The Potential for Electric Vehicles to Reduce Vehicle Emissions and Provide Economic Benefits in the Wasatch Front

Southwest Energy Efficiency Project and Utah Clean Energy

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EXECUTIVE SUMMARY

This report shows that in Utah's Wasatch Front region, light-duty plug-in electric vehicles (PEVs) reduce emissions of criteria pollutants compared to comparable gasoline-fueled vehicles. In 2017, battery electric vehicles (vehicles using only electricity as fuel) will provide the most significant emissions reductions compared to a gasoline-fueled vehicle of 98% for Sulfur Oxides (SOx), 99% for Volatile Organic Compounds (VOCs) and 90% for Nitrogen Oxides (NOx) with significant additional reductions in Particulate Matter (81% for PM2.5 and 57% for PM10). Plug-in hybrid electric vehicles (vehicles using both electricity and gasoline as fuel) also provide emissions reductions compared to a gasoline vehicle but smaller reductions than BEVs. Table 1 below shows what percentage of reduction each vehicle type provides in comparison to a new gasoline vehicle in 2017.[1]

PEVs provide economic benefits to Utah by reducing fuel costs and shifting consumption away from imported oil to more locally produced electricity sources. These fuel savings become additional disposable income that will be spent mostly in the local economy, creating additional jobs in the state. The estimated 2,500 PEVs on the road in Utah at the end of 2016 saved Utahans around $800,000 in fuel costs in 2016 alone.

Each PEV driver can expect to save between $345 and $646 annually on fuel costs, totaling between $5,514 and $10,339 over the life of the vehicle. The total economic benefit to the state of Utah in reduced fuel costs could reach $43 million per year by 2035.

[1] Upstream emissions from electric power plants are included in the emissions profiles of both the battery and plug-in hybrid electric vehicle.

Table 1 | Percent Reduction in Emissions from PEVs in 2017 Compared to New Gasoline Vehicles

Pollutant	Battery Electric Vehicle	Plug-In Hybrid Electric Vehicle
NOx	-90%	-52%
VOC	-99%	-65%
PM2.5	-81%	-42%
PM10	-57%	-30%
SOx	-98%	-56%
CO	-99%	-48%
GHG	-19%	-15%

AIR QUALITY BENEFITS

The Wasatch Front currently experiences significant air quality problems resulting in negative quality of life and health impacts for area residents. Parts of the region have been designated as non-attainment areas by the U.S. Environmental Protection Agency for Particulate Matter (of both 2.5 and 10 micrometers, PM2.5 and PM10) and Sulfur Dioxide (SO_2). In late 2016, portions of the Wasatch Front were designated as being in 'serious non-attainment' for PM 2.5.[2] Ground-level ozone and carbon monoxide levels are also monitored in the area with sections currently designated as maintenance areas. Light-duty vehicles are significant contributors for each of these pollutants. The emissions inventories developed by the Utah Department of Environmental Quality show mobile sources (of which light-duty vehicles are a major component) account for significant percentages of the pollution in region so efforts to transition to electric vehicles have significant area quality benefits.[3] Over the next 25 years, population in the region is expected to increase 35%[4] while vehicle travel is estimated to increase by 40%.[5] This increased level of vehicle travel will make it difficult for the region to maintain or improve emissions levels unless significant reductions are achieved from light-duty vehicles.

[2] Penrod. Emma. December 16, 2016. EPA Plans to Classify Utah Air Quality Misses as 'Serious' The Salt Lake Tribune. http://www.sltrib.com/news/3283508-155/utah-could-be-first-state-where.
[3] Mobile emissions account for: 80% of CO; 82% of NOx; 11% of PM2.5; 23% of PM10; 35% of Sox and 14% of VOCs. Utah Department of Environmental Quality. 2013. http://www.airquality.utah.gov/Public-Interest/Current-Issues/pm2.5/presentations/index.html.
[4] Wasatch Front Regional Council. 2015. Regional Transportation Plan 2015-2040. http://www.wfrc.org/new_wfrc/index.php/regional-transportation-plan/currently-adopted-plan/the-plan.
[5] Wasatch Front Regional Council. 2015. Regional Transportation Plan 2015-2040. http://www.wfrc.org/new_wfrc/index.php/regional-transportation-plan/currently-adopted-plan/the-plan.

Electric vehicles offer the potential to significantly reduce criteria pollutants compared to regular gasoline-fueled vehicles. This report presents an analysis of the emissions levels of electric-fueled vehicles compared with gasoline vehicles in the Wasatch Front region.

Analysis of Air Emissions from Electric Vehicles in Utah

SWEEP performed analysis comparing the emissions associated with a battery electric vehicle (BEV), a plug-in hybrid electric vehicle (PHEV) and a traditional new gasoline passenger vehicle in 2017. This analysis focused on air quality emissions within Utah's current non-attainment areas: Box Elder County, Cache County, Davis County, Salt Lake County, Tooele County, Utah County, and Weber County.

The analysis evaluates emissions of the following criteria pollutants[6]: 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). The analysis also evaluates greenhouse gas emissions. *The PM2.5, PM10 and SO_2 emissions are particularly important as the parts of the region are currently in non-attainment for permissible levels of these three pollutants.*[7] Note that SO_2, NOx and VOCs are all also precursors for PM2.5. For ground level ozone, the region is a maintenance area[8]; however, the US EPA issued new ozone standards in 2014, which may present additional challenges by lowering allowed ozone levels from 75 parts per billion (ppb) to 70 ppb.

The analysis shows that in the non-attainment area plug-in electric vehicles reduce emissions of criteria pollutants compared to a comparable gasoline fueled vehicle.

[6] "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, 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/.

[7] Environmental Protection Agency. 2016. Current Nonattainment Counties for All Criteria Pollutants. https://www3.epa.gov/airquality/greenbook/ancl.html.

[8] "A maintenance area is an area that was once designated as nonattainment, and which subsequently demonstrated to EPA statistically that it will attain and maintain a particular standard for a period of 10 years." From *Utah Division of Air Quality 2012 Annual Report*, Retrieved from http://www.airquality.utah.gov/Public-Interest/annual-report/.pdf/2012Annual%20Report.pdf.

Emissions Results

Below, we present a comparison of emissions levels from the three different vehicles. Figures 1-5 show that electric vehicles have lower levels of emissions for all the criteria pollutants compared to gasoline vehicles.

Figure 1 | Particulate Matter Emissions by Vehicle Type in Wasatch Front

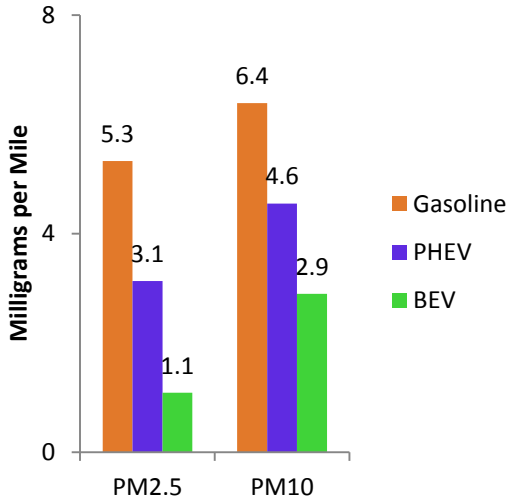


Figure 2 | Ozone Precursor Emissions by Vehicle Type in Wasatch Front

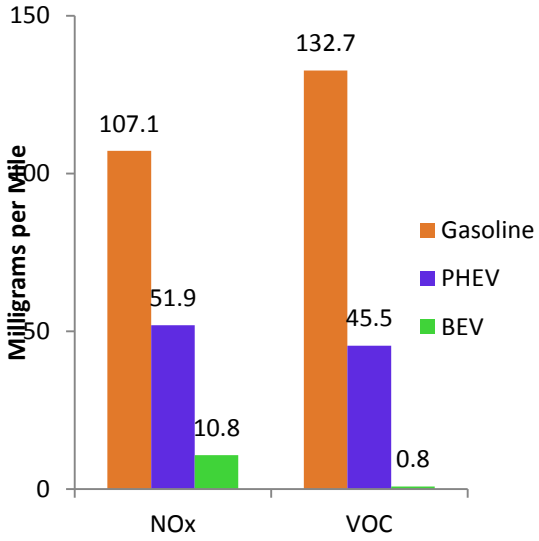


Figure 3 | SOx Emissions by Vehicle Type in Wasatch Front

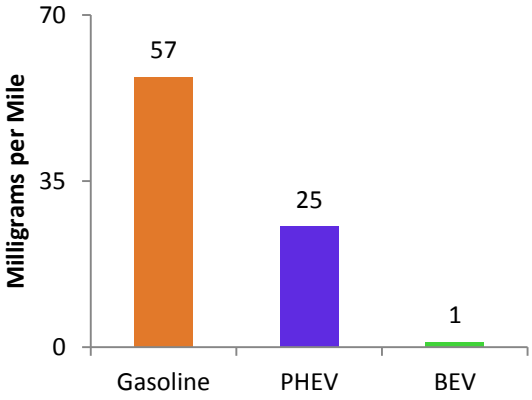


Figure 4 | Carbon Monoxide Emissions by Vehicle Type in the Wasatch Front

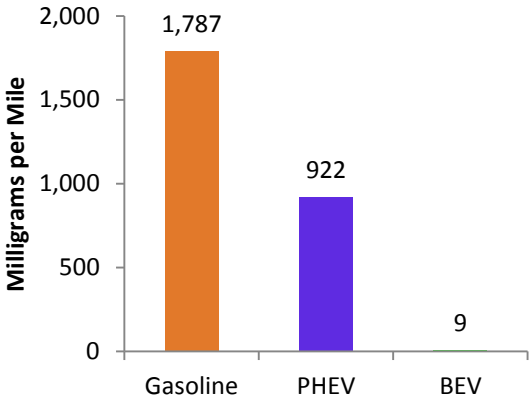
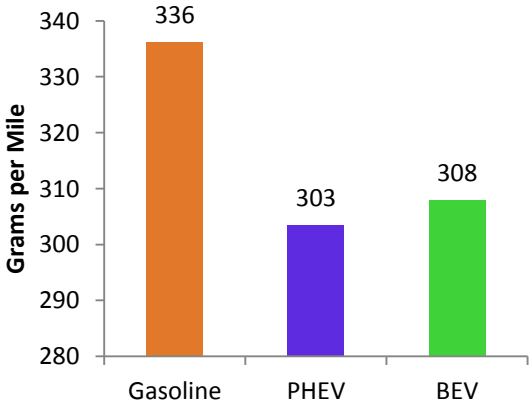


Figure 5 | Greenhouse Gas Emissions by Vehicle Type in the Wasatch Front



Discussion of Future Emissions

The EPA's Tier III standards, which will be phased in from 2017 and 2025, will reduce the sulfur content of gasoline and reduce tailpipe emissions from gasoline-fueled vehicles, which will help to reduce emissions and improve urban air quality in the Wasatch Front. Because of their availability in the market today, electric vehicles offer the opportunity to realize immediate air quality improvements from new vehicles along the Wasatch Front.

The electricity mix for the region is also expected to become cleaner over time as coal plants are retired and replaced by natural gas and renewable electricity. Electric vehicles have the advantage that because their fuel source (electricity) will become cleaner over time so an EV purchased in 2017 will become cleaner every year that it is on the road.

Over the longer term, electric vehicles, when powered by renewable electricity sources, provide the opportunity to eliminate emissions from vehicle operations and will be one of the few ways to achieve emission reductions beyond the Tier III standards once they are in effect.

ECONOMIC BENEFITS

Individual Vehicle and Economy-Wide Fuel Savings Benefits

A shift towards electric vehicles will provide tangible economic benefits for Utah. We find three distinct areas of economic benefit: increased local economic activity, greater local employment opportunity, and lower fuel costs for customers.

Utah produces only about half the oil that it consumes[9] and must import all its remaining vehicle fuel from outside the state (and the country), meaning that half of the money spent on fuel—over $3 billion annually—will leave the state's economy. Electric vehicles will reduce money currently spent on out-of-state fuels, resulting in Utah consumers spending less disposable income on imported energy and more on local goods and services.

Greater local spending is likely to increase local employment opportunities by shifting energy spending away from energy production, one of the least employment-intensive sectors in our economy, towards local goods and services, such as construction and services. An additional dollar of household spending will create 16 times more jobs than if that dollar were spent on fossil fuels.[10] The jobs created by this additional spending are spread throughout the economy, not focused in the vehicle or alternative fuel sectors; therefore, all income levels will benefit from the fuel savings benefits from electric vehicles.

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[9] Energy Information Administration. 2016. Utah: State Profile and Energy Estimates. Retrieved from http://www.eia.gov/state/data.cfm?sid=UT.

[10] Roland-Holst, D. 2012. "Plug-in Electric Vehicle Deployment in California: An Economic Jobs Assessment." https://are.berkeley.edu/~dwrh/CERES_Web/Docs/ETC_PEV_RH_Final120920.pdf.

Additionally, PEVs will benefit Utah drivers by offering lower fuel costs than gasoline vehicles. We analyzed the economic benefits of PEVs based on the forecast for the price of gasoline developed by the U.S. Energy Information Administration (EIA).[11] The average price of electricity per kilowatt-hour for Utah residents is estimated at $0.113 per kWh.[12] The average rates were increased based on EIA's projected increase in electricity prices for the Mountain region.[13]

In 2017, a BEV owner would spend $372 less than the owner of gasoline vehicle on fuel costs. A PHEV owner would save $205 in fuel costs in 2017. Because the cost of gasoline is expected to increase more than the cost of electricity over time, the fuel savings benefits of PEVs will become significantly larger in future years.

Table 2 shows the fuel savings for two types of vehicles: a Plug-in Hybrid (PHEV) with an electric range of 30 miles and a fully electric vehicle. The average annual fuel savings is the average of all fifteen years of fuel savings. For a BEV, the annual fuel savings range from $372 in 2017 to $802 in 2032. For a PHEV the annual fuel savings range from $205 in 2017 to $424 in 2032. The lifetime of all vehicles is assumed to be fifteen years.

Table 2 | Fuel Savings Benefits of EVs Compared to a New Gasoline Passenger Vehicle[14]

Vehicle Type	Annual Average Fuel Savings	Lifetime Fuel Savings
Plug-in Hybrid Electric Vehicle	$345	$5,514
Battery Electric Vehicle	$646	$10,339

The total fuel savings from existing plug-in electric vehicles is already bringing economic benefits to the state. The estimated 2,500 PEVs on the road in Utah at the end of 2016 saved Utahans around $800,000 in fuel costs in 2016 alone.

Two market scenarios for future electric vehicle sales in Utah have been developed to provide insight into the aggregate economic impact plug-in electric vehicles could have in Utah.

[11] Energy Information Administration.. 2016. Annual Energy Outlook. Reference Case. Energy Prices by Sector and Source. - Mountain http://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=0.
[12] Energy Information Administration. 2016. Electric Power Monthly. Table 5.6.A. Average Price of Electricity to Ultimate Customers by End Use Sector. https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a.
[13] Energy Information Administration. 2016. Annual Energy Outlook, Reference Case. Energy Prices by Sector and Source – Mountain. http://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=0.
[14] A new gasoline passenger vehicle in 2017 is estimated to have an on-road efficiency of 34 mpg.

The first "baseline" market penetration scenario comes from the EIA and is their projection of EV sales in the Mountain region (which includes Utah). Based on the percentage of vehicle registrations, we estimate that Utah would account for 10.3 percent of vehicles sales in the region. By 2035, EIA forecasts that EVs will make up 3.0 percent of all new vehicles sales.[15]

A second market penetration projection was also developed that examines the economic benefits of EVs making up eight percent of vehicles sales by 2035.

Table 3 shows that the adoption of EVs in Utah has the potential to provide between $29 million and $43 million in annual economic benefits to Utah in 2035.

Table 3 | Annual Fuel Cost Savings Benefits (USD)

Scenario	Fuel Savings
3.0% of Sales by 2035 (EIA Baseline)	$28.7 million
8.0% of Sales by 2035	$42.8 million

Federal Tax Credit Benefit

In addition to the money saved by PEVs from lower fuel costs, each PEV sold in Utah brings money into the state from the federal tax credit for PEVs. If there are approximately 2,500 PEVs in the state of Utah today, it is estimated that their owners have received about $18 million due to the federal tax credit.

Sales Tax Benefit

Another area where PEVs bring additional funds into the state is their contribution to sales tax revenues. Because the average PEV has a higher cost than the average new gasoline vehicle they generate more sales tax revenue for both state and local governments. The average PEV purchased in Utah in 2015 had a Manufacturers' Suggested Retail Price of $47,000 compared to an average MSRP for a new gasoline car of $26,400. This price differential would result in an extra $1,000 in sales tax revenue that would be collected by the state per PEV sold.

[15] Energy Information Administration. 2016. Annual Energy Outlook. Light-Duty Vehicle Sales by Technology Type – Mountain. Reference Case. http://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=1-8.

METHODOLOGY

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.[16] The GREET model was used to make a comparison between the life-cycle emissions of three light-duty vehicles: one fueled by gasoline, one by gasoline and electricity (PHEV), and the other by electricity only (BEV).

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, SWEEP characterized the transportation energy system in Utah to show exactly what emissions are likely to contribute to the Wasatch Front's airshed.

Regarding relevant upstream emissions from electricity, SWEEP has calculated that 0% of statewide coal plant emissions[17] and 60% of natural gas plant emissions take place along the Wasatch Front. This is based on 60% of the state's natural gas generation occurring in counties that are either in non-attainment or maintenance areas for criteria pollutants (Salt Lake, Utah, Davis, Weber, and Cache Counties all have natural gas plants). For upstream emissions for gasoline vehicles, 100% of the emissions associated with gasoline refining take place in the Wasatch Front as all five of the state's refineries (which produce more gasoline than the state consumes) are located in Salt Lake and Davis Counties.

Regarding the extraction of fuel (mining and drilling): all of the state's coal mines are located outside of the non-attainment area and a very small number of oil and gas fields are located in non-attainment counties. For the purposes of the GREET model, it was assumed that 1% of oil and gas extraction and 0% of coal mining contributes to urban emissions.

For the battery electric vehicle, the electricity mix for 2015 was taken from Rocky Mountain Power's "Utah Conservation and Respect Report 2016" which showed that in 2015 the utility's electricity mix was 62% coal, 15% natural gas, 13% renewables and 9% other.

The plug-in hybrid electric vehicle is assumed to have a fuel economy of 55 miles per gallon (mpg) for its gasoline engine[18] with an electric range of 30 miles. 48% of its miles are assumed to be electric.

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[16] Argonne National Laboratory. 2016. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation. Retrieved from http://greet.es.anl.gov/

[17] While the Kennecott coal plant operates in the Wasatch Front, its power is only used for operations at the Kennecott facility and is therefore not supplying electricity to EVs charging in the area.

[18] This is the average on road fuel economy for a new plug-in hybrid electric vehicle in 2017. Energy Information Administration. 2016.. Annual Energy Outlook. Table 41. Light Duty Vehicles Miles per Gallon by Technology Type. http://www.eia.gov/outlooks/aeo/tables_ref.cfm.

A new gasoline vehicle is assumed to have an on-road fuel economy of 34 mpg.[19] The Tier III standards will begin to be phased in beginning in 2017. Therefore, the vehicle analyzed in this report represents the first model year that will begin the reduction of tailpipe emissions from the Tier III standards. It should be noted that the Tier III fuel standards will likely begin to be phased into Utah's refineries beginning in 2020.

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.

Utah Clean Energy is a non-partisan, non-profit public interest organization that works with business and government leaders to advance the clean energy economy in Utah and the West. UCE is committed to creating a future that ensures healthy, thriving communities for all, empowered and sustained by clean energy. For more information, visit www.utahcleanenergy.org.

Questions or comments about this report should be directed to Will Toor, Transportation Program Director at the Southwest Energy Efficiency Project, wtoor@swenergy.org.

[19] This is the average on road fuel economy for a new vehicle in 2017. Energy Information Administration. 2016. Annual Energy Outlook. Table 41. Light Duty Vehicles Miles per Gallon by Technology Type. http://www.eia.gov/outlooks/aeo/tables_ref.cfm.