Air Quality and Economic Benefits of Electric Vehicles in New Mexico

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ABOUT SWEEP

The Southwest Energy Efficiency Project is a public interest organization dedicated to advancing energy efficiency in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming. For more information, visit www.swenergy.org.

SWEEP's Transportation Program 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. SWEEP's work focuses on two general strategies: reducing vehicle miles traveled and improving vehicle fuel efficiency.

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EXECUTIVE SUMMARY

Electric vehicles (EVs) provide significant air quality and economic benefits to Bernalillo County and the entire state of New Mexico. Therefore, the State should consider policies that overcome barriers to greater numbers of people acquiring EVs.

SWEEP has conducted an analysis which shows that in Bernalillo County, EVs reduce emissions of criteria pollutants compared to a comparable gasoline-fueled vehicle. In 2013, the largest emissions reductions (99% compared to a gasoline-fueled vehicle) are for volatile organic compounds (VOC) and carbon monoxide with significant additional reductions in nitrogen oxides (NOx) and particulate matter (62% for NOx, 52% for PM2.5, and 39% for PM10).

The adoption of EVs will help the region address its air quality challenges, especially high levels of ground-level ozone (created by VOC and NOx) which may not meet anticipated new federal emissions standards. Reduction of all these pollutants provides public health benefits to the region by reducing respiratory ailments, especially in vulnerable populations such as children and the elderly.

Electric vehicles also provide economic benefits to the state by reducing fuel costs and shifting consumption away from imported oil to more locally produced electricity sources. Electric vehicle drivers can expect to save between $1,100 and $1,600 annually on fuel costs. Net lifetime savings are estimated to be between $13,000 and $20,000.[1] Depending on the rate of adoption for EVs and the price of gasoline, the total economic benefit to the state of New Mexico in reduced fuel costs would be between $32 million and $200 million per year by 2030. These fuel savings become additional disposable income that will be mostly spent in the local economy, creating additional jobs in the state.

An upfront incentive, such as a tax credit to offset the incremental purchase cost of electric vehicles, would further spur the adoption of electric vehicles and maximize the benefits they bring to the state of New Mexico. A comprehensive listing of state level policies that can support the adoption of electric vehicles can be found in SWEEP's report: *Policies to Promote Electric Vehicles in the Southwest: A State Government Report Card*.[2]

BENEFITS OF ELECTRIC VEHICLES

There are currently fifteen light-duty electric vehicles (EVs) available from large scale vehicle manufacturers, including plug-in hybrid electric vehicles (PHEVs), with seven more models expected in 2014.[3] With so many diverse models available over the next few years, electric vehicles

[1] The amount saved depends on the future price of gasoline.
[2] Salisbury, M. 2013. Policies to Promote Electric Vehicles in the Southwest: A State Government Report Card Retrieved from http://swenergy.org/publications/documents/EV%20Report%20CardFNLwithCover.5.15.13.pdf.
[3] FuelEconomy.gov. 2013. Electric Vehicles and Plug-in Hybrids. Retrieved from http://www.fueleconomy.gov/feg/evsbs.shtml and http://www.fueleconomy.gov/feg/phevsbs.html.

have the potential to play an important part in the transportation future of New Mexico. The benefits of EVs compared to gasoline fueled vehicles include the following:

- *Greater efficiency*: Compared to gasoline powered internal combustion engines, electric vehicles can travel the same distance using approximately 23% less energy.[4]
- *Locally produced energy source*: Over 80% of the petroleum and refined gasoline used in New Mexico is imported, while electricity is produced using resources abundant in the state.[5]
- *Reduced emissions*: EVs have the potential to reduce greatly harmful tailpipe emissions compared to gasoline powered vehicles.[6]
- *Reduced Fueling Cost*: Because of their higher efficiency and the low cost of electricity compared to gasoline per unit of energy, electric vehicles can travel the same distance as a typical conventional vehicle at the cost-equivalent of $1.25 per gallon.[7]

Furthermore, the energy and environmental benefits of electric vehicles are expected to increase as older power plants are retired and additional natural gas and renewable generation is constructed.[8] Bernalillo County and surrounding areas suffer from air quality challenges,[9] and light duty vehicle emissions are a significant source of emissions that contribute to this problem.[10] Supporting widespread adoption of electric vehicles is an important strategy for addressing air quality in the region.

ANALYSIS OF AIR EMISSIONS FROM ELECTRIC VEHICLES IN BERNALILLO COUNTY

Analysis Methodology

SWEEP performed an analysis comparing the emissions associated with three types of electric vehicles in 2013: a plug-in hybrid electric vehicle that has an electric range of 10 miles (PHEV10);[11] an extended range EV with an electric range of 40 miles (PHEV40);[12] a battery electric vehicle

[4] Salisbury, M. and Toor, W. 2013. Transportation Fuels for the Southwest's Future: Life-cycle Energy Use and Environmental Impacts of Electric, Compressed Natural Gas, and Gasoline Vehicles. Available at www.swenergy.org.
[5] Energy Information Administration. 2013. New Mexico: State Profile and Energy Estimates. Retrieved from http://www.eia.gov/state/data.cfm?sid=NM.
[6] Salisbury and Toor, 2013. Transportation Fuels.
[7] US Department of Energy. 2013. eGallon: Compare the costs of driving with electricity. Retrieved from http://energy.gov/maps/egallon.
[8] Salisbury and Toor, 2013. Transportation Fuels.
[9] City of Albuquerque. 2013. Ozone in Albuquerque. Retrieved from http://www.cabq.gov/airquality/todays-status/air-quality-index/ozone
[10] Environmental Protection Agency.2011. Air Emission Sources. Retrieved from http://www.epa.gov/air/emissions/index.htm.
[11] The PHEV10 was modeled on the 2013 Toyota Prius Plug-in Hybrid.
[12] The PHEV40 was modeled on the 2013 Chevy Volt.

(BEV) with a range of 70 miles;[13] a compressed natural gas (CNG) vehicle;[14] and a traditional gasoline passenger vehicle.[15] This analysis focused on air quality emissions around the Albuquerque metropolitan area where approximately one-third of the state's population lives.[16]

The analysis evaluates emissions of the following criteria pollutants: ground-level ozone precursors, such as volatile organic compounds (VOCs) and nitrogen oxides (NOx); particulate matter of 2.5 and 10 micrometers (PM2.5 and PM10); carbon monoxide (CO); and sulfur dioxide (SO_2).[17] The analysis also evaluates greenhouse gas (GHG) emissions.
The NOx and VOC emissions are particularly important as the region is currently close to being **in** non-attainment for permissible levels of these pollutants. The U.S. Environmental Protection Agency (EPA) is expected to issue new ozone standards in 2014, which may present additional challenges by lowering allowed ozone levels from 75 parts per billion (ppb) to 70 ppb or lower.

SWEEP performed analysis using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) fuel-cycle model developed by the Argonne National Laboratory with funding from the U.S. Department of Energy.[18] The GREET model was used to make a comparison between the life-cycle emissions of three light-duty vehicle fuels: gasoline, electricity, and natural gas. New vehicles purchased in 2013 are analyzed to show which vehicles will have the most immediate impact regarding energy use and emissions (see Figure 1 and Table 1 below).

The analysis also looks at how new vehicles purchased in 2020 perform in that year (see Table 2 and Figure 2). We only considered regulations that have been adopted, so did not assume emissions reduction in 2020 for gasoline vehicles from the EPA's proposed new Tier III emissions and fuel standards, which will impact 2017 and later model years if they are adopted.[19] If the Tier III standards are adopted, the emissions associated with new gasoline vehicles sold after 2017 will decline significantly. We also did not assume new EPA rules that may further reduce emissions

[13] The BEV was modeled on the 2013 Nissan Leaf.
[14] The CNG vehicle was modeled on the Honda Civic Natural Gas.
[15] A new average gasoline passenger vehicle has a fuel economy rating of 28 mpg.
[16] Bureau of Business and Economic Research. 2013. Population Estimates and Projections. Retrieved from http://bber.unm.edu/demograp2.htm.
[17] "The Clean Air Act requires EPA to set National Ambient Air Quality Standards for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants can harm your health and the environment, and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats. EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels. The set of limits based on human health is called primary standards. Another set of limits intended to prevent environmental and property damage is called secondary standards." US EPA, *What are the Six Common Air Pollutants*, available at: http://www.epa.gov/airquality/urbanair/. Information about EPA's National Ambient Air Quality Standards is available at http://www.epa.gov/air/criteria.html.
[18] Argonne National Laboratory. 2012. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation. Retrieved from http://greet.es.anl.gov/.
[19] Assuming the federal Tier III emissions and fuel standards are implemented, beginning in 2017 all new passenger vehicles will have the same tailpipe emissions as the Honda Civic CNG. Therefore, beginning in 2017 EVs will represent the primary opportunity for additional reductions in tailpipe emissions in new passenger vehicles.

from electric power plants. We assumed new gasoline and CNG vehicles purchased in 2020 will meet the CAFE fuel economy standards that will be in effect in 2020.

To estimate electricity generation mixes, we relied on analysis conducted by Synapse Energy Economics for SWEEP's *$20 Billion Bonanza* study.[20] We used the same source for estimated NOx emission rates from coal power plants for 2013 and 2020.

There are two major variables to consider when estimating which electricity sources will meet the marginal demand created by increased utilization of EVs. For most utilities, natural gas is expected to meet the majority of marginal electricity demand over the course of the year. However, most EV charging is expected to take place during the evening and early morning hours when there may be spare coal capacity that could be used to meet additional EV demand. These late hours coincide with peak wind generation. As the relative importance of these two variables is unknown and especially difficult to attempt to quantify for future years, we decided to use the average generation mix forecast for 2013 and 2020 for both base load and marginal electricity demand.

The GREET model calculates the amount of emissions occurring in urban areas to show which emissions would be most likely to contribute to air quality issues. To better represent the impact that electric and gasoline vehicles will have on air quality, we characterized the transportation energy system in New Mexico to show exactly which emissions are likely to contribute to pollution in Bernalillo County's airshed. (In July 2013, SWEEP released a multi-state analysis of emissions from electric vehicles. That report arrives at slightly different conclusions for New Mexico because it analyzes *statewide* lifecycle emissions and does not focus specifically on the Albuquerque metropolitan area.)[21]

Regarding relevant upstream emissions from electricity, we calculate based on EPA data that 6% of statewide coal plant emissions and 1% of natural gas plant emissions take place in the area around Bernalillo County and contribute emissions into the County's airshed.[22] For upstream emissions for gasoline vehicles, 16% of the statewide emissions associated with gasoline refining take place near Bernalillo County.

Regarding the extraction of fuel (mining and drilling), 45% of the state's coal is mined west of Albuquerque and 3% of oil and 63% of the state's natural gas production occurs in areas near Bernalillo County.

Air Emissions Results

The analysis shows that in Bernalillo County all types of electric vehicles reduce emissions of criteria pollutants (save for SO_2) compared to a comparable gasoline fueled vehicle. Except for

[20] Geller H. et al, The $20 Billion Bonanza: Best Practice Utility Energy Efficiency Programs and Their Benefits for the Southwest, 2012.Retreved from http://www.swenergy.org/programs/utilities/20BBonanza.htm.
[21] Salisbury, M. and Toor, W. Transportation Fuels for the Southwest: Life-cycle Energy Use & Environmental Impacts of Electric, CNG and Gas Vehicles. Retrieved from http://swenergy.org/publications/documents/Regional%20Fuel%20EmissionsFNL.pdf.
[22] Environmental Protection Agency. 2013. eGRID2012 Version 1.0. Retrieved from http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html.

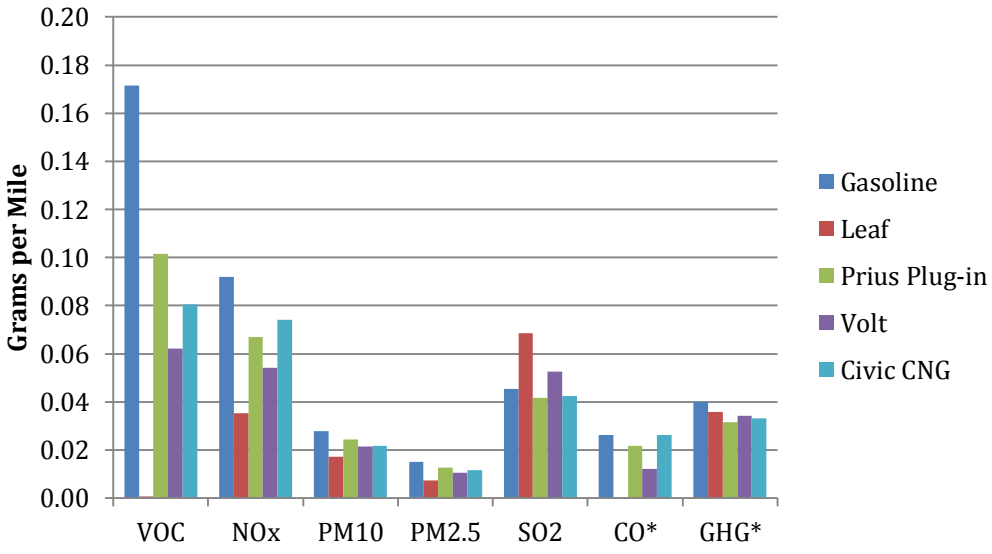
greenhouse gases, the scale of the reductions in emissions depends on the amount of electricity used as a fuel. BEVs achieve the greatest level of reductions, with PHEVs having smaller level of reductions; PHEV40s (which travel 57% of their miles on electricity) have the second greatest level of reductions and PHEV10s (which travel 26% of their miles on electricity) have the least amount of emissions reduction compared to gasoline vehicles. The analysis also shows that EVs and CNG vehicles have comparable emissions profiles, with both having a clear advantage over gasoline-fueled vehicles.

In Table 1 and Figure 1 we break down the reductions in harmful air pollutants from EVs in Bernalillo County in 2013. BEVs have essentially zero emissions of VOCs and CO. The largest reductions are in the ozone precursors, VOC and NOx. Compared to CNG vehicles, the BEVs generally have lower emissions (except for SO_2) while the PHEVs generally have more equivalent emissions.

Table 1 | Percent Reduction in Emissions in 2013 Compared to New Gasoline Vehicle

Pollutant	BEV	PHEV10	PHEV40	CNG
VOC	-99.7%	-40.9%	-63.7%	-53.0%
NOx	-61.5%	-27.0%	-41.1%	-19.2%
PM10	-38.7%	-12.9%	-22.6%	-22.1%
PM2.5	-52.0%	-15.8%	-30.2%	-22.7%
SO_2	51.3%	-8.1%	15.8%	-6.4%
CO	-99.9%	-17.2%	-54.0%	-0.4%
GHG	-10.7%	-21.4%	-14.6%	-17.2%

Figure 1 | Criteria Pollutant Emissions in Bernalillo County by Vehicle Type, New 2013 Vehicles



**The scales of emissions from CO and GHG have been changed so that all the pollutants could be placed in one chart. CO emission rates have been reduced by a factor of 100, so the actual value is about 2.0 grams per mile. GHG emission rates have been reduced by a factor of 10,000, so the actual value is about 300 grams per mile.*

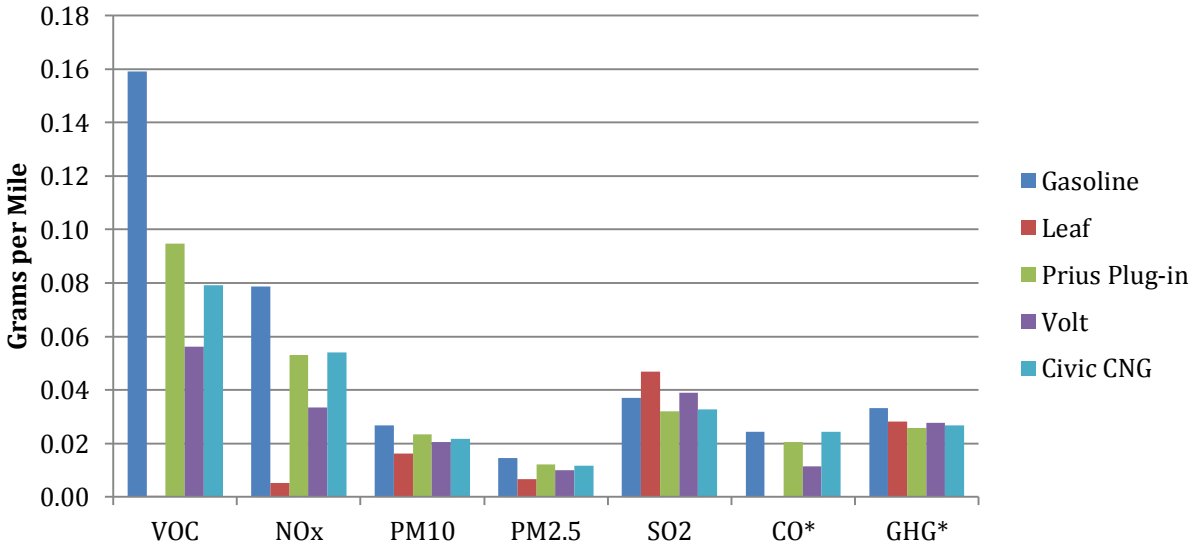
2020 Comparison

An EV driven in 2020 will offer significantly greater air quality benefits than an EV driven in 2013. EVs still eliminate almost all urban emissions of VOCs and CO and they have much lower NOx and SO_2 emissions.

Table 2 | Percent Reduction in Emissions in 2020 Compared to New Gasoline Vehicle

Pollutant	BEV	PHEV10	PHEV40	CNG
VOC	-99.7%	-40.4%	-64.6%	-50.2%
NOx	-93.5%	-32.6%	-57.5%	-31.3%
PM10	-38.9%	-12.2%	-22.8%	-18.7%
PM2.5	-54.0%	-15.1%	-31.1%	-19.1%
SO_2	26.6%	-13.1%	5.3%	-11.7%
CO	-99.9%	-15.4%	-53.5%	-0.4%
GHG	-15.3%	-22.6%	-16.6%	-19.2%

Figure 2 | Criteria Pollutant Emissions in Bernalillo County by Vehicle Type, New 2020 Vehicles



**The scales of emissions from CO and GHG have been changed so that all the pollutants could be placed in one chart. CO emission rates have been reduced by a factor of 100, so the actual value is about 2.0 grams per mile. GHG emission rates have been reduced by a factor of 10,000, so the actual value is about 300 grams per mile.*

Table 3 | Light Duty Vehicle Emissions as a Percent of Total Emissions in Bernalillo County[23]

	PM10	PM2.5	NOx	SO_2	CO	VOC
Light Duty Vehicle Emissions	<1%	1%	39%	28%	60%	31%

Electric vehicles can be effective at reducing ground level ozone (caused by VOCs and NOx) because of the scale of emission reductions offered by EVs compared to gasoline vehicles and because light-duty vehicles are responsible for a high proportion of the area's VOC and NOx emissions. Battery electric vehicles almost completely eliminate urban VOC emissions and reduce urban NOx emissions by 62% in 2013 and 94% in 2020. In addition, light duty vehicles contribute approximately one-third of the VOC and NOx emissions in Bernalillo County, as shown in Table 3.

Bernalillo County is currently in attainment for the EPA's ozone standard. However, if the EPA creates a stricter standard in 2014 (which it is considering) the County will likely no longer be in compliance. If the EPA lowers the standard from 0.075 part per million to 0.070 ppm, the area of Albuquerque and Bernalillo County will be just on the edge of compliance. If the standard is lowered even further to 0.065 ppm, the region would very likely no longer be in attainment.

As Bernalillo County develops plans to reduce ground level ozone concentrations, increasing the numbers of electric vehicles on the road can play an important part in reducing emissions. This analysis demonstrates that a shift to electric vehicles will help the County comply with both the current and the new standard.

While the region is currently in attainment for PM, CO and SO_2, electric vehicles do significantly reduce emissions of these pollutants as well. Although electric vehicles provide significant reductions of PM2.5 and PM10 compared to gasoline vehicles, light duty vehicles make up a very small portion of PM emissions. Therefore, even with high levels of adoption, electric vehicles would not have a significant impact on overall PM emissions in the region.

Reducing the levels of all these criteria pollutants provides public health benefits to the region. Elevated levels of these pollutants leads to respiratory ailments such as aggravated and more frequent asthma attacks and decreased lung function all of which increase hospital and emergency room visits.[24] Vulnerable populations, such as children and the elderly, are at greater risk from exposure to these pollutants.

ECONOMIC BENEFITS FROM ELECTRIC VEHICLES

Higher upfront costs for electric vehicles compared to gasoline vehicles will be more than offset by significantly lower fuel costs, bringing economic benefits to their owners that will in turn provide an economic benefit to the state. We analyzed the economic benefits of EVs based on two forecasts for the price of gasoline developed by the Energy Information Administration (EIA), the Reference

[23] Environmental Protection Agency. 2013. Air Emission Sources. Retrieved from http://www.epa.gov/air/emissions/index.htm.
[24] American Lung Association. 2013. Impacts on Your Health. Retrieved from http://www.lung.org/healthy-air/outdoor/protecting-your-health/impacts-on-your-health/.

Case and the High Oil Price Case.[25] The current average price of electricity for residential customers in New Mexico is estimated at $0.118 per kWh.[26] The average rates were increased based on the EIA's projected increase in electricity prices for the Mountain region.[27]

Table 4 | Economic Benefits of Individual EVs Compared to a Gasoline Passenger Vehicle[28]

Vehicle Type	Incremental Cost (less federal tax credit)	Payback Period (years)		Lifetime Savings (Lifetime Fuels Savings Minus Incremental Cost)		Average Annual Fuel Savings	
		Reference	High	Reference	High	Reference	High
PHEV10[29]	$3,735	5	4	$9,263	$13,125	$867	$1,124
PHEV40[30]	$4,095	6	5	$8,581	$13,033	$845	$1,142
BEV[31]	$4,410	5	4	$13,117	$19,738	$1,168	$1,610

To estimate the total economic impact of EVs, we must consider the potential market penetration of EVs into the light duty vehicle fleet. We used two possible market penetration scenarios. The first comes from the EIA's forecast of EV sales in the Mountain region. Based on the percentage of vehicle registrations, we estimate that New Mexico would account for 9.8% of vehicles sales in the region. EIA forecasts that EVs will make up 1.2% of all new vehicles sales by 2020 and 2.8% of sales by 2030.[32] This translates to approximately 0.3% of all light duty vehicles on the road in 2020 and 1.2% of all light-duty vehicles in 2030. We also analyzed a more aggressive market penetration scenario, which assumed that EVs would make up 2% of all light-duty vehicles by 2020 and that this percentage would rise to 5%, with a greater share of BEVs, by 2030. Table 5 shows that adoption of EVs in New Mexico has the potential to provide between $32 million and $200 million in annual economic benefits to New Mexico in 2030.

Table 5 | Annual Fuel Cost Savings Benefits (Millions of $)

	2020		2030	
	Reference	High	Reference	High
EIA Scenario	$6.8	$9.3	$32.5	$138.2
5% by 2030 Scenario	$40.7	$57.1	$46.1	$199.8

[25] In the last six years of the EIA's Annual Energy Outlook, the High Oil Price Case has actually more closely tracked with actual gasoline prices.
[26] Energy Information Administration. 2013. Electric Power Monthly. Retrieved from http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_b.
[27] Energy Information Administration. 2013. Annual Energy Outlook, Reference Case. Table 3-8. Energy Prices by Sector and Source – Mountain. Retrieved from http://www.eia.gov/forecasts/aeo/data.cfm#enprisec.
[28] A new gasoline passenger vehicle is estimated to have an on-road efficiency of 28 mpg.
[29] The PHEV10 is modeled on the 2013 Toyota Prius Plug-in Hybrid.
[30] The PHEV40 is modeled on the 2013 Chevy Volt.
[31] The BEV is modeled on the 2013 Nissan Leaf.
[32] Energy Information Administration. 2013. Annual Energy Outlook. Table 48. Light-Duty Vehicle Sales by Technology Type – Mountain. High Oil Price Case. Retrieved from http://www.eia.gov/forecasts/aeo/data_side_cases.cfm.

Job Creation Benefits

New Mexico only produces enough oil to satisfy approximately 20% of its own demand, meaning that almost all of the money spent on fuel will leave the state's economy. The fuel savings from EVs compared to gasoline-only vehicles will result in consumers spending less disposable income on imported energy and more on goods and services in the regional economy.

Producing and supplying energy is one of the least employment-intensive sectors of the economy; therefore, shifting expenditures away from this sector will increase the multiplier effect of every dollar spent and result in an increase in regional employment.[33]

Without the development of a detailed model based on regional and statewide data that could predict the employment benefits of EVs, it is not possible to provide precise estimates of this impact. However, two methodologies provide an approximate estimate of the scale of employment benefits offered by EVs fuel savings.

A 2008 metastudy (by Laitner and McKinney)[34] of 48 energy efficiency assessments from states across the country estimated that, on average, 49 jobs are created for every trillion BTUs of energy saved. Another study focusing on Colorado's economy (by Goldberg and Geller)[35] found that every 3,700 barrels of oil saved from improved efficiency standards would result in one additional job in the state's economy. Table 6 shows the job creation potential for the two electric vehicle market penetration scenarios in the year 2030.

Table 6 | Job Creation Potential in 2030 from Electric Vehicle Fuel Savings

	Laitner and McKinney	Goldberg and Geller
EIA Scenario	54	69
5% by 2030 Scenario	232	315

CONCLUSION

The analysis presented above clearly demonstrates that electric vehicles can provide significant economic and environmental benefits to the state of New Mexico if consumers purchase a sufficient number of these vehicles.

Currently, one of the major barriers to the adoption of electric vehicles is their higher purchase price compared to gasoline vehicles. An upfront incentive, such as a tax credit to offset the

[33] Roland-Holst, D. (2011, May). How Fuel Economy and Emissions Standards Will Impact Economic Growth and Job Creation. Retrieved from http://next10.org/next10/publications/vehicle_efficiency.html.
[34] Laitner, J. and McKinney, V. (2008, June). Positive Returns: State Energy Efficiency Analyses Can Inform U.S. Energy Policy Assessments. *American Council for an Energy-Efficient Economy*. Retrieved from http://www.aceee.org/sites/default/files/publications/researchreports/e084.pdf.
[35] Geller, H. and Goldberg, M. (2009). Energy Efficiency and Job Creation in Colorado. *Southwest Energy Efficiency Project*. Retrieved from http://www.swenergy.org/pubs/EE_and_Jobs_Creation_in_Colorado-April_2009.pdf.

incremental purchase cost of electric vehicles, would further spur the adoption of electric vehicles and maximize the benefits they bring to the state of New Mexico.

A further barrier is low levels of publicly available charging infrastructure for electric vehicles. Compared to other Southwestern states, EV drivers in New Mexico have fewer public charging stations that allow them to charge away from their homes and extend the range of their EVs. A small number of public stations also discourages potential EV buyers who may be concerned about the limited range of their electric vehicles. A tax credit for new public charging stations would encourage entrepreneurs to set up more charging stations providing confidence to potential EV buyers and current EV owners.

A comprehensive listing of state level policies that can support the adoption of electric vehicles can be found in SWEEP's report: *Policies to Promote Electric Vehicles in the Southwest: A State Government Report Card*.[36]

[36] Salisbury, M. 2013. Policies to Promote Electric Vehicles in the Southwest: A State Government Report Card Retrieved from http://swenergy.org/publications/documents/EV%20Report%20CardFNLwithCover.5.15.13.pdf.