the symbolic content of the signage should remain consistent, the colors and graphic elements could be varied to give signage the branded look of Colorado. Figure 24 shows some suggested options to put Colorado branding on EV charging stations throughout the state.

Figure 234. Samples of Colorado-branded EVSE artwork



EV Charging Guidelines

Many property owners and managers may be open to the idea of offering EV charging for employees and customers either for free or for a small cost, but they may lack the knowledge to successfully navigate the construction, permitting, equipment, and networking process required to install EV charging stations. The results of the survey deployed through the *EV Market Implementation Study* show that the majority of employees:

- Drive less than 50 miles to work (89%)
- Would be more likely to purchase an EV if workplace charging was an option (73%)
- Think it is fair for employees to offer workplace charging to staff (88%)
- Would be attracted to an employer who provides charging access (62%).

Sample Employee Survey for Workplace Charging

By offering workplace charging, companies signal corporate leadership and innovation—demonstrating a willingness to adopt advanced technology and provide a valuable benefit to employees.[108] A first step to offering the most effective workplace charging experience is to survey employees to determine their needs. By assessing the needs of the staff, a company can effectively plan for the type, amount, and level of charging that is most appropriate for that location. Continuing to share information with these

[108] U.S. Department of Energy, Workplace Charging Challenge, "PEV Outreach Resources for Your Employees," November 2014, http://energy.gov/sites/prod/files/2014/11/f19/Toolkit_EmployerGuidance_Final_11-14-14.pdf.

groups will, in turn, overcome communications challenges and break down the barriers of vehicle range, convenience of charging, and access to charging.

To capitalize on the positive attitudes of employees and drivers, Appendix G offers sample questions that employers can use to gauge the interest of workers. Appendix H includes a space to aggregate the responses, which should then be imported into the Best Practices section in Appendix I to provide guidelines for how this information can be used to make decisions on the types of charging to offer for EVs.

Marketing the Business Case for Offering Level III EV Charging

There are a number of reasons that companies or municipalities might consider installing Level III charging stations, including everything from wanting to display a commitment to the environment, to wanting another revenue stream on the property. The exact combination of reasons behind a decision to install a Level III charging station will be unique to each company; some of the more common reasons are identified by the Alternative Fuels Data Center:[109]

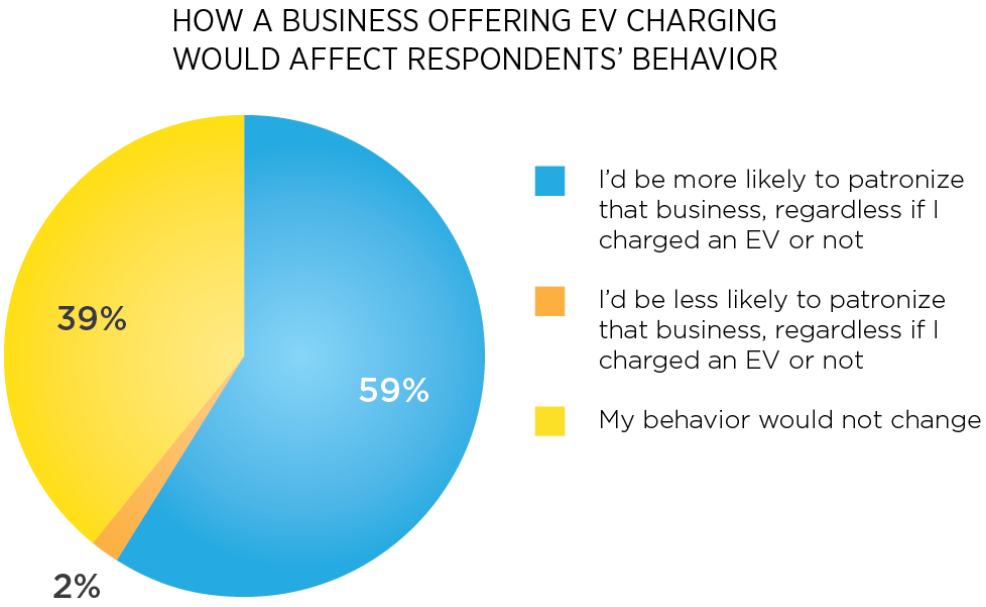
- *Marketing*—an EV charging station could support corporate branding efforts and customer attraction/retention. This positive view of the availability of EV charging is supported by the survey completed for this report, which indicated that 49% of non-EV owners would be more likely to visit a business that has EV charging available, regardless of whether they intended to charge an EV. Another 49% of non-EV owners indicated their behavior would not change, while only 2% noted they would be less likely to visit the business.[110]
- *Revenue*—companies could collect charging and parking fees for people using the EVSE services. Research conducted by Simon Property Group, who own and operate shopping centers around the United States, has shown that shoppers spend more time in stores while waiting for the electric vehicle to charge.[111]
- *Advertising*—companies can advertise their own services and products, or they could sell the advertising space for additional revenue.
- *Corporate Social Responsibility*—many companies are looking for ways to positively impact their communities, including pursuing activities that improve the environment or public health.
- *Employee Benefits*—offering EV charging supports employee recruitment and retention. In the survey administered for this report, about 53% of non-EV owners noted that they would be "much more likely" or "somewhat more likely" to accept a job at a company that offered EV charging.[112]
- *LEED (Leadership in Energy and Environmental Design) Certification*—the installation of EV charging stations contributes toward this certification.

[109] U.S. Department of Energy, Alternative Fuels Data Center, "Plug-In Electric Vehicle Handbook: for Public Charging Station Hosts," April 2012, pages 9–10, http://www.afdc.energy.gov/pdfs/51227.pdf.
[110] Colorado Electric Vehicle Market Implementation Survey, conducted by BCS, Incorporated, November 2014.
[111] "Simon says 'Charge Your EV at the Mall." Forbes Online, February 7, 2013. http://www.forbes.com/sites/peterdetwiler/2013/02/07/simon-says-charge-your-ev-at-the-mall/.
[112] Colorado Electric Vehicle Market Implementation Survey, conducted by BCS, Incorporated, November 2014.

While the total costs of installing a Level III charging station can range up to $45,000–$100,000, including equipment and installation costs,[113] there are potential ways for businesses to mitigate the associated costs and risks. Businesses could actively search for federal, state (such as Charge Ahead Colorado), and local grants or revolving loan funds focusing on renewable energy that could support the upfront costs. Additionally, businesses could become part of ongoing efforts to install Level III charging throughout the country, such as GoE3. This is an initiative that already has plans to install Level III charging from coast to coast. The route includes I-25 from Fort Collins south to the southern border, as well as I-70 from Denver to the western border.[114] The initiative is looking to install charging stations on or slightly off interstates, near food or other attractions, and on properties with commercial grade power. These requirements match with the justification provided for a Colorado Electric Highway route on I-70 and I-25. GoE3 indicates that property owners meeting these criteria could qualify for a free charging station.[115] Understanding other ongoing efforts to install Level III charging throughout the country, such as this, could result in mutually beneficial partnerships that alleviate the upfront costs and risks that can act as a barrier for businesses in deciding to install EV charging.

Additionally, working with EV charging equipment manufacturers could provide a number of benefits. Many of these, such as Blink DC Fast Chargers, have already worked with and established relationships with national businesses that could provide additional insights on, and strategies for, ways to help businesses mitigate installation risks.

Figure 25. How a business offering EV charging to customers or visitors would affect survey respondents' behavior



[113] U.S. Department of Energy, Alternative Fuels Data Center, "Plug-In Electric Vehicle Handbook: for Public Charging Station Hosts," April 2012, page 11, http://www.afdc.energy.gov/pdfs/51227.pdf.
[114] GoE3, Plans, accessed January 6, 2015, http://goe3.org/plans.html#.
[115] GoE3, Action, Property Owners, accessed January 6, 2015, http://goe3.org/action/action_property.php.

Survey results also indicated that, while 39% of respondents would not change their behavior toward a certain business if it offered EV charging to customers or visitors, 59% stated that they would be more likely to patronize that business, regardless of whether or not they owned an EV. Many survey respondents are interested in the goodwill factor of offering charging station access for EVs.

Recommendations for Colorado Energy Office's role in EV market

Through the success of existing programs and additional programs covered in this study, Colorado may reach the point where strong growth in EV adoption and infrastructure development will occur without State incentives or other program support. This longer-term point in time, when market barriers for EV adoption have been reduced or eliminated, can allow for the State to potentially retire program support and incentives for EVs. Reaching this point will involve an evaluation of three key factors: (1) Colorado consumers receive long-range EVs at competitive prices to other types of vehicles, (2) there is an adequate public EV charging infrastructure in place throughout Colorado and especially along major highway routes, and (3) a high percentage of public charging stations are being installed without state incentives. According to *plugincars*, which is a team of writers, researchers, and industry analysts that report EV news and related consumer info, the average EV range was approximately 80 miles per charge in the United States in 2012.[116] In addition, a recent review of range of vehicles available for sale in Colorado in the category of "all electric" was 62–208 miles.[117] When speaking to *Business Insider*, the world's largest business news site on the Web, leaders in the car manufacturing industry have stated that in order for an EV to be truly competitive, it would require a range of 250 miles at a price of $30,000 or less before incentives.[118] Other industry leaders have stated that 125–150 miles of range is a functional minimum for EV selection to be competitive with other vehicles.[119] In the future, the State can evaluate the market competitiveness of longer-range EVs with these current competitive targets of range and vehicle price.

With a statewide network of EV charging stations in place, the EV market would have the potential to grow without additional state support. Along these same lines, it will be important for the state to evaluate the number of new installations of public charging stations that are occurring to meet market demand without state support. Recent charging station data from CEO indicates that 45% of existing public charging ports received state incentives from the *Charge Ahead Colorado* program in support of installation (150 of the 335 publicly accessible charging ports received incentives).[120,121] A future metric

[116] Brad Berman, "The Coming Era of Long-Range Electric Cars," *plugincars*, October 19, 2014, http://www.plugincars.com/coming-era-long-range-electric-cars-130203.html.
[117] Drive Electric Northern Colorado, Commercial Vehicle Gallery, accessed December 18, 2014, http://driveelectricnoco.org/consumer-vehicle-gallery/.
[118] "Electric Car is Dead All Over Again", *Business Insider*, interview of Kevin Kelly, General Motors Manager of Electrification Communications, April 8, 2013, http://www.businessinsider.com/whats-holding-affordable-electric-cars-back-2013-4.
[119] Brad Berman, "The Coming Era of Long-Range Electric Cars," *plugincars*, October 19, 2014, http://www.plugincars.com/coming-era-long-range-electric-cars-130203.html.
[120] Data provided by the Colorado Energy Office as of December 2014
[121] U.S. Department of Energy, Alternative Fuels Data Center, Electric Vehicle Charging Station Locations, accessed January 16, 2015, http://www.afdc.energy.gov/fuels/electricity_locations.html.

for future evaluation of the EV market is to identify the number of companies that report positive return on investment from installing charging infrastructure without State program funding.

Conclusion

The strategic policies and programs already in place in the State of Colorado have been a primary factor to the rapid growth of the EV market in Colorado since 2011. The state remains poised to realize continued future gains in market share for EVs—highlighting the importance of these efforts continuing to evolve in tandem. Driver concerns such as vehicle range, convenience of charging, up-front higher cost, and performance continue to be an issue for market expansion. The growing, but still limited, availability of charging stations in public, at work, and on major highways is also a core reason that the market hasn't yet moved out of the early adopter phase.

The *Colorado EV Market Implementation Study* contains recommendations on where priority areas for charging stations will be in the future. These recommendations are two-fold. One strategy relies on the assertion that dwell timeis a key indicator that demonstrates optimal sites for EV charging stations. The longer drivers are onsite, the more likely they are to take advantage of available infrastructure, helping to eliminate the barrier of access to vehicle charging stations. The second strategy is that an Electric Highway network of Level III fast charging stations will provide Coloradans with the fuel they need to drive across the state on I-25 and I-70. This Electric Highway, similar to the I-5 corridor that stretches from Southern California to Northern Washington, will help reduce range anxiety for those that travel longer distances outside of their local area.

This report also identifies some minor tweaks that can fit within existing, effective programs in Colorado. This includes adding an element of recruiting to funding programs such as ALT Fuels Colorado and Charge Ahead Colorado. To minimize the strain on staff resources and any conflict of interests with the scoring of proposals, it is proposed that partner organizations, steering committee members, and vendors all work together to target new stakeholders. The incentives offered through Charge Ahead Colorado can also be modified to prioritize Level II and Level III charging, or charging pedestals with dual ports, as it is crucial that these investments are incentivized. CEO can also realize its organizational mission by continuing to offer technical support and services to fleets under the Refuel Colorado program, even after DOE funding is discontinued in the third quarter of 2015.

New programs can cultivate new audiences in support of the EV Everywhere Grand Challenge by approaching local branches of these national companies and encouraging EVSE onsite, as well as providing support to owners and operators of publicly accessible EV charging stations. Other new audiences include those in the vehicle car-share market, which is growing rapidly in Colorado. By modifying existing programs and adding new program elements, CEO and partners can eliminate the barriers of vehicle and charging infrastructure costs, communications challenges, range anxiety and access to convenient charging.

To continue to make EVs affordable for drivers in Colorado, CEO can help to simplify tax policy for these vehicles. The available refundable tax credits in Colorado can be changed in several ways. First, the tax credits can eliminate a complicated formula and rely on a flat tax for BEVs and PHEVs. Further, these vehicle credits can be claimed at the point of sale by following a model close to what is being used in Massachusetts. TOU rates are another way to incentivize drivers to go electric. This is a complicated issue involving many stakeholders and regulatory processes, and the report outlines a facilitation strategy to begin moving forward on these issues. These policy changes can help remove cost and accessibility issues for both vehicles and charging access.

The *Colorado EV Market Implementation Study* also includes best practices at both the federal and local levels for use of signage to help drivers find their way and obey all posted policies concerning EV charging stations. In addition, guidelines and models are available to industry to make charging available in public and at workplaces. By making charging signage standards more uniform in Colorado, the market barrier of limited access to easy-to-find charging stations will be eliminated. It is also worth noting that the support from the State of Colorado to the EV market is not permanent or perpetual.

The closing pages of the document offer guidelines on what the market indicators should be for CEO and state agencies to wind down support of EV programs and policies.

Appendix A. Electric Vehicle Counts by Colorado County

County	BEV	PHEV	Grand Total
JEFFERSON	172	280	452
BOULDER	241	186	427
DENVER	175	212	387
ARAPAHOE	161	208	369
DOUGLAS	118	201	319
EL PASO	72	194	266
LARIMER	94	127	221
ADAMS	58	122	180
WELD	35	82	117
BROOMFIELD	23	33	56
PUEBLO	9	42	51
MESA	10	34	44
EAGLE	15	15	30
PITKIN	13	17	30
SUMMIT	11	9	20
LA PLATA	8	9	17
ELBERT	4	10	14
GARFIELD	3	11	14
MONTROSE	0	12	12
PARK	1	7	8
CLEAR CREEK	2	6	8
FREMONT	2	5	7
MONTEZUMA	3	4	7
GILPIN	3	3	6
DELTA	0	6	6
GRAND	2	2	4
CHAFFEE	1	3	4
OURAY	2	2	4
SAGUACHE	0	3	3
ROUTT	1	2	3
MORGAN	0	3	3
OTERO	0	3	3
CUSTER	0	2	2
MOFFAT	1	1	2
HUERFANO	1	1	2

County	BEV	PHEV	Grand Total
TELLER	0	2	2
LAS ANIMAS	0	2	2
ALAMOSA	1	1	2
SAN MIGUEL	1	0	1
LOGAN	1	0	1
GUNNISON	0	1	1
LINCOLN	0	1	1
LAKE	0	1	1
HINSDALE	0	1	1
BACA	0	1	1
PHILLIPS	0	1	1
YUMA	0	0	0
SEDGWICK	0	0	0
RIO GRANDE	0	0	0
PROWERS	0	0	0
CONEJOS	0	0	0
BENT	0	0	0
ARCHULETA	0	0	0

Appendix B. Electric Vehicle Barriers in Colorado in Comparison to Other States

Major Barriers for Colorado EV Market	States with Similar Barrier Identified
POLICY	
Multi-resident dwellings' cost burden for financing installation: Installing EVSE in a multi-unit building is often cost prohibitive for a single user. Different cost-sharing models between property managers and tenants should be considered on a case-by-case basis. (Source: *Colorado PEV Readiness Plan 2012*)	Texas, New York
Fleet manager decision-making limitations: • "…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." • In many cases, they are not able to utilize tax incentives (e.g., municipal fleets). • "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 with Level 3 chargers or if multiple cars are charging at once)."	All states/local governments with tax rebates
Standards and certainty for EVSE installations: • Price variability of electrical permit (administered by local building departments). • Perception that permitting process is lengthy, cumbersome, and lacks standardization. • Future electrical demand needs for Level II and/or DC Fast Charge EVSE to ensure reliability. (Source: *Colorado PEV Readiness Plan 2012*)	Pennsylvania, Texas, Oregon, Hawaii
High upfront cost of PEVs: "…with the tax credits available through 2015, Coloradans can expect to pay an additional $275 to $2,400 for a PEV instead of a comparable ICE vehicle… 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." (Source: *Colorado PEV Readiness Plan 2012*)	All states
PROGRAMS	
PEV range anxiety involving need for EVSE Network serving the entire state: "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... Second, a deployment plan will help spur the	North Carolina, Missouri, Virginia, Michigan, Texas

Major Barriers for Colorado EV Market	States with Similar Barrier Identified
investment and action necessary to create a long-term EVSE infrastructure by providing investors with a level of certainty." (Source: *Colorado PEV Readiness Plan 2012*)	
Perceptions of elevation/mountain Terrain on PEV performance: The Colorado readiness project reported that there are public misperceptions that altitude negatively impacts battery performance, as well as the real challenge posed by the need of some drivers for powerful vehicles to handle mountainous terrain. (Source: *A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects*, January 2014)	Unique to Colorado among Readiness projects

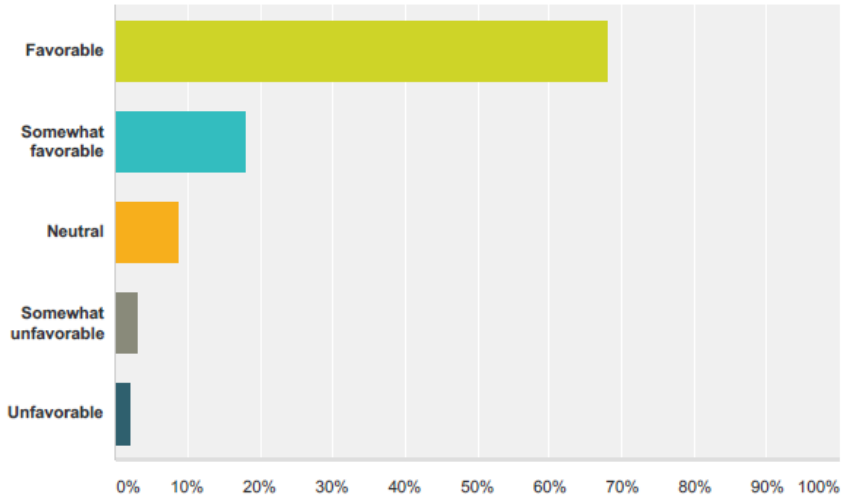
Appendix C. Colorado Electric Vehicle Study – Full Survey Responses

Q1 What is your zip code?

Answered: 285 Skipped: 0

Q2 My opinion about plug-in electric vehicles (EVs – both battery electric and plug-in hybrid electric vehicles) is:

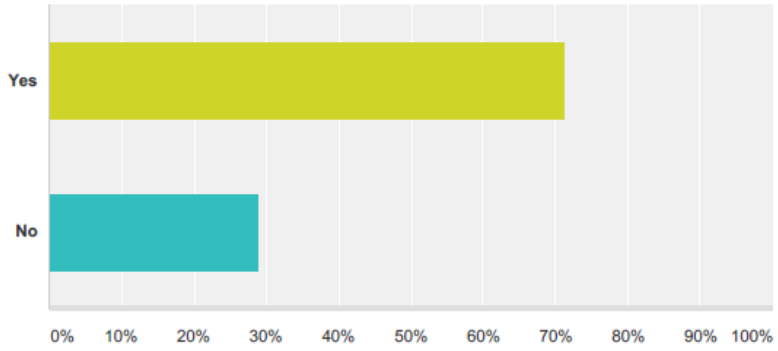
Answered: 285 Skipped: 0



Answer Choices	Responses	
Favorable	68.07%	194
Somewhat favorable	17.89%	51
Neutral	8.77%	25
Somewhat unfavorable	3.16%	9
Unfavorable	2.11%	6
Total		285

Q3 Would you consider buying an EV for your next vehicle?

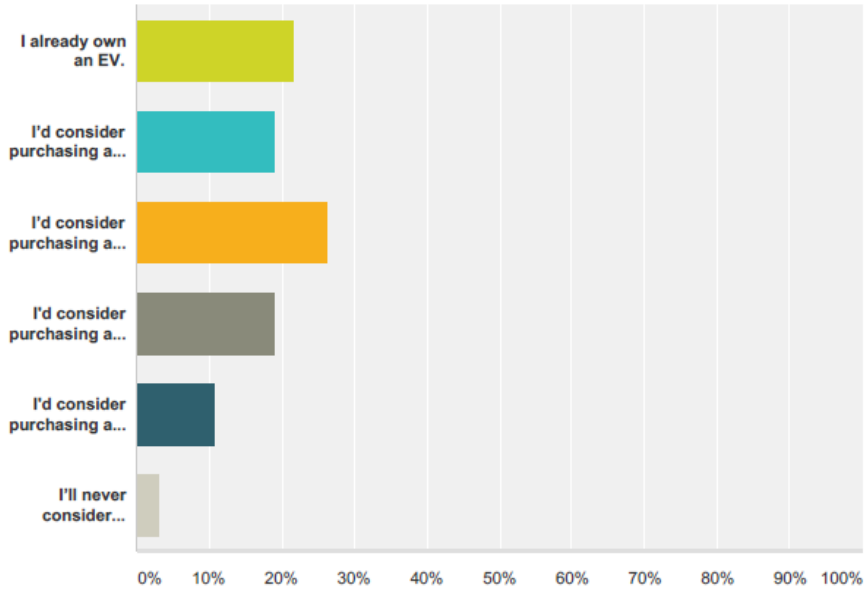
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	**71.23%**	203
No	**28.77%**	82
Total		**285**

Q4 At what point in time would you be most likely to purchase an EV?

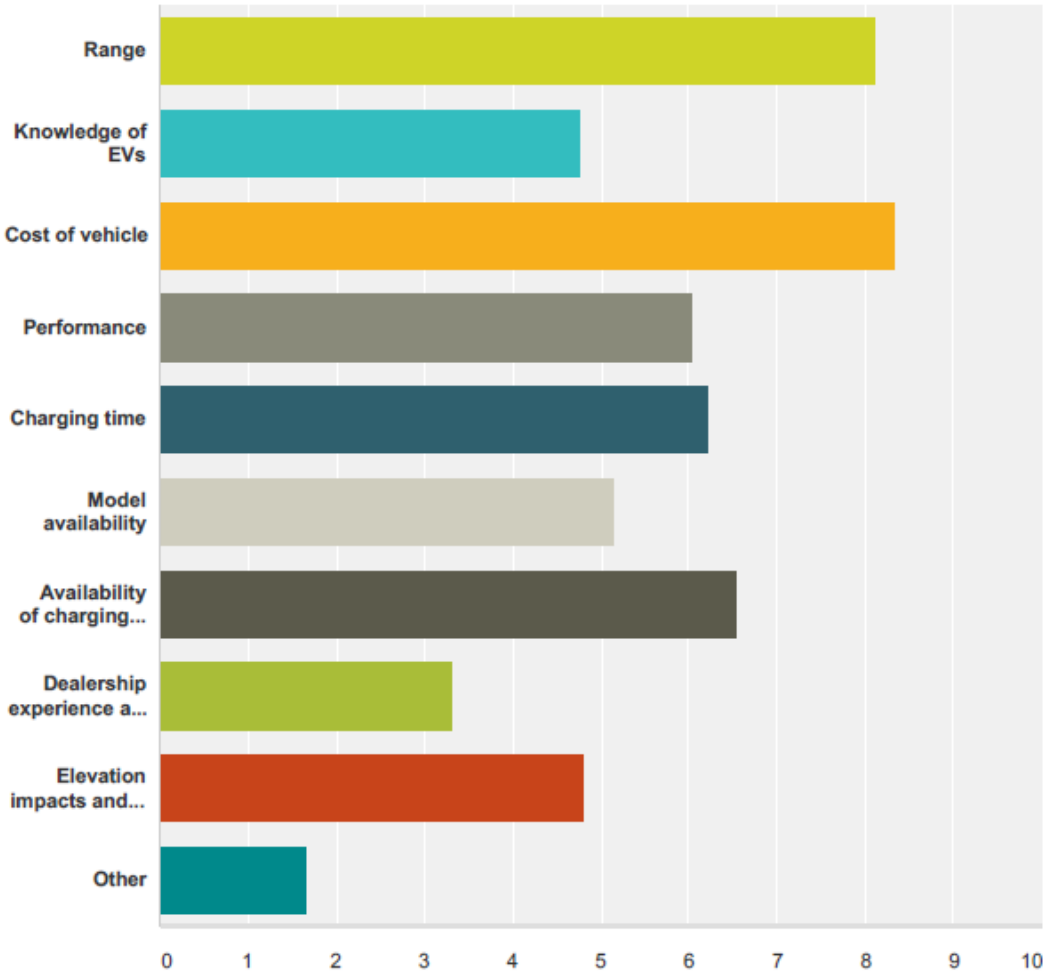
Answered: 285 Skipped: 0



Answer Choices	Responses	
I already own an EV.	**21.75%**	62
I'd consider purchasing an EV within the next 2 years.	**18.95%**	54
I'd consider purchasing an EV in 2-5 years.	**26.32%**	75
I'd consider purchasing an EV in 5-10 years.	**18.95%**	54
I'd consider purchasing an EV, but not for at least 10 years.	**10.88%**	31
I'll never consider purchasing an EV.	**3.16%**	9
Total		**285**

Q5 Please rank the following barriers to order in terms of significance to your consideration when purchasing a EV in Colorado. You can "drag and drop" to re-order where 1 is most important and 9 is least important.

Answered: 285 Skipped: 0

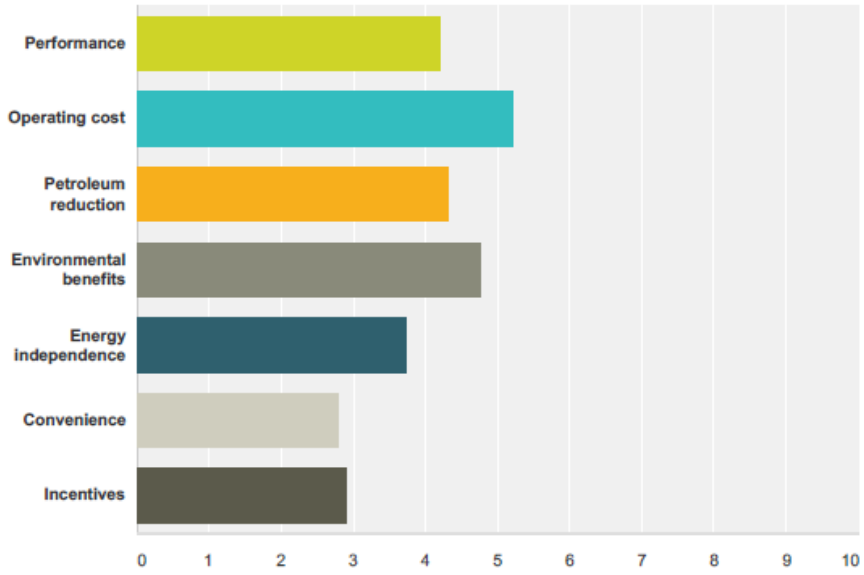


	1	2	3	4	5	6	7	8	9	10	Total	Average Ranking
Range	32.63% 93	22.81% 65	14.04% 40	11.23% 32	7.02% 20	5.96% 17	2.46% 7	2.11% 6	1.05% 3	0.70% 2	285	8.13
Knowledge of EVs	5.61% 16	8.07% 23	7.72% 22	3.86% 11	8.77% 25	10.53% 30	16.84% 48	14.74% 42	18.25% 52	5.61% 16	285	4.76
Cost of vehicle	35.09% 100	24.91% 71	10.88% 31	13.68% 39	6.32% 18	4.21% 12	3.16% 9	1.05% 3	0.70% 2	0.00% 0	285	8.34
Performance	5.26% 15	5.61% 16	14.74% 42	19.65% 56	15.09% 43	17.19% 49	8.42% 24	8.42% 24	4.21% 12	1.40% 4	285	6.04

Charging time	**1.40%** 4	**9.12%** 26	**15.79%** 45	**18.25%** 52	**21.75%** 62	**16.49%** 47	**10.88%** 31	**3.51%** 10	**2.46%** 7	**0.35%** 1	285	6.22
Model availability	**6.32%** 18	**3.16%** 9	**5.26%** 15	**9.82%** 28	**12.63%** 36	**15.79%** 45	**25.61%** 73	**15.79%** 45	**3.51%** 10	**2.11%** 6	285	5.16
Availability of charging stations	**6.67%** 19	**14.04%** 40	**20.35%** 58	**13.68%** 39	**11.93%** 34	**11.58%** 33	**11.23%** 32	**7.72%** 22	**2.11%** 6	**0.70%** 2	285	6.54
Dealership experience at point-of-sale	**1.05%** 3	**1.05%** 3	**3.51%** 10	**1.75%** 5	**5.96%** 17	**5.26%** 15	**10.18%** 29	**31.93%** 91	**34.04%** 97	**5.26%** 15	285	3.32
Elevation impacts and four-wheel drive capability	**3.51%** 10	**10.88%** 31	**6.32%** 18	**7.37%** 21	**9.82%** 28	**11.93%** 34	**8.42%** 24	**12.28%** 35	**26.67%** 76	**2.81%** 8	285	4.80
Other	**2.46%** 7	**0.35%** 1	**1.40%** 4	**0.70%** 2	**0.70%** 2	**1.05%** 3	**2.81%** 8	**2.46%** 7	**7.02%** 20	**81.05%** 231	285	1.67

Q6 Please rank the following benefits in terms of importance to you in considering the purchase of EVs in Colorado. You can "drag and drop" to re-order where 1 is most important and 7 is least important.

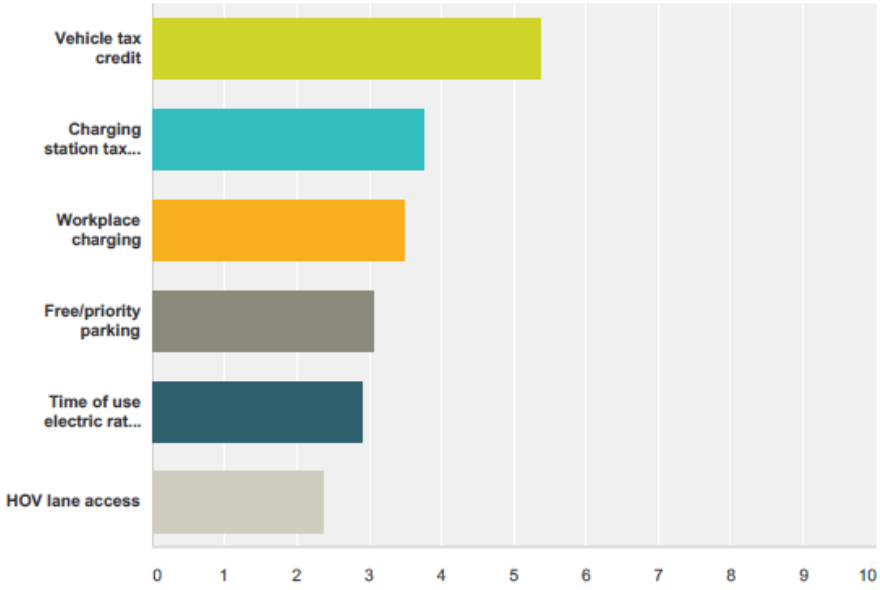
Answered: 285 Skipped: 0



	1	2	3	4	5	6	7	Total	Average Ranking
Performance	13.68% 39	16.49% 47	14.04% 40	18.25% 52	15.44% 44	15.79% 45	6.32% 18	285	4.22
Operating cost	29.12% 83	22.81% 65	14.04% 40	18.25% 52	8.42% 24	5.96% 17	1.40% 4	285	5.22
Petroleum reduction	11.23% 32	19.30% 55	20.35% 58	15.09% 43	16.14% 46	9.82% 28	8.07% 23	285	4.33
Environmental benefits	29.12% 83	12.63% 36	16.14% 46	12.63% 36	14.39% 41	8.77% 25	6.32% 18	285	4.78
Energy independence	7.37% 21	13.68% 39	12.28% 35	17.19% 49	22.11% 63	16.49% 47	10.88% 31	285	3.74
Convenience	3.86% 11	6.67% 19	11.23% 32	7.72% 22	10.88% 31	32.98% 94	26.67% 76	285	2.79
Incentives	5.61% 16	8.42% 24	11.93% 34	10.88% 31	12.63% 36	10.18% 29	40.35% 115	285	2.92

Q7 Please rank the following incentives according to their importance in determining your decision to purchase a EV. You can "drag and drop" to re-order where 1 is most important and 6 is least important

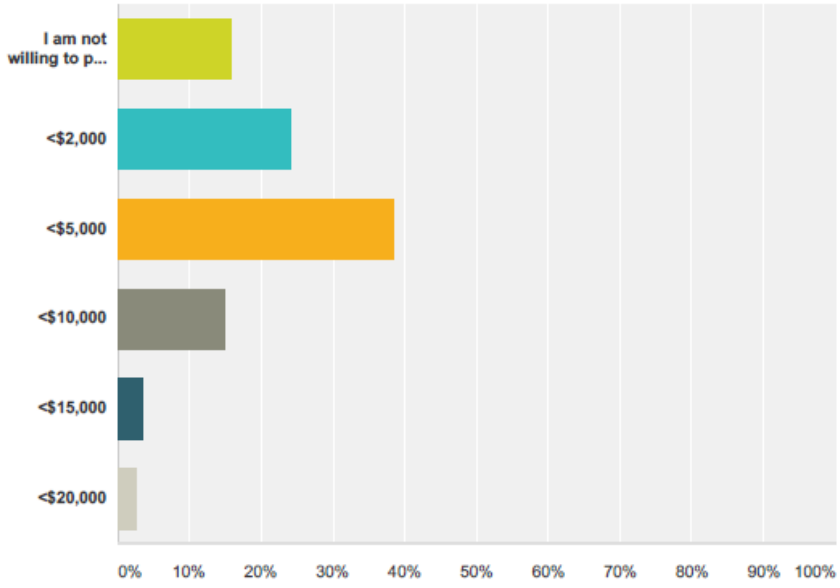
Answered: 285 Skipped: 0



	1	2	3	4	5	6	Total	Average Ranking
Vehicle tax credit	**67.37%** 192	**15.44%** 44	**10.18%** 29	**4.21%** 12	**1.05%** 3	**1.75%** 5	285	5.39
Charging station tax credit	**3.51%** 10	**36.14%** 103	**23.16%** 66	**16.14%** 46	**11.58%** 33	**9.47%** 27	285	3.75
Workplace charging	**9.12%** 26	**15.09%** 43	**27.37%** 78	**24.91%** 71	**10.88%** 31	**12.63%** 36	285	3.49
Free/priority parking	**5.96%** 17	**11.23%** 32	**15.79%** 45	**29.82%** 85	**25.61%** 73	**11.58%** 33	285	3.07
Time of use electric rate (discounted electric rate at night for PEV charging)	**8.77%** 25	**11.58%** 33	**13.68%** 39	**14.04%** 40	**31.23%** 89	**20.70%** 59	285	2.91
HOV lane access	**5.26%** 15	**10.53%** 30	**9.82%** 28	**10.88%** 31	**19.65%** 56	**43.86%** 125	285	2.39

Q8 How much more of an up-front price difference are you willing to pay for a new EV?

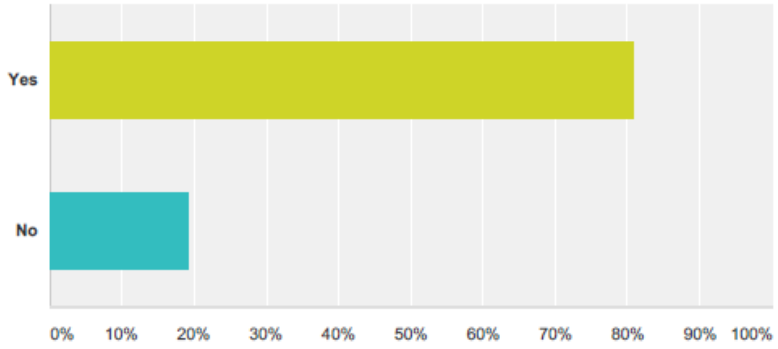
Answered: 285 Skipped: 0



Answer Choices	Responses	
I am not willing to pay any incremental cost	15.79%	45
<$2,000	24.21%	69
<$5,000	38.60%	110
<$10,000	15.09%	43
<$15,000	3.51%	10
<$20,000	2.81%	8
Total		285

Q9 Do you think that an electric vehicle saves money over the life of the vehicle, when compared to a gasoline-powered vehicle?

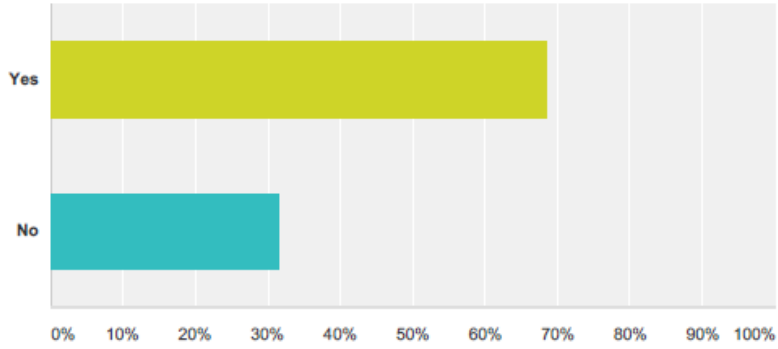
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	80.70%	230
No	19.30%	55
Total		285

Q10 Are you aware of the state tax credit available for EVs in Colorado?

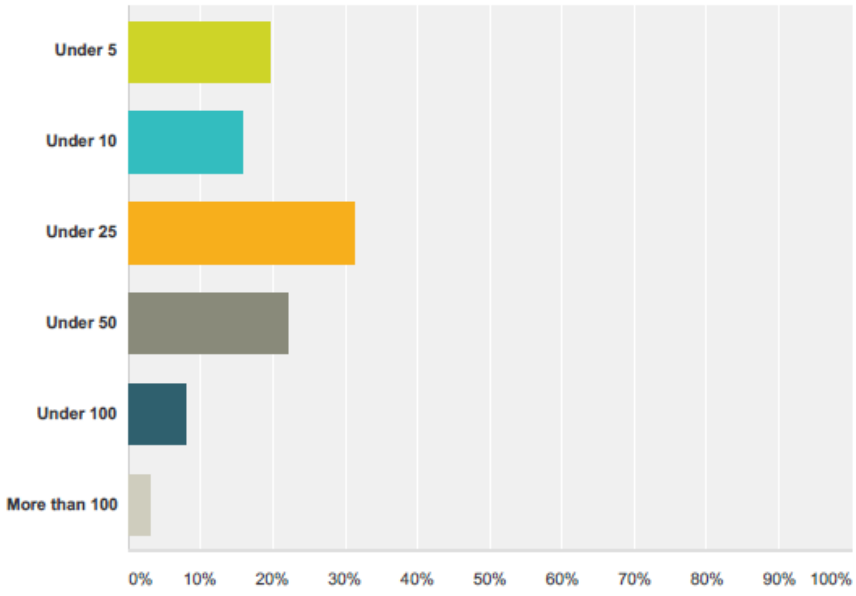
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	68.42%	195
No	31.58%	90
Total		285

Q11 On average, how many miles roundtrip do you drive for your daily commute?

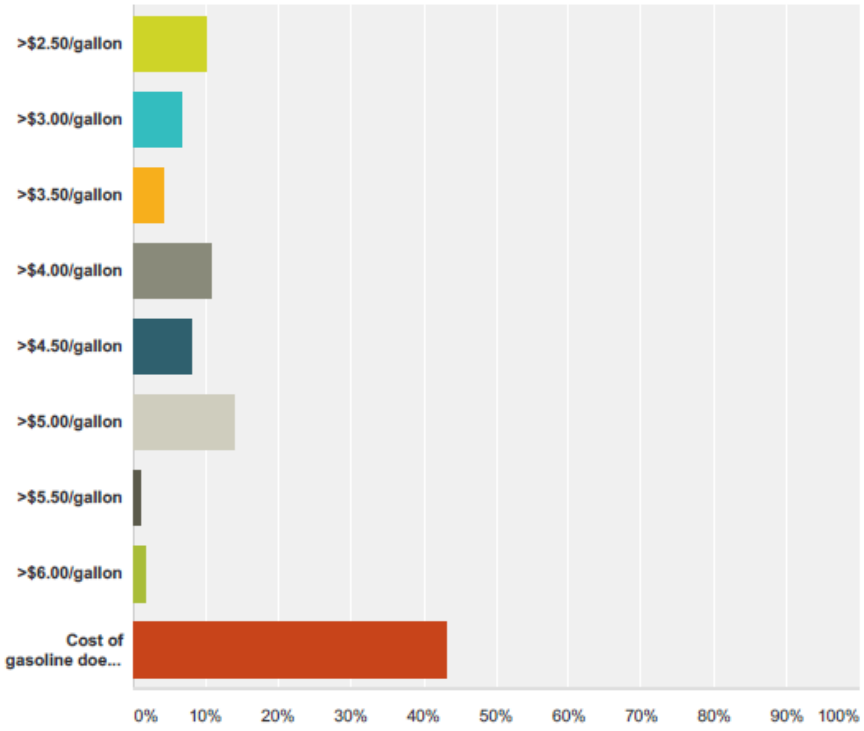
Answered: 285 Skipped: 0



Answer Choices	Responses	
Under 5	**19.65%**	56
Under 10	**15.79%**	45
Under 25	**31.23%**	89
Under 50	**22.11%**	63
Under 100	**8.07%**	23
More than 100	**3.16%**	9
Total		**285**

Q12 How expensive does gas in Colorado need to be before you'd seriously consider purchasing or leasing an EV?

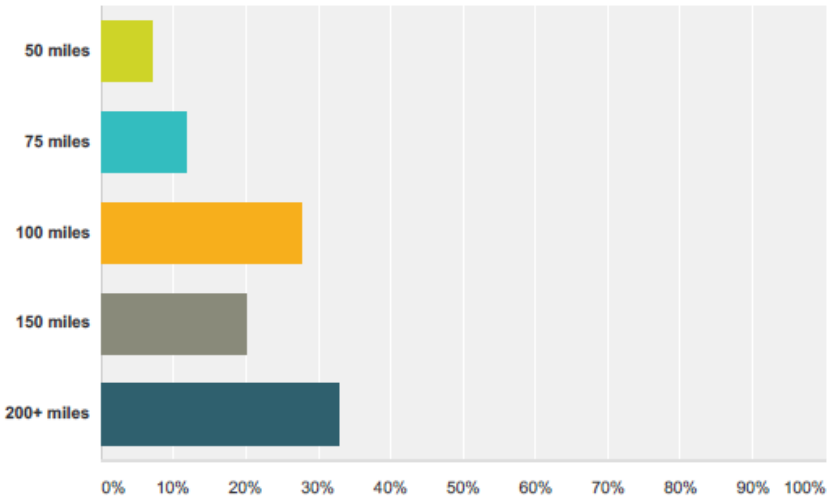
Answered: 285 Skipped: 0



Answer Choices	Responses	
>$2.50/gallon	10.18%	29
>$3.00/gallon	6.67%	19
>$3.50/gallon	4.21%	12
>$4.00/gallon	10.88%	31
>$4.50/gallon	8.07%	23
>$5.00/gallon	14.04%	40
>$5.50/gallon	1.05%	3
>$6.00/gallon	1.75%	5
Cost of gasoline does not impact my consideration of EV ownership	43.16%	123
Total		285

Q13 What is the minimum distance a PEV needs to travel on a single charge for you to feel comfortable?

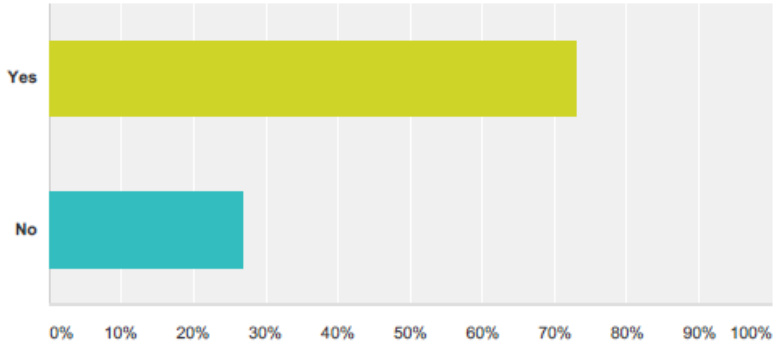
Answered: 285 Skipped: 0



Answer Choices	Responses	
50 miles	7.02%	20
75 miles	11.93%	34
100 miles	27.72%	79
150 miles	20.35%	58
200+ miles	32.98%	94
Total		285

Q14 Would access to charging at your workplace increase your likelihood to drive a PEV?

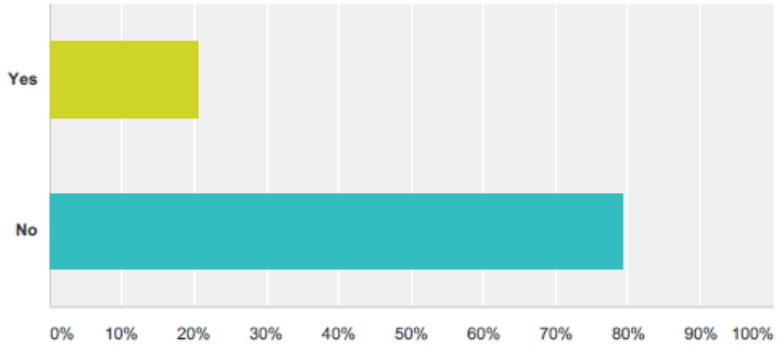
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	72.98%	208
No	27.02%	77
Total		285

Q15 Does your employer currently offer workplace charging for staff EVs?

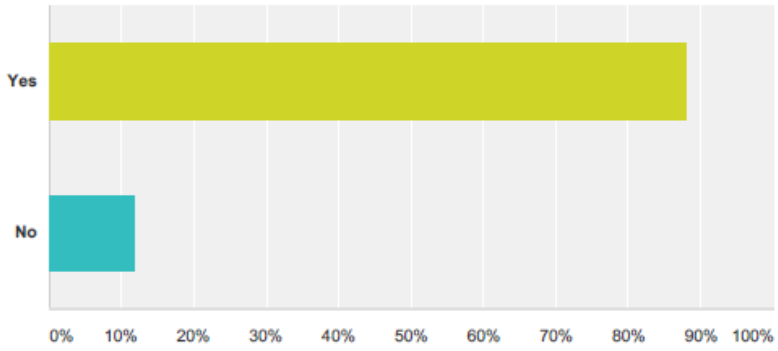
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	20.70%	59
No	79.30%	226
Total		285

Q16 Do you feel that it is fair for employers to offer EV charging to employees?

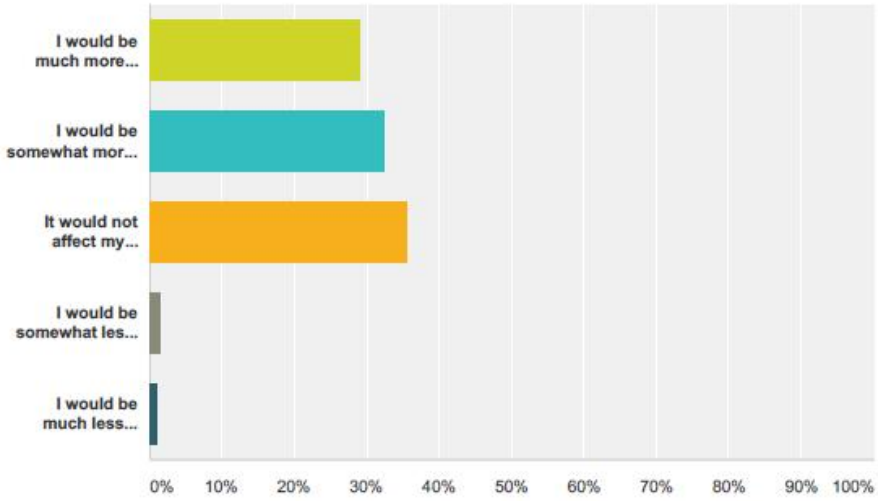
Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	88.07%	251
No	11.93%	34
Total		285

Q17 If a prospective employer offered EV charging to employees, how would it change your perception of that company/organization?

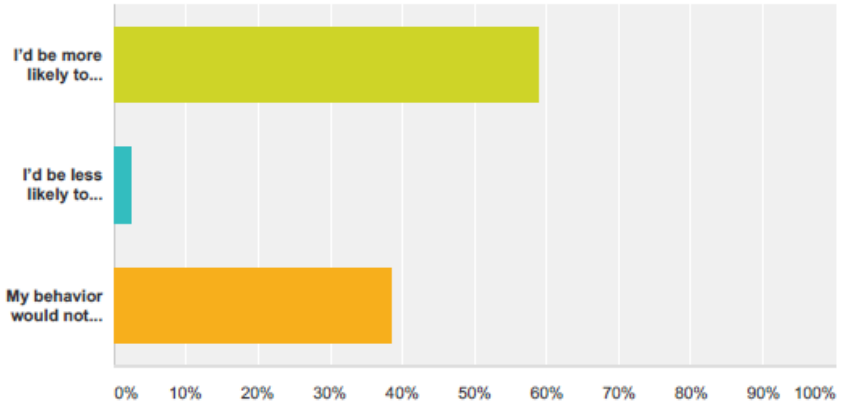
Answered: 285 Skipped: 0



Answer Choices	Responses	
I would be much more likely to accept a job at this company.	29.12%	83
I would be somewhat more likely to accept a job at this company.	32.63%	93
It would not affect my decision-making process.	35.79%	102
I would be somewhat less likely to accept a job at this company.	1.40%	4
I would be much less likely to accept a job at this company.	1.05%	3
Total		285

Q18 If a business offers EV charging to customers or visitors, it would have the following effect on my behavior:

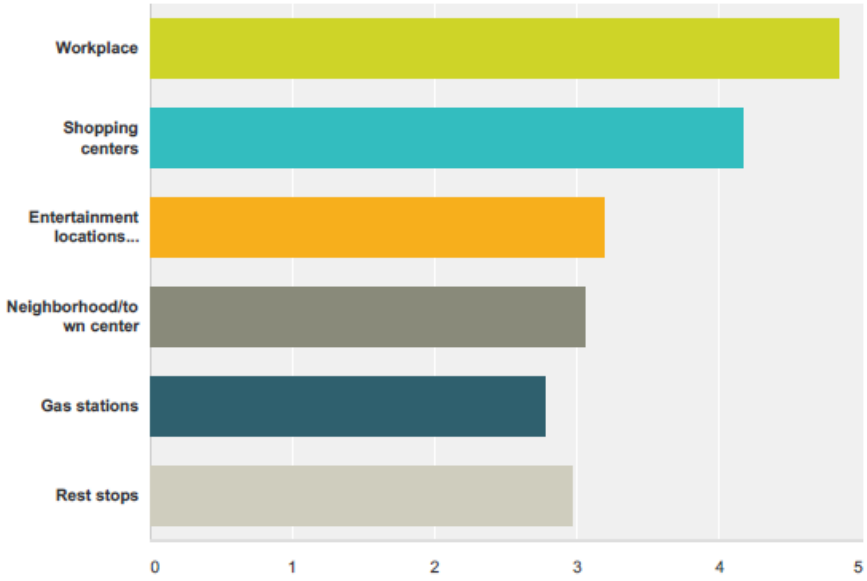
Answered: 285 Skipped: 0



Answer Choices	Responses	
I'd be more likely to patronize that business, regardless if I charged an EV or not	58.95%	168
I'd be less likely to patronize that business, regardless if I charged an EV or not	2.46%	7
My behavior would not change	38.60%	110
Total		285

Q19 In your opinion, what are the most appropriate locations for electric vehicle charging stations? You can "drag and drop" to re-order the options from 1 to 5.

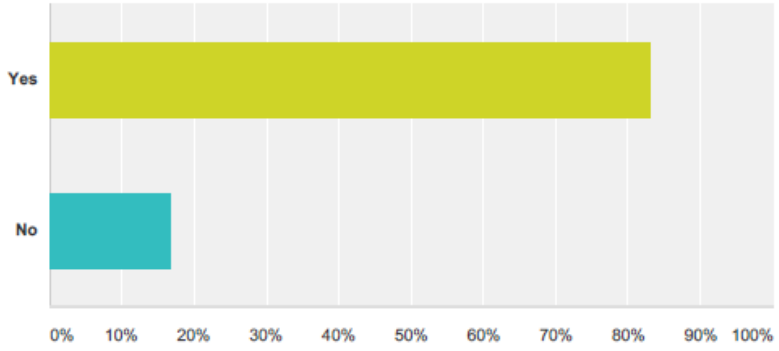
Answered: 285 Skipped: 0



	1	2	3	4	5	6	Total	Average Ranking
Workplace	**52.28%** 149	**15.09%** 43	**13.33%** 38	**8.77%** 25	**4.91%** 14	**5.61%** 16	285	4.84
Shopping centers	**13.68%** 39	**31.93%** 91	**25.96%** 74	**17.19%** 49	**8.07%** 23	**3.16%** 9	285	4.16
Entertainment locations (sports, cultural, etc.)	**2.81%** 8	**12.28%** 35	**27.72%** 79	**24.91%** 71	**22.81%** 65	**9.47%** 27	285	3.19
Neighborhood/town center	**8.07%** 23	**10.88%** 31	**13.68%** 39	**29.47%** 84	**22.11%** 63	**15.79%** 45	285	3.06
Gas stations	**14.74%** 42	**11.58%** 33	**5.96%** 17	**7.72%** 22	**24.91%** 71	**35.09%** 100	285	2.78
Rest stops	**8.42%** 24	**18.25%** 52	**13.33%** 38	**11.93%** 34	**17.19%** 49	**30.88%** 88	285	2.96

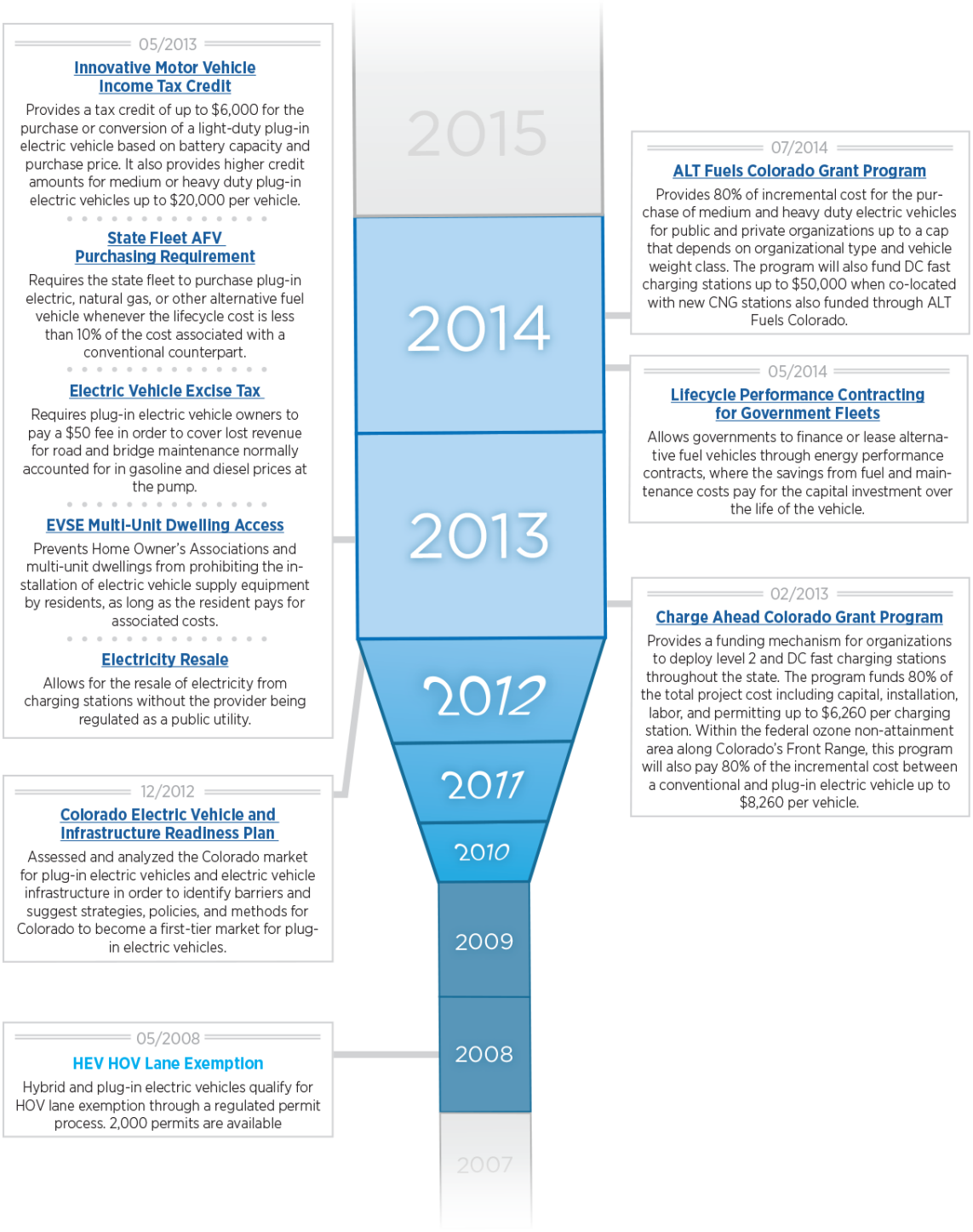
Q20 Do you see a benefit to an "Electric Highway" on Colorado interstates, with fast-charging stations every 50 miles which would charge a battery to 80% in 30 minutes?

Answered: 285 Skipped: 0



Answer Choices	Responses	
Yes	83.16%	237
No	16.84%	48
Total		285

Appendix D. Timeline of Electric Vehicle Policy and Programs in Colorado 2008–2014



Appendix E. Table of Policies and Programs in Other EV States

Topic Area	Program or Policy	Potential Policy/Program Solution	Model Policy/Program
Parking	Policy	Allow law enforcement the ability to ticket or tow cars that are illegally parked. Statewide statute that authorizes tickets for non-EVs parking in an EV space.	In California, an individual may not stop, stand, or park a motor vehicle, or otherwise block access to parking, in a stall or space designated for the exclusive purpose of charging a PEV unless the vehicle displays a valid state-issued, zero-emission vehicle decal and is connected for electric charging purposes.
Parking	Policy	Incentivize parking for EVs in the way that Car2Go vehicles are allowed parking access in downtown Denver.	In Hawaii, qualified PEVs affixed with special state-issued PEV license plates may use HOV lanes regardless of the number of passengers, and they are exempt from parking fees charged by any state or county authority.
Taxes	Policy	The original engine manufacturer could collect the tax credit and provides reduced monthly payments to the lessee or financing purchaser. With leases or dealer/bank financing, this concept alleviates the financial pressure on the customer's monthly payments. With cash purchases, it reduces the amount of liquid funds that the buyer would need to purchase an EV in the first place. In either case, the arrangement could be made optional to the buyer. Therefore, the buyer could always reject the dealer or bank offer and wait to file the tax credits himself.	n/a
Taxes	Policy	Change income tax credit to a tiered structure with a flat rate. For example, $2,500 for PHEVs and $5,000 for BEVs.	n/a
Insurance	Program	Work with insurance companies to broker policies with AFV discounts.	In California, Farmers Insurance provides an alternative fuel discount. Vehicles that run on

Topic Area	Program or Policy	Potential Policy/Program Solution	Model Policy/Program
			electric or electric/gasoline hybrid can lower auto insurance rates.[122]
EVSE	Program	More actively recruit, using data from the *EV Market Implementation Study*, to determine the next phase for Charge Ahead Colorado. Target areas where EVSE is missing compared to penetration rates for EVs. Use ArcGIS data to see where public attractions and points of interest are.	Maryland, Michigan, Texas, Washington
Financing	Program	Create a revolving loan fund that requires seed money but will see a return on investment based off of interest. CEO can set parameters for this project such as funding floor/ceiling, payback period, eligible equipment, and fuel types.	South Carolina, Nebraska
License Plate	Policy	Raise funds for EV programs and policies by creating an electric vehicle license plate.	In Hawaii, qualified PEVs affixed with special state-issued PEV license plates may use HOV lanes regardless of the number of passengers, and they are exempt from parking fees charged by any state or county authority.
Information	Program	Create a Colorado program that will offer businesses an opportunity to share successes and benefit from the positive public relations value of having EV programs.	Statewide "EV Everywhere Grand Challenge" combined with the Environmental Leadership Program (https://www.colorado.gov/pacific/cdphe/environmental-leadership-program) could include dealer recognition.
Information	Program	Disseminate information about EV performance at altitude and on steep grades.	Information on mountain topography and impacts on EVs.
Information	Program	Make a sample form for others to follow. Create an online portal that is easy to use.	https://energycenter.org/clean-vehicle-rebate-project

[122] Farmers Insurance, California Insurance Discounts, accessed December 18, 2014, http://www.farmers.com/california.

Topic Area	Program or Policy	Potential Policy/Program Solution	Model Policy/Program
Public Land	Policy	If public entities in Colorado choose to lease or sell property to fuel providers in the state, a contract can ensure that alternative fuels are being sold at these locations.	The Massachusetts Department of Transportation may not enter into, renew, or renegotiate a contract with a fuel provider for services on the Massachusetts Turnpike without requiring the provider to offer alternative fuel.

Appendix F. Market Outreach Strategy to Targeted Groups

Group name and Description/ Market Role	Outreach strategy

Colorado Automobile Dealers Association (CADA): www.coloradodealers.org
CADA is the voice of the automobile retail industry across Colorado. As the automobile dealer trade association, CADA advocates issues of importance to the auto industry, Colorado auto dealers, and Colorado drivers. CADA now represents 260 new car and truck dealers throughout the state to their various audiences, including U.S. Congress, the Colorado General Assembly, various federal and state regulatory agencies, city councils, the media, and the public. CADA owns and operates an EV charging station at its offices on Speer Boulevard in Denver.
	• CEO, in conjunction with the RAQC's existing expansive outreach effort, can co-host the booth and cars at Denver Auto Show and Green Car Parade
	• Utilize CADA resources to reach Colorado dealerships. CEO and partners could encourage CADA to include more market information on EVs to change the norm and evolve the culture of auto sales to include electric mobility. CEO partners could develop, forward, and ghostwrite content for these publications. Resources include the following:
	  • Colorado Dealer Compliance Guide—annual handbook
	  • Drive Colorado weekly newsletter—Education Training and Resources, Income 67 Tax Credit information
	  • CADA Open Road Newsletter—milestones and updates, Clean Cities Question of the Month, and seminar and event information
	  • Legislative bulletin—provides information on policy and current affairs affecting dealerships
	  • Colorado Retail Outlook—contains economic analysis and projections, county-specific summaries, and more
	  • Colorado Economic Impact Study—details information on economic impact of dealerships on Colorado market.

Large Employers[123] Many argue that workplace charging is the second most impactful location for EV charging (after residential charging) because it is the most common destination for drivers. Available workplace charging can give drivers more range confidence, enable a market sector with short commutes who do not have access to home charging, attract new talented workers to a business, allow companies to brand themselves as a green company, and help grow the market by	• In-depth engagement with EV workplace charging employers to drive EVs in Colorado. • Assist employers in developing a survey to gauge employee interest in electric vehicles • Work with the Clean Cities program to host ride and drive events at local, large employers such as University of Colorado, Craig Hospital, IHS, DirecTV, etc. • Work with human resources, Chambers of Commerce, employer councils, and/or fleet

[123] Calstart, "Best practices for Workplace Charging," September 2013, http://www.calstart.org/Libraries/Publications/Best_Practices_for_Workplace_Charging.sflb.ashx.

Group name and Description/ Market Role	Outreach strategy
providing a vehicle showcase for electric cars. According to an August 2014 DOE survey, employees of companies with charging stations are 20 times more likely to drive a plug-in vehicle. The survey also found that 90% of partners reported that their workplace charging stations are fully occupied at least five days a week. The ability to attract and retain top talent, the powerful demonstration of corporate leadership, and the sustainability benefits are three of the key motivations for employers providing workplace charging opportunities. Given the importance of workplace charging to EV drivers around the world, these initiatives will play a key role in achieving increased adoption of EVs, and a survey of Coloradans for the *EV Market Implementation Study* showed that more than 62% of employees would be somewhat or much more likely to choose an employer if it offered EV charging.	offices of large employers to conduct lunch-and-learn sessions on EVs and electrified transportation. • Provide content for employee newsletters. • Mentor the large employers to collect bids, manage work, obtain funding, and learn the process of offering EV charging to their employees. • Assist employers in conducting outreach to employees—managing expectations, handling parking rotation, addressing employee complaints, and controlling access.
General Public The general public provides the largest market for plug-in electric vehicles, more so than organizational fleets. As the model for availability, benefits, and duty cycle are appealing for commuters and two-car households, and the vast majority of vehicles on the road in Colorado are owned by individuals and not organizations. The general public may offer the largest market potential for EVs, but they are also the toughest to reach and convince through education. Most marketing and advertising strategies identified here may be targeted toward specific organizations or industry groups, but they are a means to reaching the general public, which is the ultimate goal.	Many of the efforts outlined for CEO in this section are currently being implemented successfully by the RAQC and local Clean Cities Coalitions. By dovetailing off of some of these efforts, staff resources can be saved and the regional efforts of RAQC can be spread statewide through promotion by CEO. • Use early adopters to spread message via op-eds and EV events, as well as employers. • Develop and promote social media content with EV leadership in Colorado. • Develop videos and user-generated content to be used for social media and promoted to various market segments in this table. • Update Electric Ride and Refuel Colorado, or consolidate resources. • Continue to leverage existing events where large crowds are present. This will help introduce EVs to a broader spectrum of groups. • Work closely with vehicle manufacturers and dealers to pool advertising dollars to create a 'brand' like Ozone Aware or 'Don't be an SOV,' but focus the campaign on how cheap and fun it is to drive an EV. Highlight tax credits and how Colorado is the least expensive state to buy an EV. Make it feel like it is 'Coloradan' to

Group name and Description/ Market Role	Outreach strategy
	drive electric. • Maximize advertising dollars with stakeholders by leveraging multiple marketing avenues. For example, if Nissan is putting money into TV/radio spots in this market, look for other methods—like social media, print media, LTEs, events, etc.—to maximize the reach and impact within a small timeframe. The likelihood of someone paying attention increases if he/she is getting information simultaneously through more than one source. • Ask EV owners to periodically enter their odometer readings on a site like the Electric Ride and start advertising how many "gas-free' miles Denver-area drivers have driven. Set up an inviting challenge, such as 1 million miles in 2015, to increase participation and awareness. • Engage the media through earned advertising. Invite journalists to media ride-and-drive events and have them tell the public about the benefits of electric vehicles. Make sure to get new EV charging station openings in the news through press releases, and announce any EV achievements to the media (new EV charging stations, EV grant funds, EV market adoption rates). • Focus less on how EVs will 'save the planet' and more on how they can 'save your wallet' in marketing to the general public. The operational cost savings and performance are the most intriguing aspects of EVs. Many people that are unfamiliar with electric vehicles think the only reason people drive them is to be environmentally conscious, so educating them about cost savings and performance can alter their perceptions.
First Responders As the number of EVs on the road increases, it will be increasingly important for first responders and public safety officers to be trained to properly identify and respond to incidents involving these vehicles. Comprehensive training is necessary to protect the safety of the first responders, as well as the vehicles' driver and passengers.	• Ease first responders into less technical trainings, such as with an introductory lunch-and-learn for safety management personnel to secure buy-in before introducing technical information to field personnel. • Partner with existing colleges and technical training institutes to offer courses. • Pair trainings with other technical offerings to attract more attendees. For example, a multi-

Group name and Description/ Market Role	Outreach strategy
	modal training could include bus, rail, and vehicle transit. A "bundled" approach may attract more participants. • Include vehicle test drives as part of the training. This will increase participants' knowledge of the vehicles and may also serve as an incentive to boost attendance. • Prepare printed materials utilizing National Alternative Fuels Training Consortium frameworks. Utilize existing channels to deliver materials to first responders and safety officers in both urban and rural areas. • Work with trained first responders and safety officers to communicate preparedness protocols outward to boost the public's confidence in the safety of the vehicles.
Public locations with longer dwell times According to a recent SWEEP policy brief,[124] with information from the Denver Regional Council of Governments, the top destinations in Colorado with the longest dwell times are ski resorts, Pepsi Center and other sports venues, universities, outdoor museums (such as the Denver Zoo and Denver Botanic Gardens), as well as concert and theater venues. These venues, along with others on the list, provide a real opportunity for available charging at places with long dwell times.	Many businesses in Colorado are unfamiliar with electric vehicle charging stations. They may not know that it exists, have misconceptions about the equipment, have cost constraints, or just not know where to get started. While residential and workplace charging are key areas, EV drivers need to feel reassured that they can fuel up when necessary. Possible messaging options to encourage businesses to offer EV charging include the following: • Informing businesses about the availability of funding assistance through the Charge Ahead Colorado program. • Communicating a financing mechanism or payback period to the venue. Information of this type has to focus on business plans where the venue offers charging for free and when a fee is charged. • Allowing businesses to capitalize on the PR value that offering EV charging can bring by creating a community recognition program through CEO. If it is modeled off of the EV Everywhere Grand Challenge and the Environmental Leadership Program at the Colorado Department of Public Health and

[124] Southwest Energy Efficiency Project (SWEEP), "Policy Brief: Expanding the Electric Vehicle Grant Fund to the Private and Non-Profit Sectors," February 2014, http://www.swenergy.org/data/sites/1/media/documents/legislation/documents/EV_Infrastructure_Fund_Policy_Brief_Feb_2014.pdf.

Group name and Description/ Market Role	Outreach strategy
	Environment, it could be the appropriate forum for recognition. There are many outreach mechanisms to make contact with facilities personnel at various public locations. These can include the following: • Using members of the Electric Vehicle Owners of Colorado club to be a grassroots force to expand the availability of publicly accessible EV charging. • Reaching out to ski venues through their corporate headquarters, such as Vail Resorts or Intrawest. The U.S. Forest Service could also provide a conduit into the ski resorts with their environmental management practices. • Pairing valet car companies with CEO partners to encourage the venues at which they contract to find ways to combine valet service with electric vehicle charging and concierge. • Utilizing the Green Sports Alliance, which is a consortium of more than 235 sports venues across the world, as a mechanism for reaching out to sports teams and venues in Colorado.
Ski Resorts The longer dwell times at ski areas provide an opportunity for EV drivers to charge their vehicles while skiing. Without charging infrastructure, EV drivers may not have the necessary range confidence to take their vehicles to the mountains. Barriers to increasing EV transportation to ski resorts include the impacts of cabin heating requirements to electric vehicle battery capacity, which can diminish range and the overall distance traveled, and the absence of DC fast charging infrastructure on mountain corridors.	• Continue working with RAQC and CEO to push out Charge Ahead grant opportunities for EVSE along mountain corridors. • Work with EVSE distributors to guide installation of Level III (DC fast charging) along main mountain corridors. • Partner with ski resorts to advocate for charging infrastructure and communicate to their customer base. • Provide EV owners and advocacy groups with up-to-date information on infrastructure via a website and other push notifications.
Car Sharing As a younger generation of drivers moves away from the car ownership model, car-sharing services have become increasingly popular in Colorado. These programs are based around short, one-way rentals. Users pay a membership fee and receive a radio frequency identification card. When they wish to rent a vehicle, they reserve a car online. They're able to unlock the car charger with their card and then swipe the card on the	Electrifying the car-sharing market is a strategy to overcoming multi-unit dwelling charging station access challenges. While these services are trendy and highly utilized in Denver, their petroleum-reducing impact can be increased by including EVs locally. Increasing the uptake of these vehicles can be done with the following strategies. • These vehicles function as moving billboards, meaning that they're highly visible and are seen

Group name and Description/ Market Role	Outreach strategy
windshield, which unlocks the car and allows them to drive. eThos Carshare recently launched in Golden, Colorado, and features a fleet of electric vehicles. While the Car2Go service operates in Colorado, the service has yet to include EVs in its fleet locally. However, one benefit of Car2Go is free unlimited parking at downtown Denver meters. A study by Navigant Research found that the global car sharing industry grew dramatically from 2008 to 2013 and predicted that it would be worth $6.2 billion by 2020.[125]	by many drivers. CEO can work with these car-share companies to increase the number of EVs operated locally, and CEO can work with state purchasing and procurement to authorize state employees to use car-share services when applicable or appropriate. • Social media is a great way to target potential members of a car-sharing service. By working with these companies to run contests for free access to electric vehicles, the Colorado market will see an uptake in the numbers of these vehicles on the road. • CEO, partners, and car-sharing companies can target influential people in the Denver market to be brand ambassadors for an EV car-sharing program. This can include elected officials, TV and radio personalities, athletes, and musicians.
Rental cars The availability of EVs through traditional car rental agencies allows current EV owners to continue "driving electric" away from home and provides an opportunity for travelers who are interested in test driving an EV for an extended period.	• Car rental companies at area airports and other rental locations should receive training on EV technologies in order to provide customers with accurate information. • Charging station maps need to be made available to customers prior to rental. EV drivers need to have a sense ahead of time if the current EV infrastructure will suit their traveling needs. The information should be reviewed at time of rental. Maps must include a key indicating type of access (networked, open, free, pay-per-charge, etc.). Maps should also include information on scale so customers can judge distance in order to build range confidence. • Information about renting an EV in Colorado should be made available on a centralized portal such as www.ElectricRideColorado.com. To drive the public to this website, applicable keyword searches should be purchased.
Utility programs Utilities are a major stakeholder in the adoption of EVs. They have the potential to create an entirely new revenue stream from EV owners paying them for their 'fuel.' The actions that utilities take now	• Utilities can promote what they are doing to spur EV growth as positive marketing that improves their image on issues like clean air and pollution. They can put funding into the branding campaign and get recognition through

[125] Navigant Research, Carsharing Programs, accessed December 18, 2014, www.navigantresearch.com/research/carsharing-programs.

Group name and Description/ Market Role	Outreach strategy
to encourage or discourage EVs can have a great effect on the market.	their logos and through promotion of the campaign on their websites. • Utilities can promote their internal resources for assistance with EVs, such as Xcel Energy and its response team email (RePoweringTransportation@XcelEnergy.com). • Utilities may be hesitant to directly invest in infrastructure and vehicle deployment outside of their own fleet, but they can do direct marketing to their consumers about the benefits of EVs, tax incentives, and EV news. • Offering cheaper rates for EV charging at certain times of the day (TOU rates) can be effective in encouraging EV drivers to charge at times when the grid demand is low, helping utilities use energy during off-peak hours. • Utilities can partner with original engine manufacturers to offer their renewable energy programs to new EV drivers. • Utilities may be hesitant to directly fund grant programs for infrastructure, but they can fund local groups that have substantial existing efforts to promote EVs—such as Clean Cities, RAQC, and Drive Electric Northern Colorado.
Industry leaders EVs have many advocates in state and local governments, environmental organizations, businesses, and NGOs, yet ownership rates among these groups remain relatively low. These individuals are natural ambassadors and should be encouraged to purchase and/or lease EVs as a way to increase adoption rates among the general public.	• Continue to turn enthusiasm into action. Invite industry advocates to ride-and-drive events, such as the current Clean Cities efforts being funded by RAQC and Xcel Energy, and invite them to take the vehicles for a test drive if they have not done so. • Consider offering some additional incentive for this group to accelerate adoption. Similar efforts have been undertaken with solar—offering members of certain groups' access to additional discounts or enhanced services. This could be done through an effort such as the Environmental Leadership Program.

Appendix G. Sample Questions for Assessing Employee Attitudes about EVs and Charging Stations

1. Do you currently own a plug-in electric vehicle (PEV)?
    a. Yes
    b. No

2. Have you considered a PEV for your next vehicle?
    a. Yes
    b. No

3. Would access to charging your vehicle at work increase your likelihood of purchasing a PEV?
    a. Yes
    b. No

4. Would you be willing to pay for the electricity to charge your PEV at work?
    a. Yes
    b. No

5. What is the roundtrip distance for you to commute to work each day?
    a. <5 miles
    b. <10 miles
    c. <25 miles
    d. <50 miles
    e. 50+ miles

6. Do you think we should offer PEV charging as an employee benefit?
    a. Yes
    b. No

Appendix H. Sample Employer Considerations for Workplace Charging

The employee survey in the previous section can be used to gather information from staff. The questions below can be used to aggregate responses and then use in the "Best Practices" section to provide an effective workplace charging program.

1. How many employees do you have at the location you're considering for workplace charging?

2. How many employees currently drive PEVs at the workplace charging location?

3. How many employees have considered a PEV for their next car?

4. Are you willing to provide electricity to employees without a fee or cost for charging?

5. What percentage of your employees are full time?
   - ☐ 0%–25%
   - ☐ 25%–50%
   - ☐ 50%–75%
   - ☐ 75%–100%

6. Do you own the property where your employees park?

7. How far is the nearest electrical outlet/infrastructure to the parking spaces you're considering for workplace charging?
   - ☐ <10 feet
   - ☐ 10–20 feet
   - ☐ 20–50 feet
   - ☐ 50–100 feet
   - ☐ 100+ feet

8. Do you want your company's charging stations to be open to the public at any time?
   - ☐ Yes
   - ☐ No

9. What data do you want to collect on charging usage? (Check all that apply.)
   - ☐ Electricity used by each station
   - ☐ Electricity used by all stations combined
   - ☐ Time of day charging occurs
   - ☐ Length of time charging occurs
   - ☐ Who is charging
   - ☐ We don't want to collect any data

10. Do you want the electricity you provide to be from renewable sources?

11. What is your project budget?

Appendix I. Best Practices for EV Charging Guidelines

The survey and consideration questions above should provide the basic information needed to plan for a workplace charging infrastructure project and program. The steps below provide general guidance and best practices to help determine project specifics, including the number and type of chargers to install, project costs, site considerations, monitoring, and employee education.

1. **Assessing the need and project size**

   When determining project size and number of chargers, an employer should always meet both the current and near-future demand. Questions 1–3 in the employee survey can help the employer measure current charging demand and estimate future demand. This information can be useful in determining the rules and etiquette surrounding the use of the charging stations, including maximum use or time limits to charging.

   After installing workplace charging, employees feel more comfortable considering the purchase of a PEV; therefore, PEV ownership can often rise. That is why workplace charging is such a significant tool in any organization's sustainability goals—it encourages PEV adoption. If an employer has two PEV owners today, it shouldn't just install two charging stations to meet the current charging needs; it should prepare for an influx in charging demand from other employees who buy PEVs in response to the availability of workplace charging. A ratio of 1 charger for every 2 EV has been recommended in recent articles on workplace charging.[126]

   The greatest cost associated with workplace charging is often the trenching of conduit and concrete work required—not the charging stations themselves or the electricity that is provided. While the concrete is dug up for installation of the first charging stations, prepare for future charging demand by running conduit to additional parking spaces. This will minimize the cost and expedite the expansion of charging stations in the future.

   A general rule of thumb, especially for large employers, is to provide charging for the existing PEV owners and then install additional charging for 1%–2% of the employees. A company with 100 employees that has two PEV drivers could install two charging stations to meet current demand and additional 1–2 to support additional demand. A company with 1,000 employees and 5 PEV drivers could install 15–25 charging stations (5 for existing drivers and an additional 10–20 for future demand). In both circumstances, employers should consider laying conduit to additional parking spaces during the initial installation process to prepare for long-term demand.

[126] Dana Hall, San Jose Mercury News, "'Charge rage': Too many electric cars, not enough workplace chargers," January 19, 2014, http://www.mercurynews.com/business/ci_24947237/charge-rage-too-many-electric-cars-not-enough-workplace-chargers.

2. **Site Selection**

   The site selected for installation of charging stations should be evaluated on the following criteria:

   - Proximity to existing electrical—the closer the better. This will minimize project costs associated with trenching, materials, and concrete.
   - Safety—the parking spaces and charger locations should be compliant with the Americans with Disabilities Act, have ample lighting to avoid tripping and other hazards, provide enough space for convenient access to the charger, provide space for installation of curbs and bollards, and be located away from any other potential hazards.
   - Space—the site should include enough spaces to meet both existing and future charging demand. Having to start a new project from scratch in a different part of the facility will increase costs in the future and create confusion among employees about where charging is offered.

3. **Charging Type**

   Charging station equipment can vary in price between $500 and $7,000 depending on the features and functionality desired from the unit. The first consideration for charger type is whether to provide Level I or Level II charging, which will determine the rate cars can charge. Beyond the level of charging, there are four common features available on charging stations that will need to be considered as well.

   - Level I Charging
     - 120 Volt AC.
     - Charges at 3–5 miles per hour.
     - The electricity required is less, and the units themselves are cheaper than Level II charging.
     - If the average commute of employees at the workplace charging location is less than 20 miles per day (Question 5 in employee survey), Level I charging is a cost-effective way to provide workplace charging. Level I charging also offers the opportunity to maximize the number of charging stations provided to employees, while minimizing the cost.

   - Level II Charging
     - 208–240 Volt AC, 14–70 amps (depending on model).
     - 10–30 miles per hour (depending on car charger—3.3 kW–20kW).
     - Wide range of costs and capabilities.
     - Level II is the most common type of charging station. For employees needing to put 30+ miles of charge into their cars throughout the day, Level II is likely the optimal charger type.
     - Once the level of charger has been determined, there are other features available on charging stations that should be considered:
       - Networked: Adds station to an existing charging network for a monthly service fee
       - Data collection:

    - Collects information on charging times, length, persons, etc.
    - Costs vary depending on the level of detail and quantity of information collected. Some stations have an SD card slot that is used to upload data to a computer for analyzing. To minimize costs and still collect data, stations can be sub-metered by the electrician so the employer knows how much electricity is being used by each/all stations, but won't know length of charging time, who is charging, what time charging is occurring, etc.
    - Ideal for employers that want to collect charging information for research or planning purposes.
    - Question 9 in the employer survey will help determine if data collection is needed.
- Credit card payment:
    - Allows EV owner to pay for electricity.
    - Minimizes employee benefit.
    - Questions 4 and 6 on the employee survey, along with question 4 on the employer survey, can help with this decision.
- Radio frequency identification access:
    - Limits access to people who have gone through a registration process and have attained a radio frequency identification access card.
    - Is great for workplace environments where the employer doesn't want to provide charging to the general public, only to employees. Provides a means to limit who can charge without making people pay for the electricity.
    - Allows recording and measurement of EV ownership at the facility.
    - Question 8 in the employer survey is relevant here.

4. Site evaluation and estimate with contractor

- Hire an electrical contractor to do a site evaluation.
- Efforts will include determining EVSE type, assessing building demands, and gathering all necessary permits.

5. Project cost

- Site selection and features desired from the unit will impact cost.
- There are many EVSE manufacturers and versions available on today's market, and which option you choose will determine the cost.
- Each EVSE manufacturer has additional features that set them apart from others (retractable cord reels, aesthetic properties, advertising availability, others), but deciding which of these four main features are desired will help the employer pinpoint the type of unit most suitable for their needs.
- Most employers will need to hire an experienced installer to install the charging station. Sometimes this involves trenching concrete to lay conduit, which can increase the cost of installation.

6. **Employee education and promotion**[127]
    - Invite PEV-driving employees to give a presentation or webinar about their experiences with PEVs, and encourage them to engage in discussion with fellow employees.
    - Place informational posters in office common areas to raise employee awareness about the organization's workplace charging program.
    - Hold a "Workplace Charging Tour" to demonstrate the ease and accessibility of PEV charging stations and inform employees of your organization's charging procedures.
    - Include employee testimonials and information on the benefits of PEVs in your organization's newsletter or other internal communications materials.
    - Inform new employees about workplace charging procedures and policies at orientation.
    - Develop an online forum or other communication method that allows current PEV-driving employees to improve their charging experience and potential PEV drivers to learn more.

7. **Monitoring/evaluation**
    - Determine the amount of EV charging station usage.
    - Gather detailed analytics regarding system usage, electricity consumed, and subsequent costs.
    - Monitor system health.
    - List EV charging station locations on digital maps, such as Google Maps and navigation systems.
    - Allow drivers to make reservations.
    - Control who has access to the system at certain times (e.g., business hours of employer).
    - Track the amount of greenhouse gas emissions the use of your EV charging station has prevented.
    - Upgrade software easily online for future advancements.

[127] U.S. Department of Energy, Workplace Charging Challenge, "PEV Outreach Resources for Your Employees," November 2014, http://energy.gov/sites/prod/files/2014/11/f19/Toolkit_EmployerGuidance_Final_11-14-14.pdf.