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DRIVING TOWARD A CLEANER FUTURE

ALTERNATIVE FUEL VEHICLES IN UTAH

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Driving Toward a Cleaner Future

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RESEARCH • ANALYZE • INFORM

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INTRODUCTION

Poor air quality is both a health issue and an economic challenge along the Wasatch Front. Traditional motor vehicles are one of the biggest drivers of poor air quality – a problem that could be alleviated in part by shifting from gasoline and diesel to alternative fuels.

Electric – both in terms of battery electric and plug-in hybrid – now appears to be the most promising alternative fuel for passenger vehicles. This report discusses the incentives and disincentives around electric cars, as well as the policy decisions

KEY FINDINGS OF THIS REPORT

- Electric vehicles – or battery electric cars and plug-in hybrids – accounted for less than 2% of the nation's new vehicle market share in 2018. In Utah, electric's market share was about 1.6%.
- Addressing the fears of consumers is a core challenge in alternative fuel vehicle adoption. Less than a quarter of Americans consider purchasing electric cars because of concerns about running out of power, the availability of charging stations and initial vehicle cost.
- In looking at Norway and the top-tier states for market share, it appears that electric vehicle incentives work when offered at a robust level. Changing market preferences appear to be a much stronger force than smaller incentives.
- Utah's relatively small electric vehicle tax credit was not renewed in 2016, yet electric vehicle market share has continued to increase.
- The top electric-vehicle-adopting states – all in the West – offer significant incentives. However, the 10 states with the highest market share growth in 2018 offer no incentives (though they all had 2017 market share under one percent).
- There is evidence that the looming threat of expiring tax credits can encourage short-term market uptake of alternative fuel vehicles.
- Electric vehicles are expected to cost the same as their internal combustion counterparts by the mid-2020s.
- Due to state and local investment, as well as the Volkswagen Settlement and private actors, Utah's electric vehicle charging infrastructure is poised to quickly expand.
- Large fleet vehicles account for one-third to one-half of Utah's vehicle emissions, even though they account for only 3% of the vehicle miles traveled.
- Alternative-fuel, heavy-duty fleet vehicles are more expensive than diesel and have large infrastructure costs, but offer large fuel and maintenance savings.
- In the long run, market forces will propel consumer uptake of electric passenger vehicles. If Utah were to use tax credits to encourage a more immediate market embrace, it would have to make an investment in sizable credits. However, it might consider doing so on a short-term basis to limit the fiscal impacts and discourage fence-sitting.
- To encourage the market's embrace of alternative fuel vehicles, state and local governments should continue to explore opportunities to encourage private actors to deploy alternative fuel infrastructure for customers, tenants, employees and visitors.
- Cities and counties have at least two potential roles to play: adopting building codes that are "future-proof" for the growth in alternative fuel vehicles, and retiring older public-service diesel fuel fleets.
- Utah may get a substantial air quality return on its tax credit investments by continuing to focus incentives on heavy-duty fleet vehicles and renewing them in 2020.
- Due to the urgency of cleaning up Utah's air, replacing older diesel trucks with so-called "clean diesel" offers a potential target for more modest tax incentives.
- To encourage the market's embrace of alternative fuel vehicles, public and private sector stakeholders should mount public information campaigns to explain the growing availability of alternative fuel infrastructure and address other consumer fears.

around preparation for a wide proliferation of electric vehicles in the future.

Meanwhile, a large proportion of Wasatch Front's vehicle pollutants is from heavy-duty fleet vehicles, such as buses, garbage trucks and delivery vans. Natural gas offers a cleaner alternative to diesel in terms of air quality – particularly compared to pre-2008 diesel vehicles. In addition, electric options for large fleet vehicles are becoming more common. This report discusses the incentives and requirements around public and private fleet vehicles.

Because the upfront costs of alternative fuel vehicles are currently higher than gasoline and diesel vehicles, and due to refueling constraints, governments and others are involved in encouraging their use. This report explores practical ways to make Utah a national leader in encouraging alternative fuel vehicle use. While many private entities, utilities and others are taking actions toward this end, this report focuses on possible actions involving the State of Utah, municipalities, businesses and consumers themselves.

BACKGROUND

Utahns drive slightly less than the typical American, at just over 30 miles per day per person.[1] They accumulate these miles in about four trips per day. Roughly one-third of Utahns' trips are for personal or family business, another third are for social and recreational activities, and about one in six trips is to work and back. About 75% of workers drive alone to work, while 11% of Utahns carpool. Nearly 7% work from home, just over 2% use public transit, and the remainder use some other mode of getting to work.

Utah has more than 49,000 miles of public roads, and Utahns consume 369 gallons of gas per capita per year. The tax on this gasoline helps to pay for Utah's public roadways (along with sales taxes and other fees).

In addition to passenger vehicles, Utah's roadways serve heavy-duty fleet vehicles, such as garbage trucks, delivery trucks and long-haul freight vehicles. These not only get far lower fuel economy than passenger vehicles, but drive far more miles per year.

WHAT ABOUT NATURAL GAS PASSENGER VEHICLES?

Natural gas is more common in larger fleet vehicles, such as refuse trucks and buses, than in passenger vehicles. However, natural gas passenger vehicles used to be more widely available. In fact, the lower operating costs made them a promising replacement for gasoline and diesel vehicles – particularly larger vehicles such as pick-up trucks with lower fuel economy. But with the collapse of oil prices since 2014, the savings of operating natural gas vehicles over non-alternative fuels became less appealing.* Even more problematic is the fueling station infrastructure. It is limited and expensive, unlike electric fueling infrastructure, which has far outpaced natural gas in a short period of time. (See Figure 15 on page 19.) In addition, electric vehicles can be charged at home much more easily than refueling with natural gas.

* Advanced Energy Economy, *Natural Gas Fueling Stations Continue Slow Buildout*, July 25, 2017, https://blog.aee.net/natural-gas-fueling-stations-continue-slow-buildout.

EARLY HISTORY OF ELECTRIC CARS

Electric cars are not new. Porsche developed its first electric car, the P1, in 1898, and created the world's first hybrid gas/electric car that year. Electric cars took about one-third of the market share in the early 1900s. When the Model T – introduced in 1908 – sold for half the price, the electric vehicle market took a hit. Furthermore, electric cars could not compete with newer gasoline cars for distance. They had effectively disappeared by 1935.

Utah Foundation surveys have repeatedly found the issue of air quality to be a top concern among Utahns.[2] Mobile emissions, which include both passenger and fleet vehicles, account for nearly half of the state's air pollution.[3] This pollution takes the form of winter inversion particulate matter and summer ozone, both of which cause health problems, with ancillary economic impacts. While vehicle emissions are improving, Utah's rapid population growth is playing counter to this benefit.

One way to address mobile emissions is with alternative fuel vehicles. The alternative fuel vehicles discussed in this report emit less pollution than gasoline and diesel vehicles, and in certain cases produce no tailpipe emissions at all.[4]

ALTERNATIVE FUEL VEHICLE TYPES

There are two main groups of vehicle systems: those that are dedicated to a single fuel type and those that are mixed. Dedicated systems include gasoline, diesel, compressed natural gas and electric. Mixed systems are typically gasoline or diesel, but are combined with other fuels – such as electricity or bio-fuels. Mixed systems include hybrid-electric, hydrogen-electric and flexible fuel vehicles.

Hybrid-electric vehicles have an internal combustion engine, but also include a smaller electric motor that improves fuel economy. The motor is powered by a battery that is charged through vehicle operation. Plug-in hybrids are the same concept, but tend to have larger electric motors and batteries, and can be charged between trips. This allows an operator to drive a certain distance without using gasoline at all. In fact, drivers of plug-in hybrids rely on battery-only operation about three-quarters of the time.[5]

This report focuses on two dedicated systems for passenger vehicles: compressed natural gas and electric vehicles. It also focuses on two mixed systems. Hybrid-electric and, to a lesser extent, hydrogen-electric. Of the hybrid-electric vehicles, the report mainly focuses on plug-in hybrids. For the purposes of this report, battery electric vehicles and plug-in hybrids are referred to collectively as electric vehicles.

THE GROWING MARKET FOR ELECTRIC VEHICLES

Of all the energy used in the transportation sector, about 54% is from gasoline, 23% from diesel, 12% from jet fuel, 5% from biofuels, 3% from natural gas and 3% from other sources.[6] Much of the diesel fuel and natural gas is for large fleet vehicles. That picture is somewhat different for passenger vehicles. Of the

passenger vehicles sold in 2018, fuel types are as follows:

- 92.8% gasoline – including ethanol blends
- 3.0% diesel – including bio-diesel blends
- 2.3% hybrid
- 1.3% electric
- 0.5% plug-in hybrid[7]

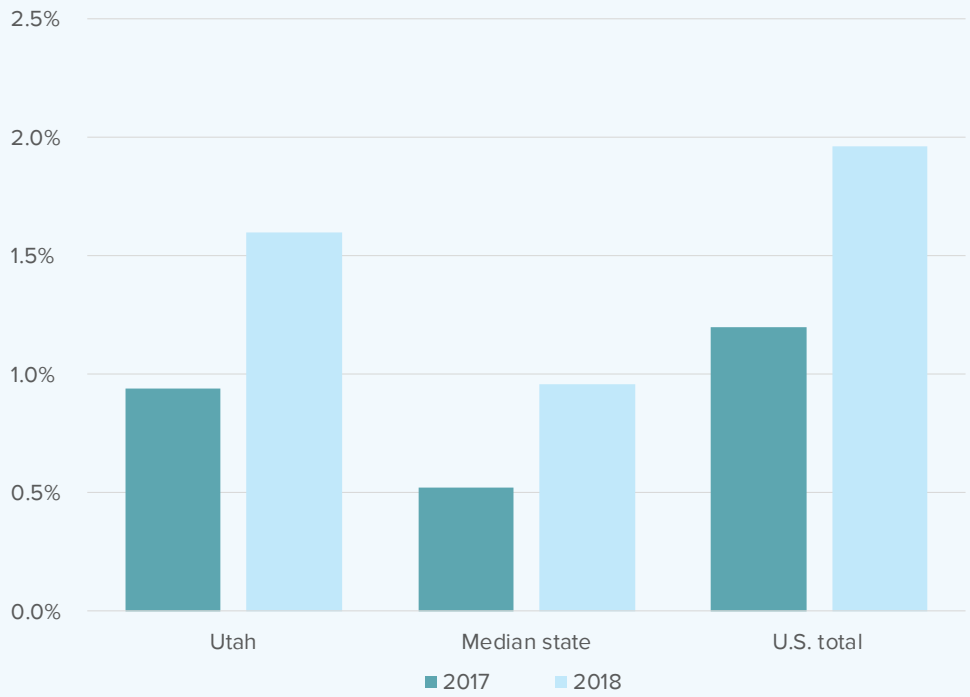
Of the alternative fuel varieties, battery electric vehicles and plug-in electric hybrids have become much more available in the passenger vehicle market. Americans have purchased more than 500,000 of them since the beginning of 2018.[8]

In the U.S., electric vehicles have jumped from 1.2% of new car market share in 2017 to nearly 2% in 2018.[9] In Utah, sales increased from under 1% to 1.6%. This exceeds the median state, but is lower than the national average, due primarily to California skewing the nation's total percentage of sales with its relatively high share of the electric vehicle market.

In Utah, sales jumped from 1,135 vehicles in 2016 to 2,295 by 2018. This increasing trend is also the case across the U.S.

Utah's electric vehicle sales exceed the median state but are lower than the national average.

Figure 1: Electric Vehicles Sales (Battery Electric Vehicles and Plug-in Electric Hybrids)



Source: EVAdoption, EV Market Share by State.

IMPEDIMENTS TO ELECTRIC VEHICLE SALES

While electric vehicle sales are growing, only 24% of American would consider or expect to purchase a plug-in hybrid for their next car, which drops down to 21% for a battery electric.[10]

A 2018 survey from Volvo Car USA and The Harris Poll looked at the state of battery electric vehicles in the United States.[11] The top concerns regarding the purchase of battery electric vehicles were as follows:

- Running out of power
- Low availability of charging stations
- Initial vehicle cost

For 58% of survey respondents, running out of power was a top barrier to purchasing a new vehicle. However, for survey respondents that had driven an electric vehicle for more than a month, that concern dropped to 38%. Additionally, battery range is quickly increasing. An analysis of vehicles since 2011 shows that battery life is increasing regularly, with a median range in 2019 of 151 miles and an average range of 190 miles (the average is drawn upwards from the median by Tesla models' range.)[12]

There is little that governments can do about range except indirectly through incentives that spur sales and any resulting R&D. (See the discussion about ZEV on page 24.) However, there are direct policy approaches to increase the availability of charging stations and mitigate initial vehicle cost.

The Volvo survey found that both of these factors are critical, with 57% of respondents saying that price parity between electric and traditional vehicles would increase their likelihood of purchasing electric.[13] And 41% responded that governmental financial incentives would help increase the likelihood.

Interestingly, however, the fear of inadequate charging infrastructure appeared to be the top concern, with 61% of respondents saying that more charging stations would increase their likelihood of going electric.

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BRINGING DOWN ELECTRIC CAR COSTS

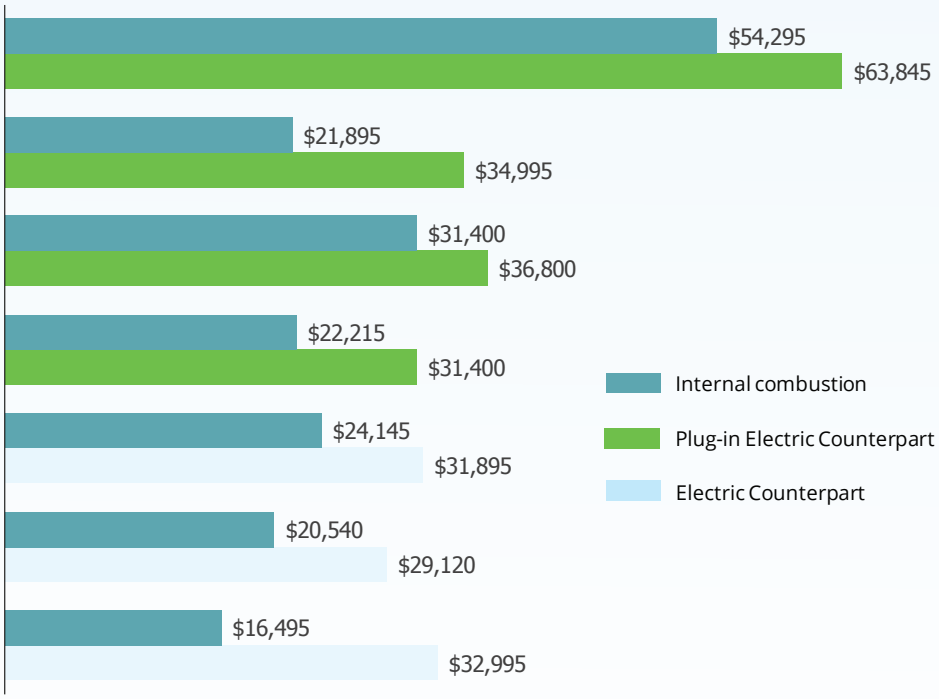
Based upon an analysis of common vehicles that are available in gasoline and electric models, Utah Foundation found that plug-in hybrids and electric vehicles cost anywhere from about $5,000 to $17,000 more than gasoline models. (See Figure 2.) Some models are equipped differently, resulting in part of the difference in price. For instance, the Fiat 500 has more expensive upgrades that are standard on electric models. When excluding those vehicles, the price difference is still significant.

This vast improvement in fuel economy is due in part to the efficiency of electric vehicles. The Environmental Protection Agency's Department of Energy Efficiency and Renewable Energy found that for gasoline and diesel passenger vehicles, only 12% to 30% of the potential energy in the fuel is used to move the vehicle.* Much of the rest is wasted. In battery electric vehicles, 72% to 94% is used to move the vehicle.

However, gasoline remains relatively cheap in the United States. It may not seem cheap when a consumer is spending $2.72 per gallon at the pump (see Figure 18), but it is far less than almost all of North America and Europe.† In fact, it is cheaper.

Electric vehicles cost at least $5,400 more than non-electrics.

Figure 2: Cost Comparison Between Non-electric and Electric Model



Note: Some models are equipped differently, resulting in part of the difference in price.

See Appendix A for list of sources and comparison models.

Electric vehicles have far better fuel economy than their internal combustion counterparts.

Figure 3: Electric Car Model Efficiency Improvement Over Non-Electric Model in Miles Per Gallon and Equivalent

	City	Highway
Plug-in Hybrid		
Volvo S90 AWD 2018	209%	122%
Subaru Crosstrek AWD 2019	233%	173%
Mini Cooper Countryman ALL4 2018	195%	103%
Ford Fusion 2018	362%	203%
Battery Electric		
Volkswagen Golf 2019	334%	200%
Ford Focus SE Hatch 2018	392%	182%
Fiat 500 2018	332%	212%

See Appendix A for sources. Utah Foundation calculations.

FUEL ECONOMY

While their purchase price is higher, electric vehicles have lower operating costs. Battery electric vehicles are cheaper to maintain than internal combustion engine vehicles as there are no oil changes required and they are much less complex. While these cost savings are not insignificant, fuel cost savings are the biggest operating cost savings for electric vehicle owners. Electric vehicles have far superior miles per gallon equivalent fuel economy – between 100% and 400% better in terms of miles per gallon equivalent.

To put these differences in perspective, the fuel savings for the electric Fiat 500e over a Fiat 500 is about $1,200 per year based upon 15,000 miles of travel at $2.65 per gallon of gasoline.* That savings if even larger for electric vehicle owners with free public or workplace charging.

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However, gasoline remains relatively cheap in the United States. It may not seem cheap when a consumer is spending $2.72 per gallon at the pump (see Figure 18), but it is far less than almost all of North America and Europe.† In fact, it is cheaper than the top 50 richest countries per capita, except for Middle Eastern oil-exporting countries (Qatar, UAE, Kuwait, Saudi Arabia, and Oman). This relatively cheap price may serve as an impediment to electric vehicle proliferation.

* U.S. Department of Energy, https://fueleconomy.gov/feg/savemoney.jsp.

† U.S. Department of Energy, Where the Energy Goes: Hybrids, www.fueleconomy.gov/feg/atv-hev.shtml.

†† U.S. Energy Information Administration, U.S. gasoline prices this Memorial Day weekend are nearly the same as last year's, May 24, 2019, www.eia.gov/todayinenergy/detail.php?id=39612; Statistics Times, Countries by Petrol Prices and GDP per capita, June 25, 2019, http://statisticstimes.com/economy/countries-by-petrol-prices-and-gdp-per-capita.php.

Plug-In Electric Drive Credit

One of the biggest incentives to help cover the increased costs of electric cars is the federal Plug-In Electric Drive Credit. Enacted in 2008, the credit grants between $2,500 and $7,500 in tax rebates to taxpayers who purchase hybrid or electric vehicles.[14] As part of the 2008 Energy Improvement and Extension Act, the tax credit is allocated on the first 200,000 cars a manufacturer sells, after which it is phased out.[15]Tesla and General Motors have now surpassed the 200,000 cap, and the credits applicable to their vehicles are currently in the process of phasing out.[16]

A survey conducted online of 2,882 electric vehicle owners in 11 states between 2011 and 2014 determined that 30% of electric vehicle sales could be attributed directly to incentives.[17] While 92% of electric vehicle owners surveyed cited the tax credit as the most important factor in their purchasing decision, 72% said they would have still purchased the vehicle if the incentive had not existed.[18]

The importance of the tax credit depends on the proportion of net savings relative to the price of the car and the income of the purchaser.[19] While Tesla owners were easily able to obtain the maximum $7,500, the high price of a Model S (currently starting at $75,000 MSRP) meant that the relative savings were small. Tesla owners were subsequently less likely to view the rebate as important and less likely to have changed their mind if it did not exist. In contrast, the electric Nissan LEAF (currently starting at $29,990 MSRP) allowed nearly all owners the full $7,500, causing owners to cite the rebate as highly influential in their purchasing decision; researchers attribute nearly half of all Nissan LEAF sales to the federal rebate.[20]

While all battery electric vehicles get the full $7,500 federal tax credit, only a handful of plug-in hybrids do.[21] And the credit leaves a substantial upfront cost gap between electric vehicles and their non-electric counterparts. (See Figure 4.)

The federal tax credit does not close the gap between electric vehicles and their non-electric counterparts.

Figure 4: The Difference in Cost and Difference After the Plug-In Electric Drive Credit of Select Vehicles

	Increase in cost from non-electric	Federal credit	Difference after credit
Plug-in Hybrid			
Volvo S90 AWD 2020	$9,550	$5,002	$4,548
Subaru Crosstrek Hybrid AWD 2019	13,100	4,502	8,598
Mini Cooper SE Countryman ALL4 2018	5,400	4,001	1,399
Ford Fusion Energi Plug in Hybrid 2018	9,185	4,609	4,576
Electric			
Volkswagen e-Golf 2019	7,750	7,500	250
Ford Focus Electric FWD 2018	8,580	7,500	1,080
Fiat 500e 2018	$16,500	$7,500	$9,000

Note: Some models are equipped differently, resulting in part of the difference in price.

See Appendix A for list of sources and comparison models.

State-Level Incentives

As of 2017, 45 states and Washington, D.C., offered incentives for electric vehicles aimed at reducing ownership costs.[22] In addition to tax credits, these include small measures such as providing vehicles emissions test exemptions and free public parking.

Utah requires emissions testing every year for vehicles seven or more years old, and every other year for newer vehicles.[23] The test tends to range between $20 and $30. There are exemptions to this requirement, including for vehicles model 1967 and older, and larger diesel vehicles model 1997 & older (though these are some of the most polluting vehicles on the road.) In addition, electric vehicles are exempt. Utah is one of 14 states that exempt electric vehicles (and some exempt hybrids) from emissions testing.[24]

Cars with Utah-issued Clean Fuel plates are allowed to park free at Salt Lake City meters, but only through the end of 2019.[25] Salt Lake City's Green Vehicle permit

THE NORWAY WAY

Norway has emerged as the international leader for electric vehicle adoption, with growth concentrated in the capital city of Oslo, which has some geographic similarities to the Wasatch Front – and similar air quality issues. Electric vehicles have risen from 22% of automotive market share in 2015 to 31% in 2018.* Tesla's delivery of the mid-sized Model 3 nearly doubled the market share rate in early 2019.† The Norwegian Electric Vehicle Association estimates that half of new car sales will be fully electric for all of 2019.† And Norway plans to ban gasoline entirely by 2030.††

Much of this growth has resulted from the country's heavy subsidization of the industry, which can be grouped into monetary and convenience incentives.¶ Norway exempts electric vehicle owners from registration fees and steep taxes such as the 25% Value-Added Tax on new vehicles.§ As documented by multiple interviews with electric vehicle owners, up-front costs are the most important factor when selecting a vehicle.|| Additionally, the cost of gasoline is double that in the United States, providing long-term savings. Norway also allows electric vehicle owners to use express bus lanes, free parking, and reduced/free fares on toll roads and ferries.§ These subsidies and exemptions are significant, in some cases covering nearly 50% of the cost of a new vehicle over 10 years.*

Ironically, Norway is able in part to afford such deep alternative fuel vehicle subsidies because it has one of the world's highest levels of oil production per capita.#

Nonetheless, these incentives are unsustainable as they are subsidized by those that continue to use gasoline vehicles. Toll-road fees and vehicle taxation are required for transportation revenue, and many municipalities in Norway have signaled that they will be rolling back some convenience benefits.¶

* Noel Melton, Jonn Axsen, and Suzanne Goldberg, Evaluating plug-in electric vehicle policies in the context of long-term greenhouse gas reduction goals: Comparing 10 Canadian provinces using the "PEV policy report card," Energy Policy, Vol. 107, p. 386.

† Lefteris Karagiannopoulos, Tesla boom lifts Norway's electric car sales to record market share, Reuters, April 1, 2019.

†† Dale Hall, Hongyang Cui, Nic Lutsey, Electric vehicle capitals: Accelerating the global transition to electric drive, International Council on Clean Transportation, October 30, 2018, www.theicct.org/publications/ev-capitals-of-the-world-2018.

¶ Tracey Lindeman, Will Norway's Electric-Vehicle Boom Outlast Its Incentives," Citylab, December 27, 2018.

§ Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany and European Climate Initiative, Incentives for Electric Vehicles in Norway, September 03, 2018, pp. 6-8.

|| Kristin Ystmark Bjerkan, Tom Norbech, and Marianne Nordtomme, Incentives for promoting Battery Electric Vehicle (BEV) adoption in Norway, Transportation Research Part D: Transport and Environment, Vol. 42, pp. 173-176; Marie Aarestrup Aasness and James Odeck, The increase of electric vehicle usage in Norway – incentives and adverse effects, European Transport Research Review, Vol. 7, No. 34, pp. 3-5.

United Nations Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section, World Population Prospects, Total Population - Both Sexes, the 2017 Revision, accessed October 10, 2019,; U.S. Energy Information Administration. "Production of Crude Oil including Lease Condensate 2019."

offers free 2-hour parking for more-recent hydrogen, hybrid and electric vehicles.[26]

Another inexpensive Utah incentive was single-commuter access to carpool lanes without paying for an Express Pass. The federal government funds much of the development of interstate highway system, and as such imposes rules and regulations on their functions. This includes the usage of high-occupancy vehicle (HOV) lanes. These lanes typically require two or more people in each vehicle. Exemptions are given under certain circumstances, including for low emission vehicles. Utah is one of more than a dozen states to allow low emission vehicles in HOV lanes under this federal allowance. However, since Congress did not extend the HOV authorization, the exemption expired on September 30, 2019.[27] This is likely discouraging to some; a 2013 survey of California electric vehicle drivers found that 59% responded that the HOV lane exemption was an extremely important factor in their decision to purchase electric vehicles.[28] Furthermore, this subsidy was highly effective at targeting long-distance commuter, which tend to be comparatively higher-polluting drivers.

A potentially more effective – and more expensive – incentive is a state tax credit. Like the Plug-In Electric Tax Credit from the federal government, state tax credits help to further close the price gap between higher cost alternative fuel vehicles and cheaper internal combustion ones.

Mountain State Incentives. Among the Mountain States, Utah is just above average for electric vehicle market share. (See Figure 5.) It lags behind Arizona, Colorado, and Nevada for market share, and behind four of the Mountain States in terms of growth from 2017 to 2018.

Among the Mountain States, Idaho, Montana, New Mexico and Wyoming are more rural than Arizona, Colorado, Nevada and Utah, all of which are among the 15 most urban states in the nation.[29] All of the four more-rural Mountain States are below one percent of market share for electric vehicles. The more urban states are all

Utah is in the upper half of the Mountain States in electric vehicle market share.

Figure 5: Mountain States by Electric Vehicle Market Share and Growth

	Market share	Increase 2017-2018
Colorado	2.61%	66%
Arizona	1.84%	104%
Nevada	1.62%	105%
Utah	1.60%	70%
New Mexico	0.81%	72%
Idaho	0.77%	88%
Montana	0.47%	68%
Wyoming	0.35%	40%

Source: EVAdoption and Alliance of Automotive Manufacturers.

AFTER GEORGIA'S CREDITS

By 1998, Atlanta had been in violation of national air quality standards for two decades. In an effort to cut back on vehicle emissions which accounted for the largest source of pollution, the Georgia General Assembly passed HB 1161, which began offering a $1,500 tax credit for purchase or lease of clean alternative fuel vehicles.* In 1999, the credit was raised to $2,500 and included all low-emission vehicles. By 2000, the credit became $5,000 for zero-emission vehicles. The intent of the credit was to incentivize consumers to buy electric vehicles, and in turn spur business investment in the new technology.†

However, Georgia's state legislature removed this rebate in July of 2015 with the passage of HB 170, as well as introducing a $200 registration fee, resulting in an 89% decline in electric vehicle sales between its passage and the end of 2016.†† (See Figure 6.)

While nowhere near the electric vehicle adoption rate it had in 2014, Georgia has experienced promising market share growth of 123% from 2017 to 2018, ending at 1.18% for 2018. While this sits below the national average of 1.33%, it demonstrates the renewed interest in the industry by consumers.

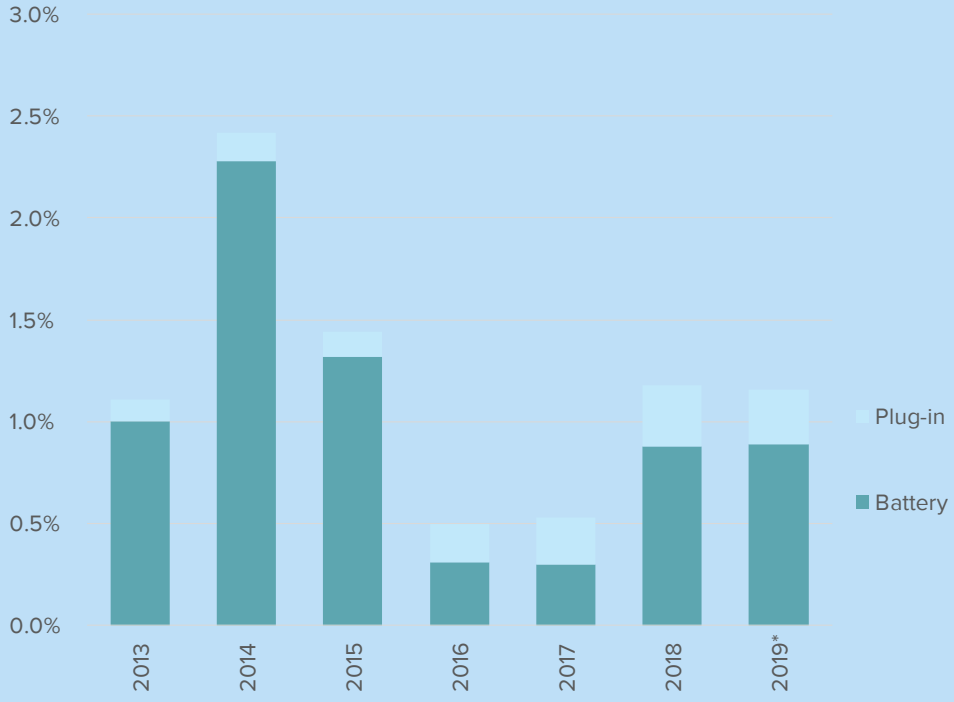
* M. de Zeeuw, and L. Wheeler, Georgia's Tax Credit For Zero- and Low-Emision Vehicles. Georgia's Tax Credit For Zero- and Low-Emission Vehicles. Atlanta, GA: George State University Andrew Young School Fiscal Research Center.

† A. Simmons, Georgia Slams Brakes on Electric Cars, April 14, 2015.

†† Nancy Badertscher, "Electric car sales hit the brakes as tax credit axed and fee added," The Atlanta Journal-Constitution, November 1, 2015; Alliance of Automobile Manufacturers, Advances Technology Vehicle Sales Dashboard, from HIS Markit (2011-2018) and Hedges & Co. (2019). And Georgia General Assembly, HB170, https://dor.georgia.gov/transportation-funding-act-2015-hb-170.

Georgia saw a large dip in its electric vehicle sales after the expiration of a generous tax credit in 2015.

Figure 6: Georgia's Electric Vehicle Share of Auto Sales



Source: Alliance of Automobile Manufacturers.

above 1.5%. This difference may be due in part to this rurality – as electric vehicle owners are more likely to live in cities.[30] But the two top states by market share also offer relatively generous financial incentives.

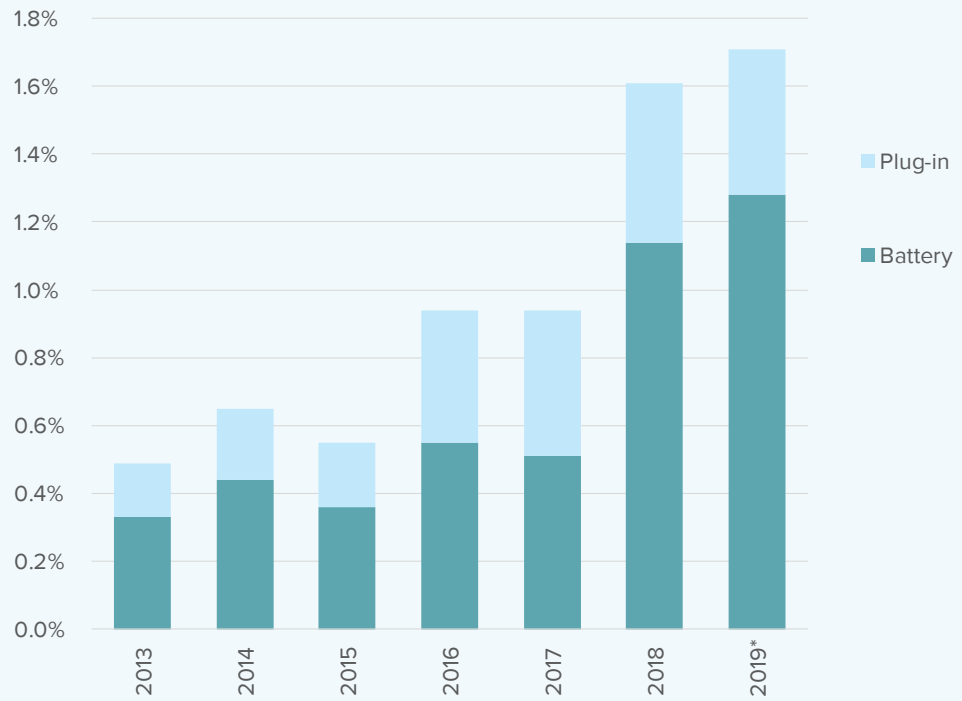
Among the Mountain States, Colorado has the only tax rebate for electric vehicle purchases; it is particularly generous, granting up to $5,000 in rebates either on the day of the vehicle purchase or through tax returns.[31] Due in part to this credit, Colorado has the highest electric vehicle market share of the Mountain States – and the fourth highest nationally.[32] This credit was simplified in 2017. Previously, the rebate was indexed to personal income and battery size, which generated consumer confusion and did not lead to expected electric vehicle market gains in 2014 and 2015.[33] The 2017 simplification created a flat rebate adjusted to vehicle weight. Starting in 2020, the tax credit will be refundable, meaning that purchasers with less than $5,000 in total tax burden will receive a refund check from Colorado to make up the difference.[34]

Arizona provides fuel tax exemptions, an emissions exemption and free parking incentives for consumers. Additionally, the state offers a discounted vehicle license sales tax where electric vehicle owners pay 20% of the sales tax of other vehicles.[35]

The remaining Mountain States offer very little in terms of direct incentives to electric vehicle owners, though all provide exemptions from emissions testing.[36]

Utah's electric vehicle market share has increased markedly since 2017.

Figure 7: Electric Market Share of Plug-in Hybrid Electrics and Battery Electric Vehicles, Utah



Source: Alliance of Automobile Manufacturers.

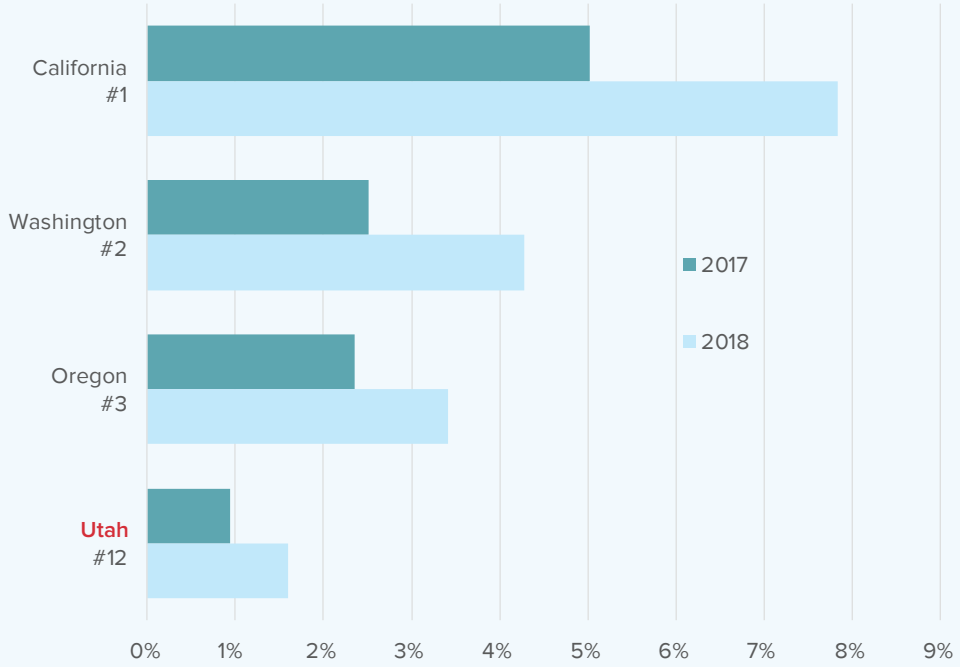
Incentives in Utah. Utah put its first alternative fuel vehicle tax credit in place in 1992. The most recent credit offered a $1,000 tax credit on plug-in hybrid purchases and a $1,500 credit on battery electric vehicle purchases. The credit's authorizing legislation was not renewed at the end of 2016.

Nonetheless, while market share remained stagnant the year following the elimination of the credit, it has markedly increased since.[37] (See Figure 7.) The pause in growth may be due to the removal of the credit, and the subsequent growth suggests that changing market preferences has been a much more powerful force than smaller state credits.

A bill to renew the tax credit

West Coast states lead the nations in electric vehicle adoption.

Figure 8: Electric Vehicle Market Share by Year in the Top Three States and Utah, and Ranking



Source: EVAdoption and Alliance of Automotive Manufacturers.

was considered during the 2017 legislative session, but it narrowly died on the House floor, with a vote of 37-38.[38] Concerns settled on whether tax credits even work.[39] Another concern was whether they were primarily helping wealthy people purchase expensive vehicles at a large cost to taxpayers. There were also concerns that the limited number of new electric vehicles under the program would not have a significant impact on air quality.[40]

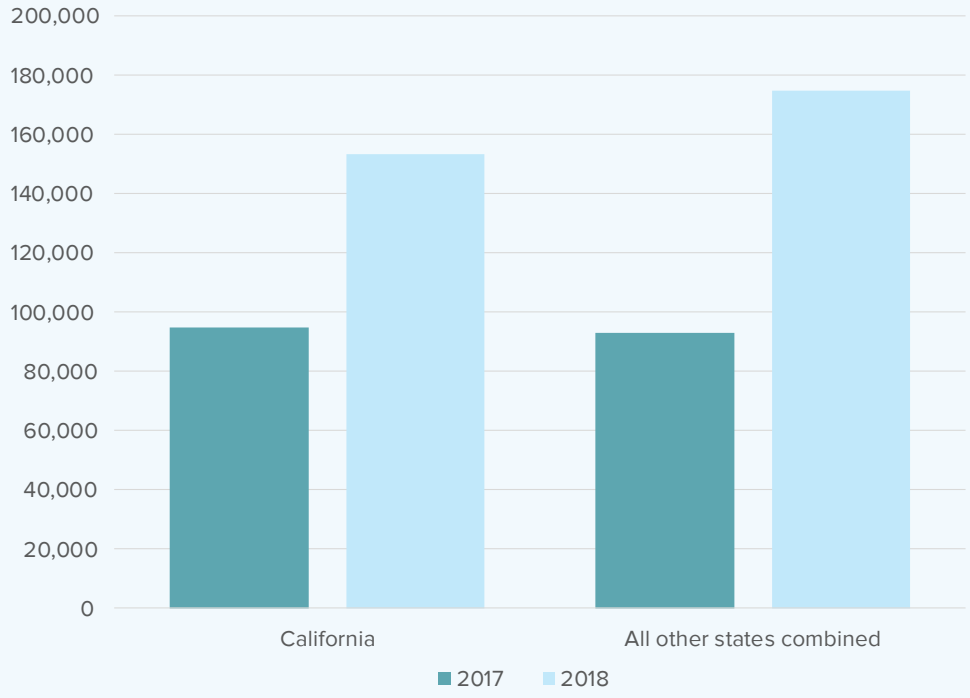
In 2019, Rep. Ward proposed a $1,000 tax credit for the purchase of new electric and plug-in hybrids, but that bill did not make it out of committee.[41]

The Highest Adopters. The three states with highest adoption are the three West Coast states.[42] Utah ranks 12th in the nation. (See Figure 8.) California far surpasses other states for electric vehicle sales, which represented 7.8% of the market share in 2018 for the Golden State.[43] In total, Californians have purchased 570,000 electric cars since 2011, with first quarter 2019 sales 13% higher than first quarter 2018.[44]

For perspective, between 2011-2016, 49% of all electric vehicles purchased in the United States were purchased in California, and the state surpassed the rest of the U.S. in 2017, though it dipped back to 47% in 2018.[45] If California were a country, it would stand in third place internationally for electric vehicle adoption rates.[46]

California alone accounts for nearly half the nation's electric vehicles sales.

Figure 9: Electric Vehicle Sales



Source: EVAdoption and Alliance of Automotive Manufacturers.

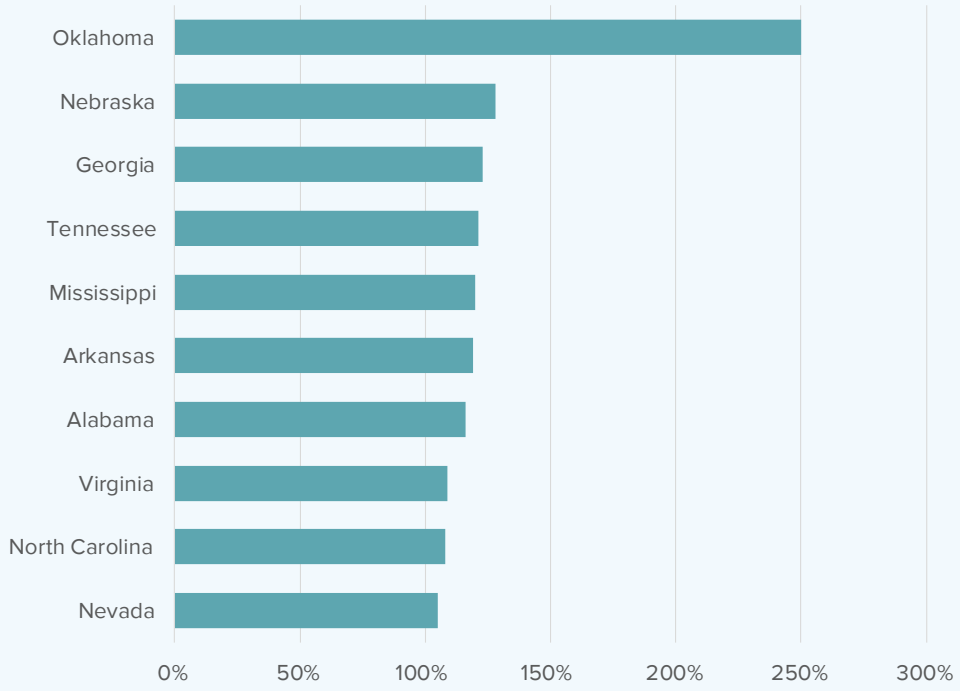
California has granted aggressive incentives to both electric vehicle producers and consumers. In total, California has provided 277,000 rebates totaling $620 million for electric vehicle purchases.[47] Under the Clean Vehicle Rebate Project, taxpayers, businesses and governmental agencies are eligible for up to $6,500 in rebates, depending on income.[48] Additionally, residents of the San Joaquin Valley are eligible for a $3,000 rebate.

While Washington does not provide a point-of-sale rebate to consumers, it does exempt alternative fuel vehicle purchasers from sales and use taxes on up to $32,000 of the vehicle.[49] With a motor sales tax of 6.8%, electric vehicle purchasers can save up to $2,167.[50] Businesses are additionally eligible for a tax credit of 50% of the price of new alternative fuel vehicle vehicles. These business credits range from $5,000 to $100,000.

Oregon is on the frontier of electric vehicle adoption, ranking third nationally for 2018 market share below its two coastal neighbors. Like California and Washington, Oregon offers a variety of monetary incentives for private and public electric vehicle adoption.[51] Primary among them is a point-of-sale rebate of between $1,500 and $2,500 for cars priced $50,000 or less, depending on the size of the battery.

None of the 10 states with the highest increase in electric market share last year offer tax credits – though all had 2017 market share of under one percent.

Figure 10: Top 10 State for Electric Market Share Increase, 2017-18



Source: EVAdoption.

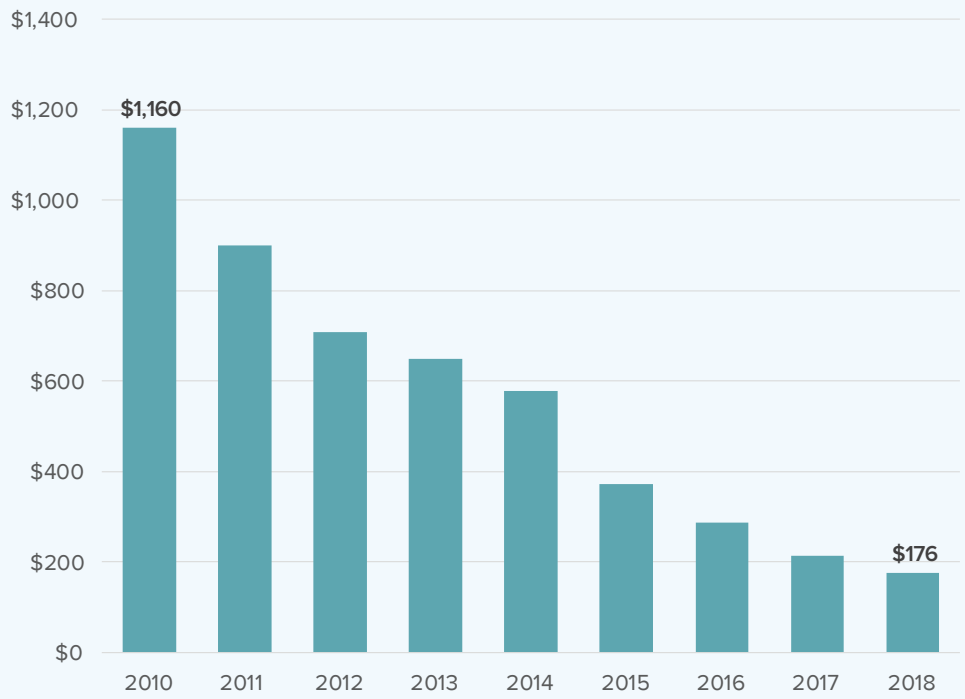
Concerns with State Tax Rebates. There are several concerns around the subsidization of electric vehicles.

To begin with, most buyers are still in upper income households. The average Tesla Model S owner between 2011 and 2014 had an annual household income of $376,000, hardly representative of everyday Americans.[52] An online survey by CARMAX in 2017 revealed that 64% of electric vehicle owners had household incomes over $100,000.[53] As such, there is some concern that electric vehicle tax credit programs tend to subsidize higher-income taxpayers.

Another concern is that, unless they are large (and costly), state tax credits are not sufficient to encourage electric vehicles adoption.[54] A possible example can be found here in Utah, where market penetration actually increased significantly two years after the state incentives ended. Electric sales in Utah nearly doubled from 2017 (1,163) to 2018 (2,295) *without* state incentives.[55] In fact, of the 10 states with the highest increase in market share, none offer state tax credits for electric vehicle purchases, although several offer small benefits like emissions exemptions.[56] (See Figure 10.)

The cost of electric vehicles batteries is sharply declining.

Figure 11: Volume Weighted Average Lithium-ion Pack Price, Real 2018 USD per Watt-hour



Source: BloombergNEF

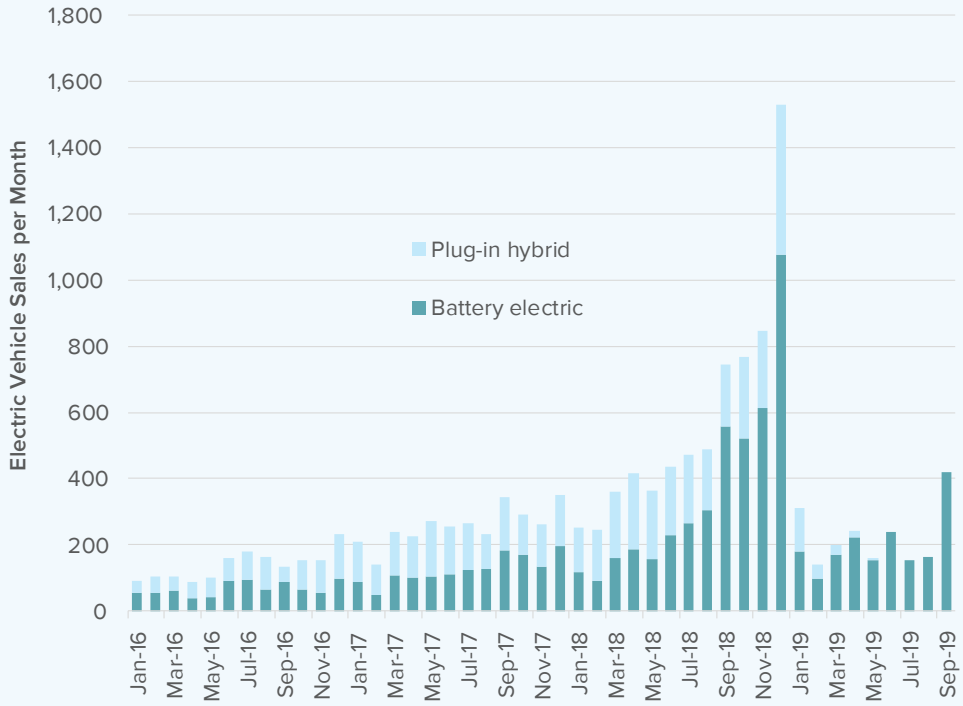
Furthermore, tax credits might not be necessary in the near future for the proliferation of electric vehicles, because a number of projections indicate that price parity will occur in the coming years. Prices are coming down, particularly with the decrease in battery costs. (See Figure 11.) With a continual decrease in costs, industry experts expect price parity between electric and internal combustion vehicles to occur by the mid-2020s.[57]Assuming federal tax credits remain in place, advances in technology, shifts in consumer expectations and market responses could make the impact of state tax incentives all the more marginal in the coming years.

With that said, it should be noted that aggressive approaches to incentives, such as those found in California and Norway, have clearly spurred higher levels of electric market share. If Utah wanted to significantly increase consumer embrace of electric vehicles with similar financial inducements, it would need to make a major investment. See the *What Utah Might Do* section beginning on page 35 for an investment example.

Finally, tax credits can influence or – depending the point of view – distort consumer decisions in unexpected ways. In Massachusetts, for instance, there was a major run-up in electric purchases in late 2018 due to a change in the credit that limited it to vehicles under the MSRP of $50,000.[58] It led to a rapid increase in sales of

The withdrawal of incentives can influence consumer decisions.

Figure 12: Massachusetts Electric Vehicle Sales Over Time



Source: Massachusetts' MOR-EV program.

higher-priced cars and then, beginning in 2019, a major drop-off in sales. (See Figure 12.) This is similar to sales fluctuations in Georgia and elsewhere.

As shown in Figure 10, Oklahoma topped the nation for electric vehicle uptake from 2017 to 2018. While the state does not have a robust incentive program, it is seeing a private push for electric vehicle infrastructure – with the help of state grants. Oklahoma will see the completion of a push for DC fast charge infrastructure that covers the state with 250 stations at 110 locations.[59] This represents a very high ratio of fast charging stations per capita.

PROMOTING ELECTRIC INFRASTRUCTURE

As previously noted, perhaps the top factor needed to encourage electric vehicle purchases is access to charging stations.[60] Consumers fear a lack of charging infrastructure could limit the feasibility of electric vehicle ownership.

There are three levels of charging infrastructure for charging stations.

Level 1 chargers are cheap, easy to install, and do not require dedicated electric wiring. They use a simple 20-amp, 120-volt connection found in normal, household

Charging infrastructure costs widely vary.

Figure 13: Charging Infrastructure Costs and Speeds, by Type

	Level 1	Level 2	Level 3
Charge Rate	3-5 mi/hr	10-20 mi/hr	80% charge in 20-30 minutes
Equipment Cost	$300-$1,500	$500-$6,000	$10,000-$40,000
Install Cost	0	$2,100-$4,600	$4,000-$51,000

Note: Variances in charge rate and costs are dependent upon a variety of factors, from battery conditioning to installation readiness.

Source: Leaders for Clean Air.

outlets. Charging times are variable, but these allow for approximately five miles to be charged per hour.[61]

Level 2 charging requires a dedicated 240-volt, 40-amp connection similar to outlets used for household dryers and ovens. These allow for approximately 30 miles to be charged per hour.[62]

DC fast charging – sometimes referred to as Level 3 – allows for more than 250 miles to be charged per hour. However, installation is costly.[63] (See Figure 13.) Additionally, energy supply demands make Level 3 charging impossible in many households and other locations.

Public charging infrastructure provides a benefit to electric vehicle drivers because it is often free of charge, saving them from paying for their fuel. But it is also important for people with longer commutes and trips who have slow, less expensive charging at home, and for people on trips farther from home. That said, electric vehicle drivers charge most often at home.[64] (See Figure 14.)

There are two ways to help provide improved infrastructure for electric vehicles: Directly to consumers and indirectly through public investment.

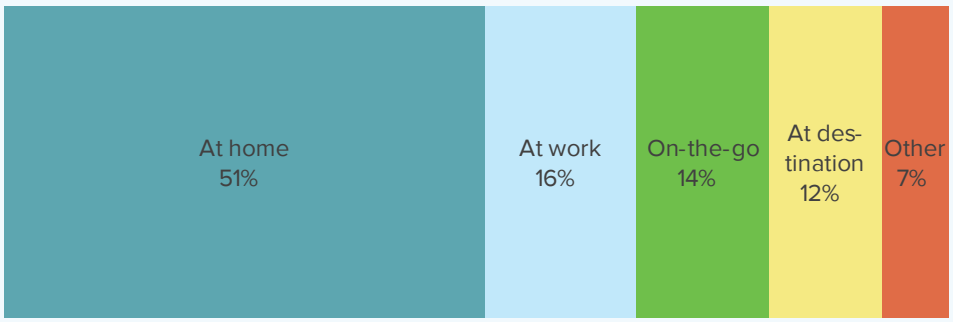
Direct to Consumers

In addition to tax credits for vehicles, some states provide personal and corporate electric charging stations. While most drivers charge their vehicles at home using just a regular 110 volt outlet, for those who need more than a slow charge because of longer commutes, such a tax credit can be particularly beneficial for faster home charging.[65]

In addition, numerous states offer tax credits for workplace and residential charging installation. These include Arizona's $75 tax credit for those who install charging stations at home.[66]

Electric vehicle owners most often charge their batteries at home.

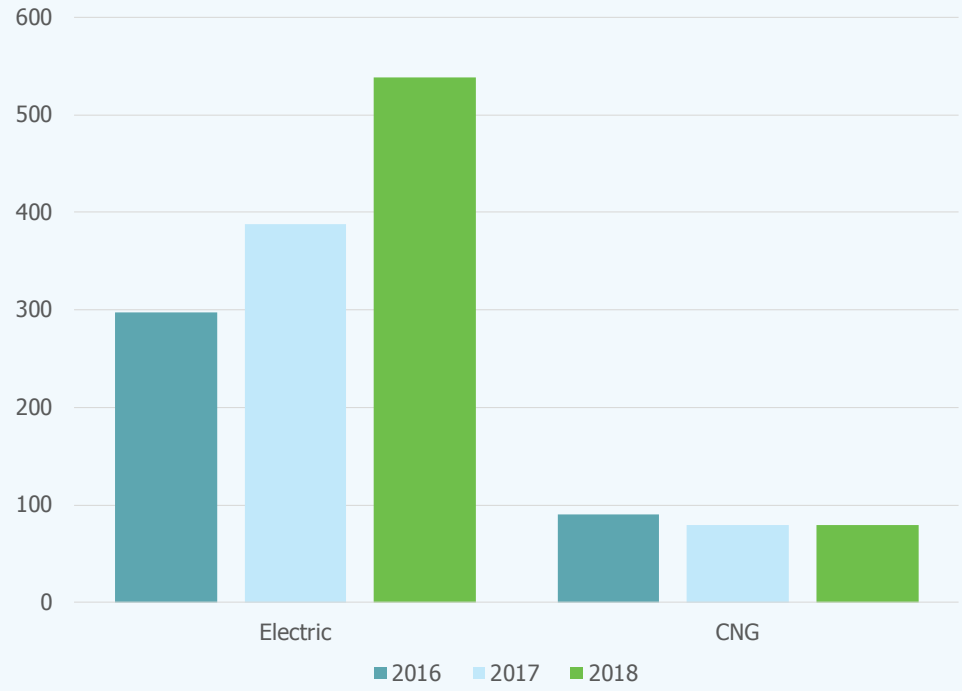
Figure 14: Average Charging Frequency by Location



Source: Volvo, The State of Electric in America.

Electric fueling stations are dominating fueling infrastructure.

Figure 15: Utah's Public Non-gasoline and Non-diesel Vehicle Fueling Stations



Source: U.S. Bureau of Transportation Statistics.

Indirect Investment and Regulation

There are now more than 22,000 charging stations in the U.S., three quarters of which have been built since 2015.[67] In Utah, the number of stations increased by more than 80% from 2016 to 2018 – and continues to expand.[68] (See Figure 15.) Public subsidy has been a major impetus behind Utah's electric charging stations.

However, availability of charging stations remains a concern, particularly in multi-family housing, rural areas and even suburban communities.[69]

Multifamily housing – like condominiums and apartments – provides a particular challenge for charging infrastructure. This is due to cost. The most significant costs for installing charging infrastructure involve trenching concrete and upgrading electrical paneling. Electrical paneling is usually not located close to central electrical paneling, and dedicated wires from the central panel to the parking space must be laid underground.

For a residential parking lot installing two Level 1 charging stations, installing infrastructure during the initial construction of the lot adds an estimated $1,840; retrofitting the same lot would cost nearly $7,420.[70]

For larger buildings, upgrading electrical paneling is not always necessary or

expensive; however, the majority of smaller buildings would need to work with utility companies to handle the increased energy demands.[71]

In addition, a high rate of adoption could put pressure on infrastructure. For instance, with California's 600,000 electric cars on the road, there are concerns about the sufficiency of electric infrastructure going forward.[72] And with a shortage of public charging options for the number of vehicles on the road, there might be a slowdown of electric vehicle adoption.

Infrastructure in the West

In response to these concerns, states are taking action. Washington, Oregon, California and Hawaii have implemented statewide building codes requiring electric charging infrastructure in new construction projects.

Building codes can be grouped into three general categories: EV-Capable, EV-Ready, or EVSE-Installed.[73] EV-Capable ordinances require builders to install a dedicated electric panel and lay wire to parking spaces, avoiding concrete trenching costs. EVSE-Ready spaces require a dedicated outlet for easy installation of electric vehicle supply equipment (EVSE) in addition to dedicated paneling and wiring. Finally, EVSE-Installed ordinances require that a fully operational charging station be installed.

Oregon requires all one-to-two family homes and 5% of parking spaces in all multi-family buildings with 50 or more parking spaces to be EV-Capable.[74] The California Air Resources Board has proposed raising the multi-family building requirement from 3% to 10% of parking spaces.[75]

Multiple cities have additional requirements embedded within their zoning codes. Palo Alto, California, for example requires all new one- and two-family dwellings to be EV-Capable, 100% of multi-family buildings to be EV-Ready, and either 25%

A TREND TOWARD LIGHT TRUCKS – AND LOWER FUEL EFFICIENCY

In the 1980s, light trucks made up less than a quarter of all U.S. sales.* Consumer choice has led to a trend away from cars to light trucks, due in part to low fuel prices. By 2018, about three-quarters of new passenger vehicle sales in Utah were light trucks, such as vans (and minivans), SUVs (and crossovers) and pickups.† These vehicles tend to have poorer fuel economy, which roughly translates into more air pollution and greenhouse gas emissions than smaller vehicles produced at the same time.

But consumer preference may not be the only reason for the trend toward larger vehicles. Vehicles may be getting larger in part to align with the incentives under federal standards. The corporate average fuel economy – or CAFE standard – favors large SUVs and pickup trucks because it is easier to reach for light trucks than it is for cars.†† And it is easier to reach for larger vehicles based on the size of the vehicle.

* Statista, U.S. car and truck retail sales from 1980 to 2018 (in 1,000 units), June 19, 2019, https://www.statista.com/statistics/199981/us-car-and-truck-sales-since-1951/.

† Auto Alliance, https://autoalliance.org/economy/consumer-choice/.

†† National Highway Traffic Safety Administration. "2017–2025 Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards: Supplemental." See also Reuters, Obama Unveils Sharp Increase in Auto Fuel Economy, July 29, 2011, www.reuters.com/article/us-usa-autos-standards/obama-unveils-sharp-increase-in-auto-fuel-economy-idUSTRE76S4AR20110729.

of commercial parking to be EV-Capable or 5% of parking be EVSE-installed.[76] The city and county of Boulder, Colorado requires all new one- and two-family dwellings to be EVSE-ready. [77]

Nonprofit and for-profit enterprises are also chipping in. In Wyoming, the Yellowstone-Teton Clean Cities Coalition offers 12 first-come, first-served $5,000 rebates annually to businesses that purchase and install charging stations.[78] Additionally, because of the heavy use of I-80 and I-25, Tesla is building charging stations across Wyoming for its customers on long road trips.[79]

Infrastructure in Utah

Utah's Wasatch Front is a relatively dense corridor, allowing potential for convenient electric vehicle infrastructure for commuters. The distance between Ogden and Provo (80 miles) is at the median charge range roundtrip for electric vehicles.

State and local governments are taking action to that end. During Utah's 2019 legislative session, two appropriations focused on charging infrastructure. A one-time appropriation of $2 million is aimed at installing Level 2 charging stations at state-owned facilities.[80] Another one-time appropriation of $4,990,000 offers incentives for businesses and governmental entities to install Level 2 charging stations at a 50% match by the requesting organization.[81]

In addition, through Utah's PEV Infrastructure Bond Authorization, interlocal entities, such as counties and local districts, may issue bonds for PEV charging infrastructure.[82]

Many cities are providing chargers for commuters and travelers. The Division of Air Quality granted Salt Lake City $200,000 to assist in its push toward electric charging infrastructure.[83] Salt Lake City provides dozens of charging stations around the city and at Salt Lake City International Airport, all free of charge.[84] It also offers one DC fast charger for a fee. And the city is not alone. Sandy City and others have added hundreds of charging stations in the past couple of years.

PACKSIZE EMPLOYEES GET THE MESSAGE

Packsize is an international, custom-packaging company headquartered in Salt Lake City. In 2017, Packsize's electric vehicle charging campus became the largest in the state with 50 Level 2 chargers.* It now has 54 Level 2 and two DC fast chargers.†

Approximately half of Packsize's 270 employees now drive electric cars. Electric vehicle ownership among Packsize's Salt Lake employees has increased 35% since the charging station installation.††

Packsize CEO Hanko Kiessner helped form Leaders for Clean Air in 2015, a nonprofit that provides organizations with a free charger in an effort to get them started. To date, Leaders has provided more than 750 chargers,¶ with its largest installation upcoming at a site in Draper.*

* Packsize, press release, https://www.packsize.com/packsize-international-becomes-largest-electric-vehicle-charger-installation-in-utah/.

† Britton Bettridge, Director of Business Operations at Leaders for Clean Air.

†† Utah Clean Cities, http://utahcleancities.org/fleetfix-packsize-ev-fleet-employee-use/.

¶ Leaders for Clean Air, http://leadersforcleanair.org/who-we-are/#history.

Not all charging infrastructure is created equal. Utah could fund many more Level 2 stations than DC fast-charge Level 3 stations, given the much lower cost. But it may be better to prioritize speed over quantity in areas that are less likely to have longer-term stops, such as along interstate highways.

In addition, Salt Lake City has encoded a private sector mandate for infrastructure, requiring one in 25 (4%) parking spaces in new multi-family buildings to be EVSE-Installed.[85] Salt Lake is one of 12 cities in the U.S. with infrastructure requirements, along with three counties and four states (California, Hawaii, Oregon and Washington). (See Appendix B.) Most of the charging requirements are for EVSE-Capable. The tradeoff is that the cost of EV-Installed is far higher than EV-Capable, giving lawmakers a decision to require more EV-Capable spaces or fewer charging-ready ones.

Not all charging infrastructure is created equal. Utah could fund many more Level 2 stations than DC fast-charge Level 3 stations, given the much lower cost. But it may be better to prioritize speed over quantity in areas that are less likely to have longer-term stops, such as along interstate highways.

In 2015, the EPA filed claims against Volkswagen asserting that the German auto manufacturer had installed software which activated emission controls only during emission testing, while controls were inactive during normal use.[86] The company sold an estimated 590,000 diesel vehicles, each vehicle emitting between nine and 40 times the federal limit for acceptable nitrogen oxide emissions.[87] To settle charges of violating the U.S. Clean Air Act, conspiracy, obstruction of justice, and entry of goods by false statement and fraud, VW agreed to a $15.7 billion settlement.[88]

Of that settlement, $2 billion will be used for electric vehicle public charging infrastructure, including Level 2 and DC fast charger in 17 metro areas across the nation.[89] Funds will also be used to install Level 2 charging stations in workplaces and multi-unit dwellings.[90]

Another nearly $3 billion has been distributed to states, including $35 million to Utah.[91] The settlement includes specific Eligible Mitigation Actions related to eliminating eligible diesel vehicles and increasing charging infrastructure for zero emission passenger vehicles.[92] States may use up to 15% of their allocation on the costs necessary for electric and hydrogen fuel cells stations.[93] The Mountain States of Colorado, Idaho, Montana, Nevada and New Mexico are spending the maximum 15% on infrastructure. Arizona and Wyoming are spending nothing on it. (See Appendix C.)

Of the $35 million awarded to Utah, the state plans to allocate 11% to "light duty zero-emission vehicle supply equipment" – much of which will be used for

ENCOURAGING ELECTRIC VEHICLES IN THE WORKPLACE

The U.S. Department of Energy has complied a comprehensive list of 15 ways employers can encourage electric vehicles in the workplace.

1. Invite electric-vehicle-driving employees to give a presentation or webinar about their experience with electric vehicles, and encourage them to engage in discussion with fellow employees.
2. Place informational posters in office common areas to raise employee awareness about the organization's workplace charging program.
3. Work with the organization's travel coordinator to encourage electric-vehicle rentals for employee travel. Learn more about Workplace Charging Challenge Partner's Smart Mobility rental choices.
4. Work with the organization's fleet manager to deploy electric vehicles in the fleet. Connect with the local Clean Cities coalition to learn more about adopting electric vehicles and other alternative fuel vehicles. Check out DOE's Alternative Fuels Data Center for best practices, case studies, cost calculators, interactive maps, customizable database searches, and mobile applications to evaluate potential electric-vehicle fleet usage.
5. Work with grounds managers to utilize electric vehicles for lawn maintenance needs. See the Clean Cities Guide to Alternative Fuel and Advanced Technology Commercial Lawn Equipment for more information.
6. Provide optimally located reserved parking places for electric-vehicle-driving employees to use, when they're not parked at a charging station, as an added benefit for electric-vehicle drivers and an incentive to potential electric-vehicle drivers.
7. Allow employees a few hours each month to participate in an electric-vehicle-related learning opportunity and encourage them to share what they learned with coworkers.
8. Invite local electric-vehicle dealers to participate in a Ride and Drive day. Use Advanced Energy's Ride and Drive kit for tips on organizing the event, and find a local dealer by contacting the nearby Clean Cities coalition.
9. Hold a "Workplace Charging Tour" to demonstrate the ease and accessibility of electric-vehicle charging stations and inform employees of the organization's charging procedures.
10. Include employee testimonials and information on the benefits of electric vehicles in organization's newsletter or other internal communications materials.
11. Inform new employees about workplace charging procedures and policies at orientation. Keep employees engaged by communicating changes in policy in organization's internal communications materials.
12. If the organization has an electric-vehicle fleet, develop an electric-vehicle carshare program where employees can use vehicles for local trips.
13. As an employee benefit, offer employees a monthly allowance for purchasing or leasing an electric vehicle.
14. Develop an online forum or other communication method that allows current electric-vehicle-driving employees to improve their charging experience and potential electric-vehicle drivers to learn more.
15. Encourage the creation of a "Green Team" that includes electric-vehicle-driving employees who are willing to help educate interested coworkers and promote workplace charging.

Source: U.S. Department of Energy, Plug-in Electric Vehicle Outreach Resources for Employees, p. 6., https://afdc.energy.gov/files/u/publication/WPCC_employertoolkit_1114.pdf.

electric charging stations – with the remainder going to other emissions reductions such as providing grants to swap out older, more-polluting buses and local freight trucks with newer, cleaner vehicles. According to the Department of Environmental Quality, the state will install electric charging stations at government facilities in areas where air quality falls below certain federal standards.[94]

In addition, in 2017, seven of the eight Mountain States (Utah, Idaho, Montana, Wyoming, Colorado, Nevada, and New Mexico) signed a Regional Electric Vehicle agreement to create an "Intermountain West Electric Vehicle Corridor" across the signatory states' major transportation routes.[95] The plan is to provide electric vehicle charging stations along this corridor so that an electric vehicle could drive seamlessly along it. It also includes pressure on dealers to increase electric vehicle stock available to consumers, and to market electric vehicles.[96]

Lastly, House Bill 107, passed in 2019, authorizes Dominion Energy to develop alternative fuel vehicle infrastructure under the Sustainable Transportation and Energy Plan act.[97]

OTHER INTERVENTIONS

Electric Sales Mandates

California and nine other U.S. states (Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont) have adopted a Zero-Emission Vehicles (ZEV) standard requiring that automakers research, develop and market electric and other zero-emission vehicles.[98] Colorado is now making its way toward the ZEV standard as well.[99] Most significantly, a fixed percentage of vehicle sales must be electric, with the 2019 requirement at 7%, stepping up to 22% by 2025.

Assessing the success of these mandates is beyond the scope of this report, and they do not appear to be likely for consideration in Utah. However, advocates argue that they have helped to propel technological advances in electric vehicle technology, particularly with regard to hybrid electric. Critics raise concerns about distortions in the auto market and negative impacts on automobile affordability.

Removing Disincentives

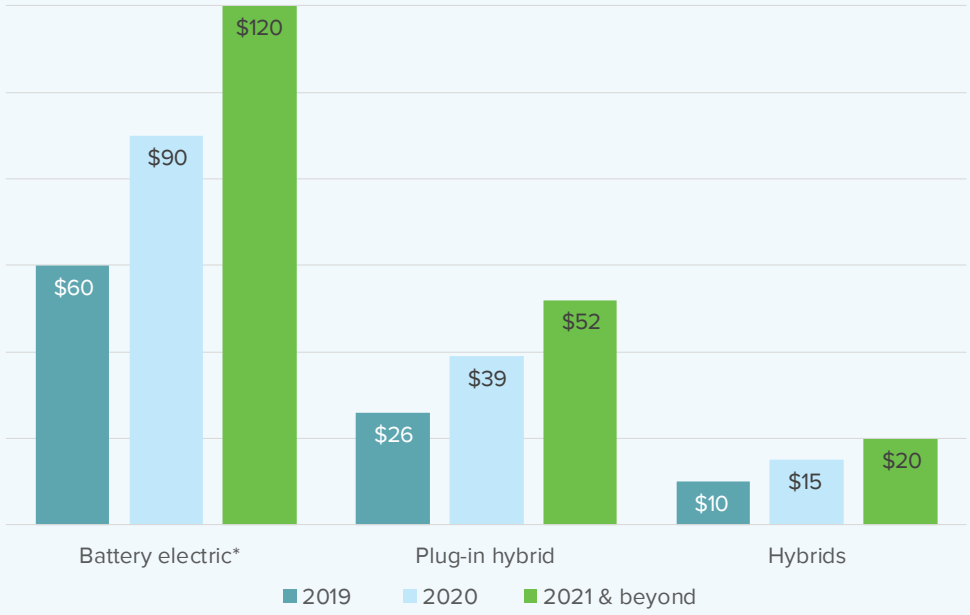
Twenty states have imposed higher electric vehicle registration fees, potentially disincentivizing electric vehicle ownership.[100] These fees are intended to make up for lost gas tax revenue.[101]

Idaho electric vehicle owners must pay a $140 annual fee and hybrid owners a $75 fee.[102] Wyoming electric vehicle owners have a special vehicle registration fee of $50 annually.[103] Most recently, Washington State implemented a $75 electrification fee to help finance electric car charging stations.[104] This fee is on top of a $150 electric car fee, but is also applied to hybrid vehicles – much to the chagrin of some hybrid owners that do not need the charging stations at all.

Given that electric vehicle ownership is such a small percentage of Utah's overall passenger vehicle fleet, the lost revenue from more fuel-efficient hybrids and electric vehicles is far outstripped by the diminished purchasing power of gas tax revenue in Utah since 1999, and the overall increase in vehicle fuel efficiency and in road construction costs.[105] This diminishing gas tax revenue was only partially addressed by the Utah Legislature's change to the gas tax in 2017. Utah lawmakers

Utah's hybrid and electric fees maximize by 2021.

Figure 16: Utah's Hybrid and Electric Vehicle Fees



*And other alternative fuels, other than natural gas and propane.

Source: U.S. Department of Energy.

passed a hybrid and electric vehicle fees law which took effect in 2019, doubling by 2021.[106] (See Figure 16.)

In addition to fees, in Wyoming, the Mountain State with the lowest market share, electric vehicle owners pay a license tax of $0.24 per gasoline gallon equivalent of alternative fuels, the same amount taxed on gasoline.[107]

One small way to promote electric vehicles is to consider removing these types of disincentives. This lowers marginal costs for owners and signals state support for increasing the proliferation of electric vehicles.

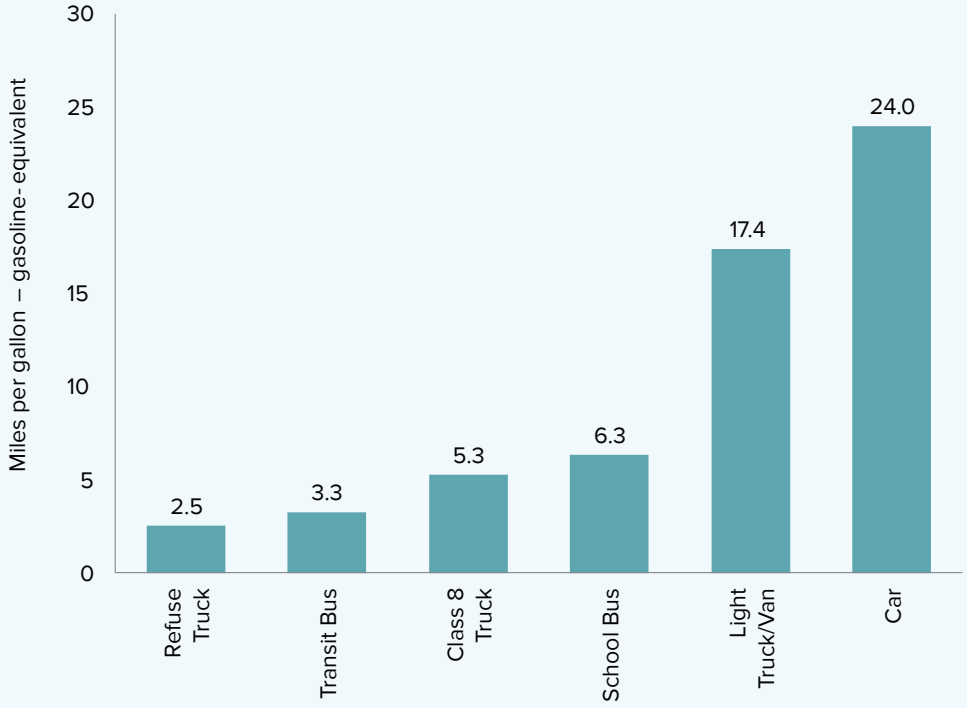
THE 80,000-POUND TRUCK IN THE ROOM: LARGE FLEET VEHICLES

The U.S. fleet inventory is made up of 3.2 million business vehicles and 3.1 million public sector vehicles, as well as 2.3 million rentals. Trucks make of the lion's share of these, with over 2.6 million of them owned by businesses, 1.9 million by the public sector, and 0.5 million made available for rent.[108]

This section examines alternative fuel fleet vehicles, with a particular focus on heavy trucks in the business and public sectors. Governments can certainly incentivize certain business practices. But they can also – within budgetary constraints

Large fleet vehicles get exceedingly low miles per gallon compared to passenger vehicles.

Figure 17: Average Fuel Economy of Major Vehicle Categories, 2016, U.S.



Note: The Utah Transit Authority's buses average nearly one MPG higher than shown in this figure.

Source: Clean Cities Database and the Department of Energy's Alternative Fueling Data Center.

– easily implement chainges to their own public sector fleets.

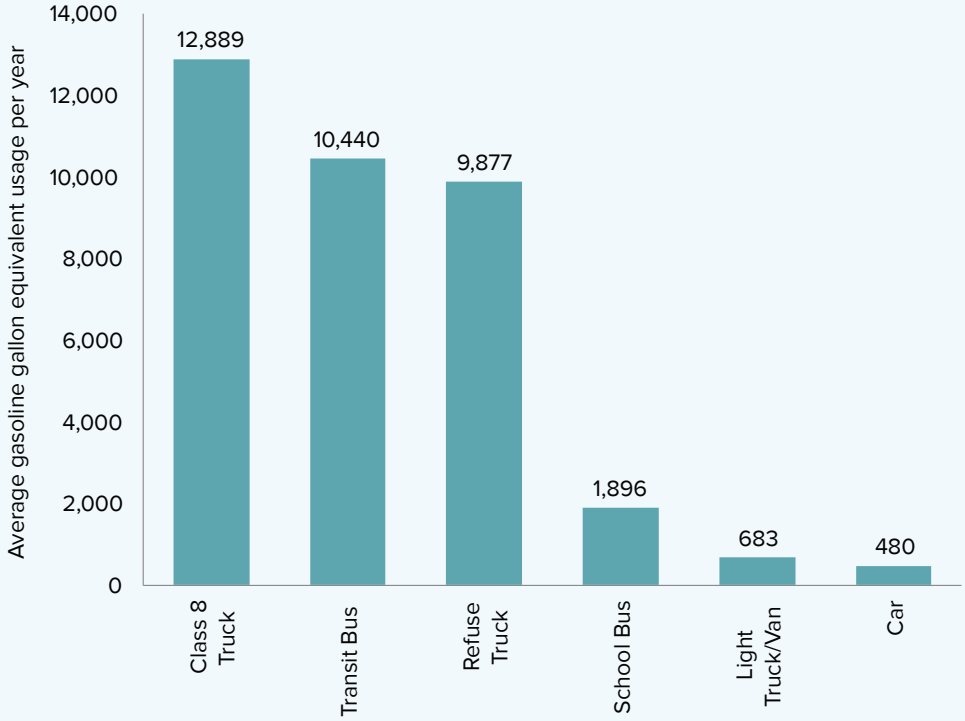
When thinking about fleets, it is most important to look beyond pickups to heavy vehicles such as buses, long-haul trucks and garbage trucks. While historical sales of heavy trucks hover around only two percent of all vehicle sales and three percent of vehicles miles travelled, some estimates put long-haul and commercial truck vehicles at more than one-third to one-half of the pollution problem from vehicles overall.[109]

To begin with, fuel economy is much lower in large vehicles. The average fuel economy of a garbage truck is two and one-half miles per gallon.[110] (See Figure 17.) For a car, fuel economy averages 24 miles per gallon. That equates to 40 gallons for 100 miles for a garbage truck versus just over four gallons for 100 miles for a car. Depending upon fuel type and vehicle pollution controls, pollution and greenhouse gas emissions for garbage trucks are far higher.

To make matters worse, the average heavy truck is also driven far more per day than a typical car. When this is multiplied by fuel consumption, differences really emerge. Compare the gasoline gallon equivalents per year used by different types of vehicles. A long-haul rig uses nearly 13,000 gallons, versus less than 500 for a car.[111] A transit bus uses over 10,000 gallons (though carries many passengers). A

Large fleet vehicles expend far more fuel than small vehicles, placing an out-sized burden on air quality.

Figure 18: Average Annual Fuel Use by Vehicle Type, 2016, U.S.



Source: Clean Cities Database and the Department of Energy's Alternative Fueling Data Center.

garbage truck uses just under 10,000. Cleaning up these vehicles goes a long way toward cleaner air and fewer greenhouse gas emissions. (See Figure 18.)

It is important to reiterate that fuel economy does not equal emissions, and that vehicles have very different emissions depending upon the year of production and emission controls. In addition, diesel vehicles are more likely to have modified emissions systems, resulting in yet higher emissions.

POTATO CHIPS COME CLEAN

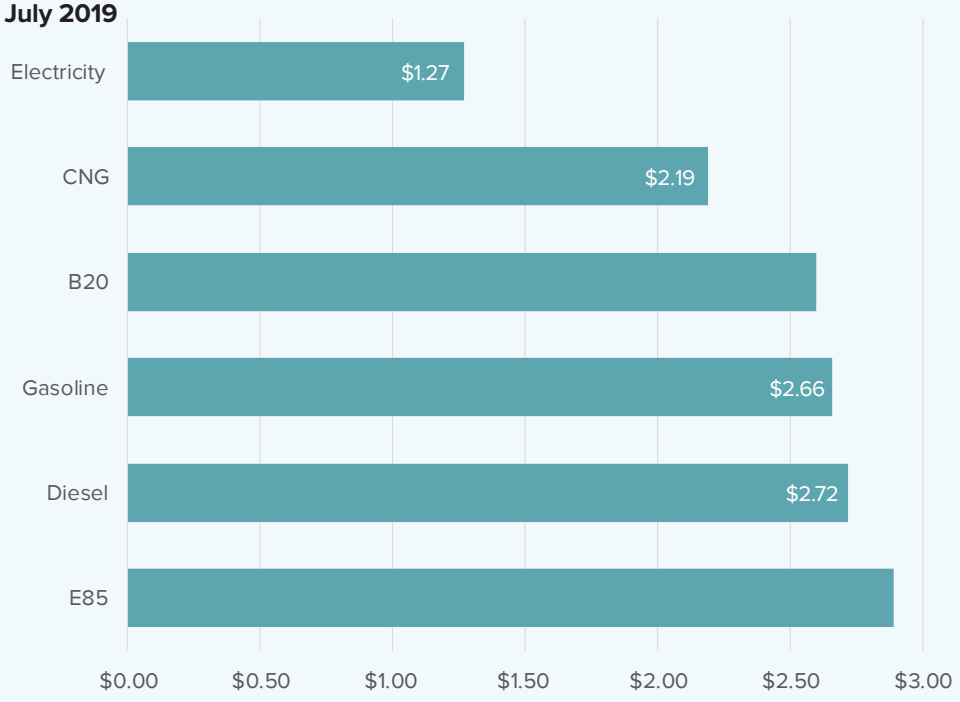
Frito-Lay in Modesto, Calif., is turning toward alternative fuels, with 15 Tesla long-haul trucks, 28 Volvo natural gas-powered long-haul trucks (adding to the 10 it has now), six electric Peterbilt box trucks, 12 electric forklifts and three electric yard tractors. It is also installing natural gas fueling stations and electric charging stations for its fleet and employees, a solar energy storage system, and a carport with solar panels that will double the plant's existing solar energy output.

The project is funded in part by a $15.4 million grant from the California Air Resources Board (CARB), which taps into the statewide cap-and-trade program designed to reduce greenhouse gas emissions from major corporations, utilities and other sources. As part of the program, companies buy credits based on their emission levels, and then those funds are used to support the state's clean energy goals. In addition to the CARB grant, Frito-Lay has kicked in $13.5 million in matching funds with another $1.8 million coming from American Natural Gas.

Source: Marijke Rowland, Why you'll see electric Tesla semis rolling out of Modesto's Frito-Lay plant soon, Modesto Bee, October 03, 2019.

Electricity and CNG tend to be cheaper than other commonly used fuels, though the vehicles come with a higher initial investment.

Figure 19: Fuel Costs in Gasoline-gallon Equivalents, U.S., Average October 2017 - July 2019



Source: U.S. Department of Energy.

TURNING TO ALTERNATIVE FUELS FOR LARGE FLEET VEHICLES

Heavy vehicles often use diesel, but are increasingly switching to alternative fuels for their fuel cost and emissions benefits. The main alternatives are compressed natural gas (CNG) and electric, as well as hybrid-diesel powered vehicles.

CNG as a fuel is almost always cheaper than diesel. (See Figure 19.) And since 2000, electricity has been the least expensive of the major alternative and non-alternative fuels on a gasoline-gallon equivalency basis.[112] This can be of particular benefit to fleets because of the volume of fuel they use per year.

Of natural gas vehicles, compressed natural gas is much more common than liquid natural gas (LNG) – the latter of which is liquefied by cooling to negative 260 degrees Fahrenheit. Bio-methane is a CNG alternative that has lower greenhouse gas emissions than traditional natural gas. While bio-methane is not widely available now, companies like Wasatch Resource Recovery and Dominion Energy are partnering to capture large amounts of methane from waste facilities.

There are benefits to CNG and electric besides fuel costs. Electric buses are quieter and much more efficient than their internal combustion counterparts – four times more efficient than diesel and CNG buses.[113] And, most importantly for the purposes of this report, switching to electric buses does the most to reduce air pollution

along Utah's Wasatch Front, in the Cache Valley and in the Uintah Basin, each of which struggle with poor air quality.

BARRIERS TO ALTERNATIVE FUEL FLEET ADOPTION

In a study of 16 cities with electric buses in their fleets, one study found that there are three barriers to entry for electric bus adoption.[114] Two are related to the barriers faced by electric cars – such as battery limitation, charging infrastructure and cost. The third set of barriers are institutional ones; these include electric-bus adoption leadership, and a lack of institutional authority and funding.

In addition, since electrified buses, long-haul trucks and heavy vehicles are so new, there remain many unknowns. These include reliability, maintenance needs and costs, and battery lifespans.[115] Furthermore, seasonal temperature changes might have significant effects on electric vehicle driving range, particularly due to the demands in transit and school buses for heating and air conditioning large spaces.

There are similarities between the barriers facing electric adoption and those impeding a switch to CNG. The infrastructure cost borne by CNG fleets is not insignificant. A small fleet of 10 trucks requiring a fast-fill option might need to spend around $50,000, while large fleet operators might need to spend more than $500,000 for a station that can support up to 40 refuse trucks or 80 school buses.[116] These costs are based upon fueling demand and how quickly the vehicles need to be refueled.

This certainly seems like a large investment. However, garbage trucks cost between $150,000 to $230,000. Thus, the fast fueling infrastructure per vehicle is only a small proportion of the overall cost, and the stations themselves do not depreciate as quickly.

ENCOURAGING ALTERNATIVE FUEL FLEET UPTAKE

Transit Buses

More than 60% of the nation's nearly 70,000 transit buses run on diesel, while 18% run on natural gas, followed by gasoline, biodiesel and other fuels, as well as hybrid and electric.[117] Just 0.2% of buses are electric. Some hybrid buses are electric propulsion, meaning that, like the Chevy Volt but unlike most hybrid pas-

CLEANING UP WASTE MANAGEMENT

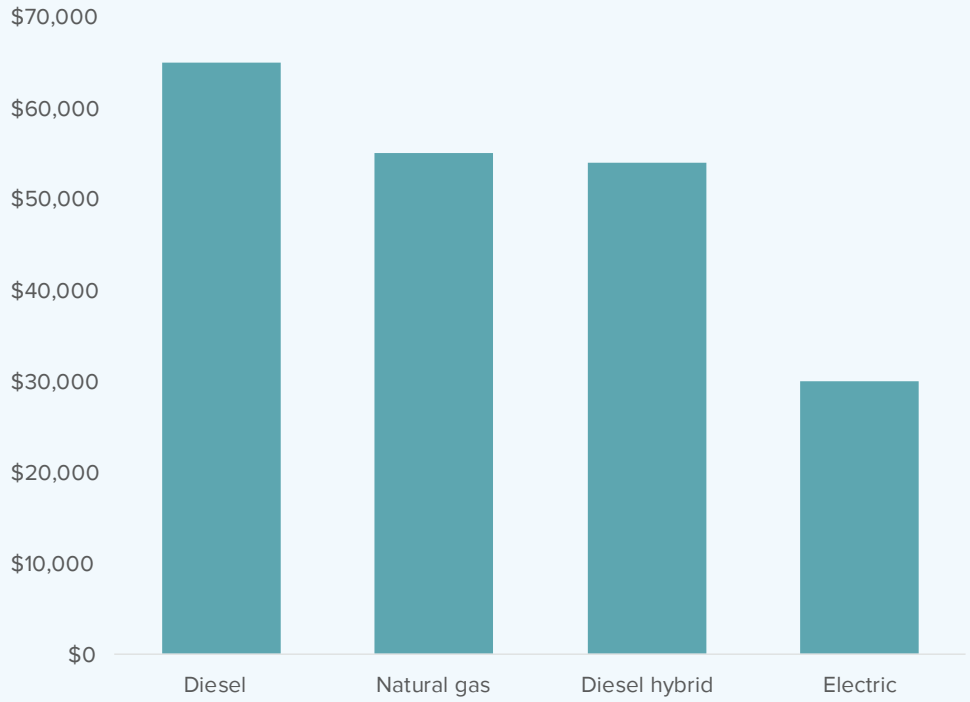
Ace Recycling and Waste Disposal, headquartered in West Valley City, has a fleet of 115 garbage collection trucks. The company is converting its entire fleet to compressed natural gas (CNG) trucks. Ace received its first CNG truck in 2009. Ten years later, almost 60% of Ace's garbage and recycling trucks are running on CNG.

Ace serves Davis, Salt Lake, Summit, Tooele, Utah and Weber counties in Utah, and Uintah County in Wyoming. The company picks up trash and recycling for 13 Utah cities, and for commercial customers across Utah.

Source: Ace Recycling and Waste Disposal and Utah Clean Cities http://utahcleancities.org/fleetfix-ace-recycling-disposal-fleet-introduction/.

Electric transit buses provide huge savings over traditional diesel fuel vehicles.

Figure 20: Estimated Annual Operating Costs of Transit Buses, by Fuel Type



Source: Environment America.

senger vehicles, only the electric motor is connected to the wheels; the internal combustion engine is used only to charge the battery.

While alternative fuel vehicles cost more upfront, there are considerable savings thereafter. For instance, the Chicago Transit Authority estimates that each electric transit bus in its fleet saves the city $25,000 in fuel costs every year and an additional $10,000 in maintenance costs.[118] (See Figure 20.)

Due in part to these operational savings, many transit agencies are moving away from diesel buses to natural gas and electric, even in the face of the high initial investment.

And initial investment costs are coming down. From 2009 to 2015, California's Foothill Transit electric bus costs decreased from $1 million (for a 35-foot bus) to $789,000 (for a 40-foot bus).[119] (Though the Utah Transit Authority's recent purchases were closer to $1 million.) In 2015 the cost of a CNG bus, meanwhile, was about $575,000. However, this was still higher than a diesel bus, at around $450,000.

As of 2017, there were approximately three million municipal buses in the world. While electric buses may not seem very familiar to Americans, 13% of the worldwide fleet, 385,000 in all, are electric.[120] Almost all of them – 99% – are in China. By 2025, nearly half the worldwide fleet is expected to be electric; again, however,

most of these will be in China.[121]

In 2017, there were only 360 electric buses in the U.S.[122] That number increased by 44% in 2018 to 520 buses, with another 1,000 buses on order by 13% of U.S. transit agencies.[123]

Los Angeles is leading the way in electric bus adoption in the U.S., committing to a 100% electric fleet (2,240 buses) by 2030. New York and Chicago are making the transition to 100% electric by 2040.[124] Seattle is expanding its small fleet of electric buses to 120 by 2021.[125] And other states are spending a portion of their Volkswagen Settlement funding on electric buses, including Colorado.[126]

There are about 600 transit buses operating in Utah, offering an opportunity for alternative fuel transition.

Figure 21: Full-size Transit Buses in Utah, 2017

Agency / City	Number
Utah Transit Authority	549
Park City Municipal Corporation	31
Cache Valley Transit District	26
City of St. George	7
Uintah Basin Association of Governments	1

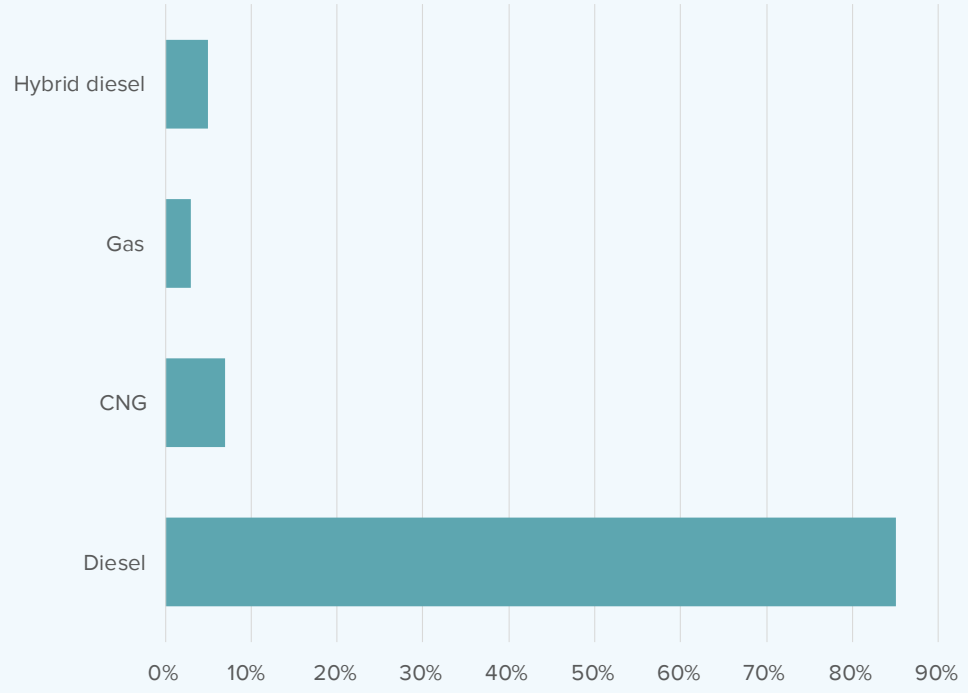
Note: This figure includes over 100 alternative fuel buses.

Source: Federal Transit Administration.

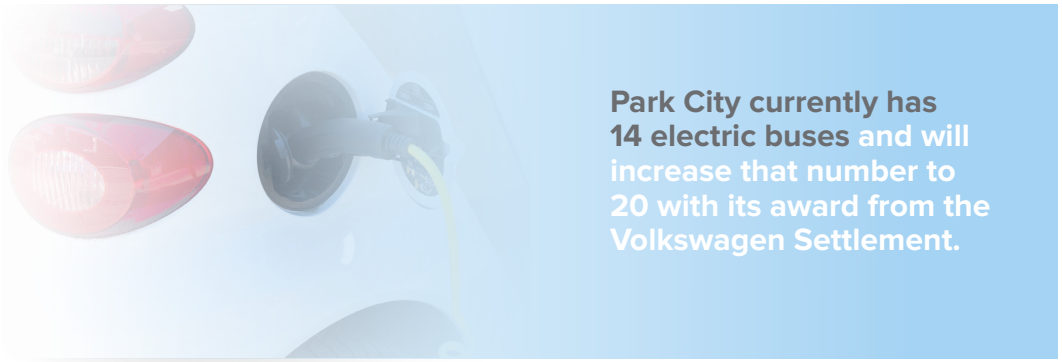
Utah transit agencies operate more than 600 buses, offering a lot of room for alternative fuel transition. (See Figure 21.) The state's largest operator by far, the Utah Transit Authority (UTA), primarily operates diesel buses. (See Figure 22.) However, when older buses are retired, UTA upgrades to "clean diesel," hybrid diesel,

UTA is adopting alternative fuel buses, although most transit buses currently operate on diesel.

Figure 22: UTA Buses by Fuel Type, 2017



Source: Federal Transit Administration.



CNG and now battery electric – most recently through a state grant for 20 new electric buses from Utah's Volkswagen Settlement funds.[127] However, the alternative fuel technologies each come with a set of concerns. UTA is finding that the hybrids have certain maintenance issues to overcome, and it does not currently have the capacity to fuel a large CNG-bus fleet or to meet the demands that a large electric-bus fleet places on the area's electric grid.[128]

To overcome these obstacles, UTA is currently in the process of constructing a new bus facility in Salt Lake City specifically designed for servicing and maintaining CNG buses and charging electric buses. UTA is also working with Rocky Mountain Power on a study to determine future grid infrastructure improvements to enable the organization to increase the number of electric buses in the fleet.

Park City currently has 14 electric buses and will increase that number to 20 with its award from the Volkswagen Settlement.[129]

School Buses

Approximately 95 percent of school buses in the U.S. run on diesel.[130] However, many school districts are moving toward CNG. And propane is another alternative. A case study of propane school bus fleets found that they offer a cost savings of nearly 50% per mile for fuel and maintenance over diesel.[131] This savings offers a payback period of three to eight years to recoup the costs of the buses and fueling infrastructure.

Electric offers less of a business case for school buses than for transit buses. The annual cost savings of electric over diesel is about $2,000 in fuel and $4,000 in maintenance costs.[132] This savings of $6,000 compares to $25,000 for transit buses – which difference is due to the average number of miles driven.

Nonetheless, school buses are going electric. Some states are using Volkswagen Settlement funding to help districts make the transition to electric. Virginia is offering up to $20 million in competitive grants, providing reimbursements of up to $265,000 per bus.[133] Rhode Island is using $10 million in settlement funds to retire about 20 diesel buses. And Hawaii is using more than half its funds for electric school buses, transit buses and other fleet vehicles.

Utah's public schools operate over 2,400 buses.[134] Many are converting to alternative fuels. For instance, Jordan School District purchased 36 new CNG school buses in 2018 using $1.7 million in state and federal grants. This brings its total number of CNG buses to 105 – more than half of its fleet.[135] This saves the district $630,000 in fuels costs per year.[136]

The Salt Lake City School District received an award from the state for nearly $700,000 for the purchase of four school buses as part of the Volkswagen Settlement.[137]

Refuse and Other Municipal Trucks

Diesel-powered refuse and other large municipal trucks are some of the biggest polluters in cities due in large part to fuel economy and miles travelled (see Figure 18 on page 27), as well as weaker heavy-duty truck emissions regulations. There are few electric options available at this time, but many cities and private refuse and recycling companies are making the switch to CNG.[138] This reduces fueling and maintenance costs, and the amount of air pollution versus diesel. And, depending upon the source of the fuel, CNG could have some greenhouse gas savings.

One study of CNG refuse fleets looked at Republic Services, a recycling company headquartered in Phoenix; Groot Industries Inc., a residential refuse company in northern Illinois; and the City of Milwaukee's Department of Public Works. All received federal funding under the American Recovery and Reinvestment Act of 2009. The study found that these fleets saved about $0.90 per mile in fuel costs by using CNG – which could recoup investment costs in three to eight years.[139] In addition, the drivers liked the quieter operation of the vehicles and CNG's acceleration.

Some communities in Utah are making the change. For instance, in 2019, Salt Lake City completed its years-long shift to CNG for its garbage and recycling truck fleet – 33 vehicles in all.[140]

Long-Haul Trucks

Almost all long-haul trucks run on diesel fuel. In 2017, there were 175 million tons of truck freight flow in the state, which resulted in 75 billion ton-miles.[141] A majority of this freight delivery was on Utah roads, but also to and from neighboring states.

The transition to alternative fuels for long-haul trucks has been slow. This is due in part to initial vehicle cost, as well as the availability of fuel. An average diesel long-haul truck costs about $120,000. A Volvo CNG semi costs about $185,000. And Tesla semis will cost $150,000 to $180,000 when they become commercially available in 2020. However, Teslas have a range of only about half to two-thirds of the Volvo CNGs and very little charging capability for long-distance trips.[142]

The transition to alternative fuels for long-haul trucks has been slow. This is due in part to initial vehicle cost, as well as the availability of fuel.

Another alternative fuel option for long-haul

trucks will soon be available from a company called Nikola, which is building hydrogen fuel cell long-haul trucks. Nikola plans to lease the vehicles to operators, given the high purchase price. These provide the zero-emission advantages of electric, but with a greater range. And Nikola plans on building a nationwide long-haul truck fueling infrastructure – much like the electric infrastructure that Tesla made for its passenger vehicles.

Federal Support for Fleet Vehicles

The Federal Transit Administration (FTA) provides grants for alternative fuel vehicles and fueling infrastructure. For instance, the Transit Investments for Greenhouse Gas and Energy Reduction program provides grants which often cover between 80 and 90 percent of increased costs.[143]

In addition, the FTA's Clean Fuels Grant Program is used to help nonattainment and maintenance areas to achieve National Ambient Air Quality Standards for ozone and carbon monoxide, and grants funds for alternative fuel vehicle costs and refueling.[144]

Lastly, the FTA provides funding to states and local governments for zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities. Under the Fixing America's Surface Transportation Act, $55 million per year is available from the FTA until fiscal year 2020. In 2019, the program provided funding to 38 transit agencies, including $3 million to SunTrans in St. George, Utah, for electric buses and chargers for its St. George-Springdale route.[145]

Other Western States' Incentives and Mandates

Several Mountain States offer incentives and requirements for alternative fuel fleet vehicles.

- Arizona offers multiple requirements and incentives for governmental fleet vehicle adoption. For instance, local governments in the state's three largest counties are required to have at least three-quarters of their fleets operate on alternative fuels. And all bus fleets in larger counties must operate on alternative fuels. In addition, 90% of the vehicles in federal fleets in the largest counties must operate on alternative fuels.[146]

- Colorado also has multiple management and funding incentives to increase the market share of alternative fuel fleet vehicles in government and business.[147] In addition, the state's Alternative Fuel Vehicle Tax Credit provides an incentive towards the purchase of dedicated or bi-fuel natural gas and propane vehicles; the incentive is up to $20,000 in 2019, though it decreases to less than half by 2026.[148] (See Figure 23.)

Colorado's alternative fuel tax credit decreases over time.

Figure 23: Colorado's Tax Credit for Dedicated or Bi-fuel Natural Gas and Propane Vehicles

Truck category	2019	2020	2023	2026
Medium-duty	$10,000	$8,000	$5,000	$4,000
Heavy-duty	$20,000	$16,000	$10,000	$8,000

Note: The tax credit is also available for light-duty vehicle purchases and leases at smaller credit amounts.

Source: Department of Energy, Alternative Fuel Data Center.

- In Montana, businesses and individuals who convert vehicles to operate on alternative fuels can receive an income tax credit covering 50% of the equipment and labor costs for the conversion.[149]

- Nevada provides funds to school districts for the reduction of emissions; these funds are from penalties assessed for violations of air pollution control laws.[150]

- New Mexico has an alternative fuel loan program providing state agencies, political subdivisions and educational institutions funding to purchase natural gas, propane, electric or hydrogen fueled vehicles.[151] The incentive is $5,000 for vehicles up to 14,000 pounds (gross vehicle weight rating), $10,000 for up to 26,000 pounds, and $20,000 for larger vehicles.

In addition, all Mountain States have awarded or are preparing to award amounts under the Volkswagen Settlement for the specific replacement of various governmental and quasi-governmental diesel fleet vehicles.

Utah's Approach to Fleet Vehicles

The state's own governmental fleet requirements previously included a Utah Air Quality Board mandate that fleets of 10 or more vehicles use alternative fuels if they are capable of being fueled at a central location and if the region remains below National Ambient Air Quality Standards. The fleet requirement expired July 1, 2019.[152]

Under Utah's Clean Fuels and Vehicle Technology Fund Grant and Loan Program, the state provides grants and loans to businesses and governmental entities to purchase clean fuel refueling equipment, and to purchase clean fuel or convert existing vehicles to clean fuel.[153]

Finally, the state offers a tax credit up to $18,000 in 2019 and up to $15,000 in 2020 toward the purchase of a qualified, heavy-duty, alternative-fuel vehicle. The Heavy Duty Natural Gas Vehicle, Clean Fuel Vehicle Tax Credit Program requires that at least 50% of the qualified vehicle's miles must be driven in the state, and no single taxpayer may claim more than 10 credits annually unless credits are unused.[154] A quarter of the credits are reserved for smaller fleets (of less than 40 vehicles). The credit expires December 31, 2020.

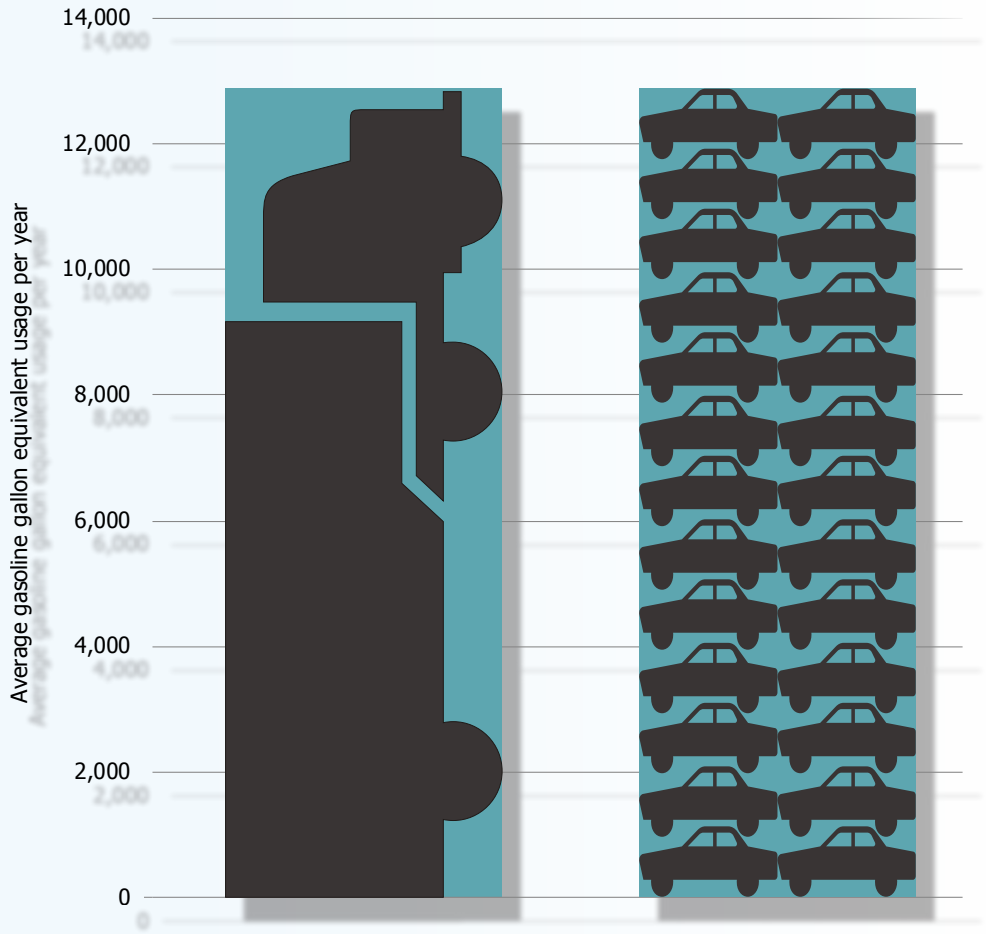
State agencies have one final mandate under Utah's Alternative Fuel Use and Vehicle Acquisition Requirement. With respect to light-duty vehicles, at least half of the new and replacement vehicles must have low tailpipe emissions (bin 2 standard set by the EPA), or run on electricity, natural gas, propane, hydrogen or biodiesel.[155]

What Utah Might Do

The impetus behind this report is improving Utah's air quality. Particulate matter and ozone issues concern Utahns, and many policy levers are being pulled to improve the air Utahns breathe. These levers need to include those affecting public embrace of motor vehicles running on gasoline and diesel, since they are the single biggest source of the problem.

A large fleet vehicle's fuel usage is roughly equivalent to 26 passenger cars – and overall emissions can be much worse than that.

Figure 24: Comparison of Annual Fuel Usage Between Heavy Fleet Vehicles and Passenger Vehicles



Source: Clean Cities Database and the Department of Energy's Alternative Fueling Data Center.

With respect to electric passenger vehicles, market momentum is picking up; Americans – and Utahns – are buying more electric vehicles. This is in part because the federal tax incentive goes a long way to closing the cost gap between electric and regular internal combustion vehicles. And the gap is expected to close further – or completely – by the early-to-mid-2020s. It should be noted that new, non-electric cars are not the primary air pollution contributor – particularly with the Tier 3 improvements for new cars. Rather, older vehicles are more of the problem.

Lawmakers might consider continuing the work to clean up or remove those old cars from Utah's roads. But medium- and heavy-duty fleet trucks pose a significant challenge as well. While there are far more passenger vehicles on the road, medium- and heavy-duty truck emissions account for about one-third of the pollution along the Wasatch Front. It is clear to see why, as they use far more fuel than passenger vehicles, and they tend to be older, with antiquated emission controls. In fuel consumption alone, one long-haul rig is equal to roughly 26 passenger vehicles.[156] (See Figure 24.)

Accordingly, there might be a bigger payoff dollar-for-dollar in subsidizing the replacement of trucks over cars. And the possible local air quality savings are enormous, particularly for trucks older than 2008 – many of which are still on the road because diesel engines can remain in operation for decades.[157] While natural gas heavy duty vehicles have become more common, the relative air quality improvement they offer over diesel is not as great as it once was because of significant advances in "clean diesel" techonology. However, electric and hydrogen still provide large air quality benefits over even clean diesel.

So what should Utah policymakers do? They might consider pulling several policy levers, with a focus on tax credits for passenger vehicles, a mix of incentives and mandates for fleet vehicles, and local infrastructure ordinances.

Tax Credits for Passenger Vehicles

Utah Foundation's analysis suggests that smaller tax credits for electric passenger vehicles tend not to make a significant impact on consumer decisions. While a robust tax credit program in line with the four Western states that top U.S. sales could make a significant impact, it would be costly.

For instance, if Utah were to match Colorado's $5,000 incentive, then – using a baseline sales of 3,000 vehicles per year – it would cost $90 million over three years to double the number to 6,000 cars sales each year, assuming consumers were to respond at a rapid pace. And they might, because a $5,000 incentive would close the initial cost gap for most electric vehicles.

A key question as to policy design would be whether to cap the vehicle MSRP at, say, the $50,000 level imposed in Massachusetts. This would have the advantage of reducing subsidies to the highest income households, and high-end purchasers are less likely to be swayed by incentives anyway. However, if the goal is clean air, then the cap might have the negative effect of reducing the pool of potential purchasers.

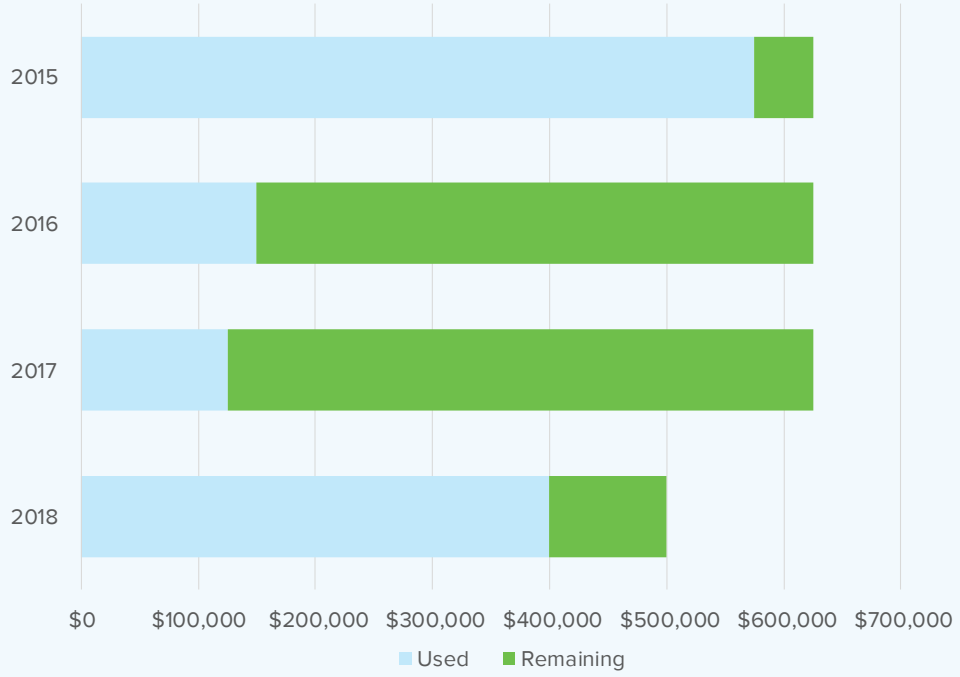
Another question is whether to make the tax credit temporary. The fluctuation in Massachusetts electric vehicle sales shown in Figure 12 on page 17 raises a question as to the strategic utility of approaching incentives on a temporary basis. On the one hand, results over time may smooth out. But if the goal is to achieve immediate gains in market uptake in order to reap air quality benefits now, it may be useful to signal to consumers that they have only a brief window of opportunity to benefit from the tax credits on an electric vehicle. A larger, short-term incentive may end up being more cost-effective than a smaller, long-term incentive because long-term electric vehicle market share can be expected to grow anyway.

HOW UTAHNS HELP CALIFORNIANS BUY CARS

Where does California's Zero Emissions Vehicle Program fit in as a policy option in Utah? Well, it was rejected by the Utah Legislature in 2018. However, it affects Utah nonetheless. The Utah Division of Air Quality has said that electric vehicles are around $5,000 more in Utah than in California because of supply issues.[161] In effect, Utah purchasers are subsidizing purchases in California.

Demand for Utah's heavy-vehicle tax credit has room to expand.

Figure 25: Usage of the Heavy-Duty Natural Gas Vehicle, Clean Fuel Vehicle Tax Credit Program, and the Amount Remaining



Source: Utah Division of Air Quality.

Fleet Incentives and Mandates

Utah's Heavy Duty Natural Gas Vehicle program expires in 2020. As noted, the 2019 credit is $18,000 and the 2020 credit is $15,000. The credit is now limited annually to $500,000.[158] But demand for the credit has yet to outstrip the limit.[159] (See Figure 25.) And the credit has thus far only been used by companies as opposed to self-employed truck owners.

Lawmakers need to decide if they want to continue past the 2020 sunset date. And they need to decide if they want to consider a more robust per vehicle incentive program, because covering the cost of one CNG long-haul truck over a diesel one, for instance, would require closer to $50,000. This would more than double Utah's current credit as well as the credit provided by Colorado for natural gas and propane vehicles – the only other Mountain State with such a credit.

It may be instructive to consider the cost-benefit picture in light of the $90 million, three-year scenario previously set forth for passenger vehicle tax credits. (It should be noted that Utah Foundation is not recommending this approach; the $90 million examples are for illustrative purposes only.) A $50,000 refundable tax credit could incentivize up to 600 vehicle replacements per year, or a total of 1,800 heavy-duty trucks over a three-year period. If half of the miles from those trucks were driving within the state (as the current credit requires), this could equate to a reduction of 900 trucks-worth of emissions over the three years. At roughly the equivalent of 26 cars per truck, that is

23,400 cars-worth of emissions – greater than the 18,000 cars in the scenario for $5,000 electric car incentive.

A $69 million investment over three years – or $23 million per year – could roughly balance out the emissions savings with a $90 million investment in electric passenger vehicles, all else being equal. However, the emissions savings might still be larger for heavy vehicles as they would likely be replacing older, more-polluting vehicles. And illegal diesel emissions controls modifications are a problem, meaning that cleaning up heavy-trucks might be even more beneficial.

But replacing older diesel vehicles with CNG vehicles would not have the air quality benefit of focusing on electric and hydrogen. Further, it should be noted that long-haul trucks tend to log fewer miles in urban areas than passenger vehicles do – and urben areas tend to have Utah's biggest air quality problems.

Importantly, getting more of the older diesels off the road in exchange for "clean diesel" might have a bigger potential air quality impact for the dollar than focusing on alternative fuel vehicles alone.[160] This is because the improvement of natural gas over new "clean diesel" trucks is relatively small. While CNG and other alternative fuel technologies are cleaner than clean diesel, the technology is more expensive.

Lawmakers might want to consider focusing on removing older, pre-2008 heavy fleet trucks from the road, just as the federal government's Cash for Clunkers program did for "gas-guzzling" passenger vehicles in 2009. That program offered incentives of between $2,500 and $4,500 for consumers trading in for more fuel-efficient vehicles.

Maintaining the current $18,000 or $15,000 tax incentive, but allowing it to be used beyond just CNG vehicles might go far in reducing pollution. Such an incentive could be adjusted upward for electric or hydrogen heavy trucks, though lawmakers could explore whether the program should be broadened in some way to include "clean diesel" when replacing older trucks. In addition, while state and local governments are migrating their own fleets toward alternative fuels, the Utah Legislature might consider leveraging additional mandates to speed up that transition. The robust requirements in Arizona are one approach. Another approach is by providing loans like those in New Mexico. (See the *Other Western States' Incentives and Mandates* subsection on page 34.)

Infrastructure

As noted, alternative fuel infrastructure development is proceeding rapidly across the states. Charging station infrastructure predicts electric vehicle adoption rates, and potential consumers frequently cite driving distances and ability to charge as the greatest concerns for purchasing an electric vehicle. Incentives that increase charging infrastructure are effective at increasing electric vehicle market share, especially when coupled with other incentives. However, the direction of this causal arrow is still unknown. It could be that charging infrastructure follows high adoption rates and does not cause them.

Looking within the state, there is much that can be done. Local-level policies are a key component of success in top electric vehicle markets.[162] And among the best ways for cities to encourage consumers to switch to electric cars is providing for multi-unit and commercial parking charging opportunities.[163]

Electric charging development faces significant challenges in meeting the growing rate of adoption of electric vehicles in the U.S. Construction of multi-unit dwellings has nearly begun to pace single-family households, rising from just over 20% in 2008 to 46% of new residential units in 2018.[164] Additionally, the construction of condominiums and duplexes has surpassed the construction of dense apartment complexes.[165] Condos generally have easier access to electrical paneling and require less intrusive concrete trenching when compared to the subterranean parking lots of large apartment complexes. Given Utah's rapid construction growth and modest electric vehicle adoption rates, realizing policy focused on implementing EV-Capable or EV-Ready parking spaces as opposed to complete EVSE-Installed spaces could prove more effective at encouraging electric vehicle adoption and managing costs.

Adding charging stations in existing buildings and garages helps incentivize electric vehicles ownership; however, the costs are significant. Creating ordinances that require levels of EV-readiness in new construction projects creates significant cost savings when compared to retrofitting existing spaces.

Incentivizing and subsidizing infrastructure upgrades for multi-unit dwellings can help offset the upfront costs of charger upgrades. Most rebates for charging infrastructure center around providing publicly accessible chargers, despite the majority of charging being conducted residentially.

In Salt Lake City, the sustainability department recommends 20% EV-Ready charging infrastructure in new construction to help "future proof" the city's multifamily housing.[166] City codes would need to be designed and implemented now to reflect the needs of Utahns of 2030 and beyond. In addition, like the West Coast states and Hawaii, Utah lawmakers might consider passing state energy codes to complement municipal and county efforts to future proof buildings and eliminate future infrastructure barriers.

Finally, if a key goal of new infrastructure across Utah is to encourage alternative fuel vehicle adoption, then it behooves public and private stakeholders to launch public awareness efforts to address any unfounded consumer fears.

CONCLUSION

Utah Foundation surveys in recent years have repeatedly found that air quality is a top concern for Utahns, and motor vehicles are the biggest contributor to Utah's particulate matter and ozone issues. This suggests that Utah should aspire to be a national leader in finding cost-effective approaches to encouraging greater adoption of alternative fuel vehicles.

Utah has a distance to go. Electric vehicles – or battery electric vehicles and plug-in hybrids – accounted for almost 2% of the nation's new vehicle market share in 2018, but in Utah, the electric market was only about 1.6%.

Addressing the fears of consumers is a core challenge in alternative fuel vehicle adoption. Less than a quarter of Americans would consider purchasing an electric car, with concerns about running out of power, the availability of charging stations and initial vehicle cost causing hesitation.

Tax credits are a potentially important factor in addressing cost concerns. In Norway and the top-tier U.S. states for electric market share, it appears that electric vehicle incentives work when offered at a robust level. The top electric-vehicle-adopting states – all in the West – offer significant incentives.

But changing market preferences appear to be a much stronger force than smaller incentives. Utah's relatively small electric vehicle tax credit sun-setted in 2016, yet electric vehicle market share has continued to increase. The 10 states with the highest market share growth in 2018 offer no incentives (though they all had 2017 market share under one percent, suggesting they had significant room for growth).

Ultimately, consumers will lead the charge toward cleaner fuel alternatives, but there is much that public and private sector leaders can do to rev up a change.

In the long run, market forces will propel consumer uptake of electric passenger vehicles. Electric vehicles are expected to cost the same as their internal combustion counterparts by the mid-2020s. If Utah were to use tax credits to encourage a more immediate market embrace, it would have to make a significant investment in sizable credits. However, it might consider doing so on a short-term basis to limit the fiscal impacts and discourage fence-sitters. There is evidence that the looming threat of expiring tax credits can encourage short-term market uptake of alternative fuel vehicles.

Another key to the embrace of alternative fuel vehicles is the presence of reliable infrastructure. Due to state and local investment, as well as the Volkswagen Settlement and private actors, Utah's electric vehicle charging infrastructure is poised to quickly expand. To encourage the market's embrace of alternative fuel vehicles, state and local governments should continue to explore opportunities to encourage private actors to deploy alternative fuel infrastructure for customers, tenants, employees and visitors. Cities and counties have a potential role to play in adopting building codes that are "future-proof" for growth in alternative fuel vehicles and in migrating to alternative fuel fleets for public services.

Which brings us to the significant challenge posed by large fleet vehicles. These vehicles account for one-third of the Utah's vehicle emissions, with their individual air quality impacts far outstripping passenger vehicles. However, CNG-fueled large fleet vehicles offer a much cleaner alternative. They are currently the most promising alternative to diesel. While alternative fuel large fleet vehicles in general are more expensive than diesel – and require large infrastructure investments – they offer significant annual fuel and maintenance savings. Because the impact of a single truck equates to a fleet of cars, Utah may get a greater air quality return on its tax credit investments by continuing to focus incentives primarily on large fleet vehicles and renewing them in 2020. However, due to the urgency of cleaning up Utah's air, replacing older diesel trucks with so-called "clean diesel" offers a potential target as well. And a very targeted program seeking to remove pre-2008 heavy-duty trucks might be most effective.

Finally, to encourage the market's embrace of alternative fuel vehicles, public and private sector stakeholders should mount public information campaigns to explain the growing availability of alternative fuel infrastructure and address other consumer fears. Ultimately, consumers will lead the charge toward cleaner fuel alternatives, but there is much that public and private sector leaders can do to rev up a change.

APPENDIX A

Figure A: Vehicles for Comparison in this report

Internal Combustion Gasoline Model	Electric Model
	Plug-in Hybrid
Volvo S90 AWD R-design 2020	Volvo S90 AWD 2020
Subaru Crosstrek Limited AWD 2019	Subaru Crosstrek Hybrid AWD 2019
Mini Cooper Countryman ALL4 2018	Mini Cooper SE Countryman ALL4 2018
Ford Fusion 2018	Ford Fusion Energi Plug in Hybrid 2018
	Battery Electric
Volkswagen Golf 2019	Volkswagen e-Golf 2019
Ford Focus SE Hatch 2018	Ford Focus Electric FWD 2018
Fiat 500 2018	Fiat 500e 2018

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APPENDIX B

Figure B: Building codes

	State	Year	Location	One or two-family dwellings	Multi-family units dwellings	Commercial
States						
California	CA	2010	IBC / IRC	EV-Capable	EV-Capable: 3% of parking (17+ spaces)	EV-Capable: 5% of parking (10+ spaces)
Hawaii	HI	2012	IBC / IRC	–	EV-Capable: 1% of parking	–
Oregon	OR	2017	IBC	EV-Capable	EV-Capable: 5% of parking (50+ spaces)	Same as multi-family
Washington	WA	2015	IBC / IRC	–	EV-Capable for 5%, Panel capacity for future EVCS at 20%	Same as multi-family
Counties						
Boulder County	CO	2015	IBC / IRC	EVSE-Ready Outlet	EVSE-Ready Outlet: 2% of parking	Same as multi-family
Montgomery County	MD	2014	Ordinance	–	EVSE-Installed: 2% of parking (50+ spaces)	Same as multi-family
Denver County	CO	2017	IBC / IRC	EV-Capable	–	–
Cities						
Atlanta	GA	2017	Ordinance	EV-Capable	EV-Capable: 20% of parking	Same as multi-family
Aspen	CO	2017	IBC / IRC	EV-Capable	EV-Capable: 3% of parking	–
Boulder	CO	2017	IBC / IRC	EVSE-Ready Outlet	EVSE-Ready Outlet: 10% of parking (25+ spaces)	Same as multi-family
Denver	CO	2017	IBC / IRC	EV-Capable	–	–
Fort Collins	CO		IRC	EV-Capable	–	–
Lakewood* (proposed)	CO	2018	Zoning Ordinance		For new development with 10+ spaces: 5% EVCS installed + 10-15% EVSE Infrastructure	Same as multi-family
Los Angeles	CA	2014	IBC	EV-Capable or EVSE-Ready Outlet	EV-Capable: 5% of parking	–
New York City	NY	2013	IBC / IRC	–	EV-Capable: 20% of parking	Same as multi-family
Oakland	CA	2017	Ordinance	–	EVSE-Ready Outlet: 10% of parking, Panel Capacity: 20% of parking, EV-Capable: 90% of parking	Same as multi-family
Palo Alto	CA	2017	IBC / IRC	EV-Capable, Outlet, or Installed	EVSE-Ready Outlet or Installed: 100% of parking	EV-Capable: 25% of parking, EVSE-Installed: 5% of parking
Salt Lake City	UT	2017	IBC / IRC + Zoning Ordinance	–	EVSE Installed - 1 for every 25 spaces	–
San Fransisco	CA	2017	Ordinance	EV-Capable	EV-Capable: 100% of parking	EV-Capable or Outlet: 10% of parking

Source: Matt Frommer, Cracking the Code on EV-Ready Building Codes, Southwest Energy Efficiency Project, October 23, 2018.

APPENDIX C

Figure C: Mountain State Trust Fund Award and Beneficiary Mitigation Plans

State	Trust Fund Awarded	Beneficiary Mitigation Plans
Utah	$35,177,506	· 73.5% for 1, 2, 6 · 11% for 9 · 7% for 10 · 8.5% for Administrative Expenditures
Arizona	$56,660,078	· 24% for 1, 3 · 67% for 2 · 9% for Administrative Expenditures
Colorado	$68,739,918	· 26% for 1, 2 (school/shuttle), 3, 6, 7, 8 · 26% for 2 (transit) · 15% for 9 · $5 million for 10 · 10% for Administrative Expenditures · 17% Flexible Funds accounting for market demand and trust fund uptake
Idaho	$17,982,661	· 35% for 1, 2, 6 · 20% for 3, 7, 8 · 15% for 9 · 15% for 10 · 15% for Administrative Expenditures
Montana	$12,602,425	· 55% for 1, 2, 6 · 10% Flexible Funds for projects related to 1, 2, 3, 4, 6, 7, 8, 10 based on demand · 15% for 9 · 5% for 10 · 15% or less for Administrative Expenditures
Nevada	$24,874,024	· 80% for 1, 2, 6, 7 · 15% for 9 · 5% for 10
New Mexico	$17,982,661	· 70% for 1, 2, 6 · 7% for 3, 7, 8 · 15% for 9 · 3% for 10 · 5% for Administrative Expenditures
Wyoming	$8,125,000	· Will be focusing on 1, 2, 3, 6, 7 but no information on specific spending.

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