CHAPTER 4: TRANSPORTATION

The efficient movement of goods, services, and people is the backbone of a thriving economy and quality of life for all Oregonians.

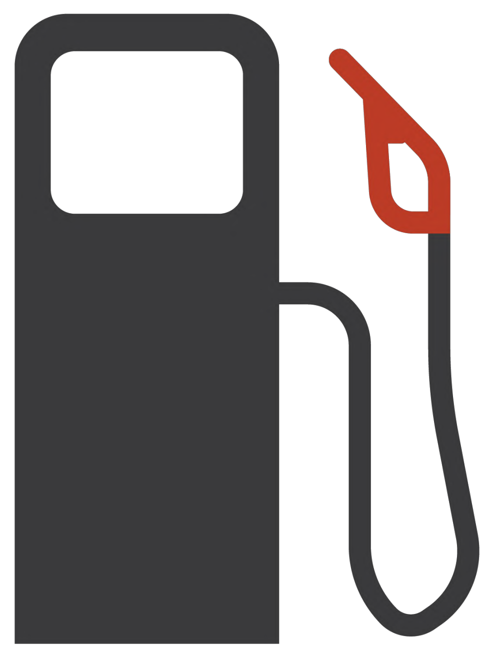
Operating vehicles, and building and maintaining roadways, railways, and other transportation corridors, requires significant energy resources.

Most of the energy used in the transportation sector comes from fossil fuels, which have significant effects on our economy, environment, and public health.

KEY TAKEAWAYS

- The transportation sector accounts for the **single largest category of greenhouse gas emissions**, at 39 percent of total Oregon emissions. Oregonians also spend $7.4 billion annually on transportation fuels, more than any other energy sector. Ninety-eight percent of transportation fuels are imported into the state; the majority of those dollars are not retained in Oregon.
- While per vehicle fuel consumption and GHG emissions have declined because of improved fuel efficiency and increased adoption of alternative fuels, overall transportation sector fuel consumption, GHG emissions, and vehicle miles travelled (VMT) are rising in Oregon, mainly due to population growth and the choices we make in a growing economy. This makes increased support for walking, biking, multiple-occupancy modes of transportation including flexible public transit options, and especially adoption of electric vehicles, necessary to conserve transportation fuels and **reduce GHG emissions** from the transportation sector.
- Oregon will need to adopt additional transportation policies, strategies, and programs to meet the state's **climate change goals**.

Introduction



The efficient movement of goods, services, and people is the backbone of a thriving economy and quality of life for all Oregonians. Operating vehicles, and building and maintaining roadways, railways, and other transportation corridors, requires significant energy resources. Most of the energy used in the transportation sector comes from fossil fuels, which have significant effects on our economy, environment, and public health.

As Oregon's population grows, so does the number of light duty vehicle registrations. As a result, gasoline consumption continues to rise in the state. Low fuel prices coupled with a growing economy and population growth have led to an increased number of vehicle miles traveled. Transportation sector fuel consumption has cost Oregonians, on average, from 2005 to 2016, $7.4 billion annually; and because 98 percent of transportation fuels are imported into the state, the majority of those dollars are not retained in Oregon.[1] Ninety-three percent of the state's transportation fuel demand is met with petroleum products. Gasoline at the pump accounted for 68 percent of all transportation fuel costs. In October 2018, the retail price of gasoline was about $3.30 per gallon. Over half of that cost is for the raw crude oil, and the rest is for refining, distribution and marketing, and taxes.[71]

The cost of transportation fuels tends to be higher in Oregon than in most of the continental United States due to the higher-cost sources of crude, and the Pacific Northwest's isolation and distance from fuel supplies as well as limited refineries in the region. Ninety percent of our petroleum products come from four refineries located in the Puget Sound near the Canadian border.[2] Coupled with the high degree of volatility in the petroleum market, transportation fuel costs can create financial burdens for Oregon businesses and families, especially in rural areas where a greater percentage of household income is spent on transportation (see Chapter 7 for more detail).

As discussed in Chapters 2 and 5, greenhouse gas emissions affect our health, our environment, and our economy. Transportation petroleum fuel consumption increases air pollution and can have negative effects on public health. The American Lung Association estimates that the health and climate effects associated with passenger vehicles cost Oregon $1.3 billion in 2015.[3] The transportation sector is also the highest emitter of greenhouse gases in the state. In 2016, transportation produced 39 percent of total in-state emissions,[4] and in large part due to the increases in transportation sector emissions, Oregon is not on track to achieve our statewide 2020 GHG reduction goals.

Table 4.1 shows the transportation sector fuel mix by type of fuel, and for ease of comparison each fuel is converted to gasoline gallon equivalent (gge). The amount of lifecycle GHG emissions is shown (in metric tons of CO2 equivalent), as well as their percentage of overall transportation fuel GHG emissions.

Table 4.1: Transportation Fuels and Associated GHG Emissions[5]

Transportation Fuel	GGE	Lifecycle GHG Emissions (MTCO2e)	Percent of Total GHG Emissions
Gasoline	1,430,179,140	17,651,807	54.69%
Diesel	709,580,224	8,835,152	27.38%
Jet Fuel	229,569,368	2,858,423	8.86%
Ethanol	125,325,574	968,678	3.00%
Asphalt & Road Oil	104,230,084	1,371,075	4.25%
Biodiesel	49,067,998	311,377	0.96%
Lubricants	10,014,595	124,694	0.39%
Aviation Gasoline	4,052,883	50,463	0.16%
Renewable Diesel	3,309,077	41,202	0.13%
Electricity	2,673,688	10,175	0.03%
Compressed Natural Gas	2,592,953	25,381	0.08%
Liquefied Petroleum Gas	1,682,828	17,121	0.05%
Bio-Compressed Natural Gas	575,528	4,508	0.01%
Bio-Liquid Natural Gas	410,997	4,049	0.01%
Total All Fuels	**2,673,264,937**	**32,274,105**	**100%**
Gasoline & Ethanol Only	1,555,504,714	18,620,485	57.69%

This chapter primarily focuses on fuel use and emissions of fuels used in light-duty vehicles, a segment of the transportation sector that is the biggest cost to Oregonians and the highest emitter of greenhouse gases. In 2016, gasoline consumption – which includes both gasoline and the additive ethanol –accounted for nearly 58 percent of overall transportation emissions.[5] However, understanding and addressing emissions and fuel use in the medium- and heavy-duty sectors is also necessary for the state to achieve our GHG reduction goals.

MEDIUM- & HEAVY-DUTY DOING THEIR PART

One of UPS's hybrid delivery trucks.
Photo: UPS

As electric vehicle technology advances, companies across Oregon are looking at how they can take advantage of zero- or low-emissions options for their fleets. **United Parcel Service (UPS)** has deployed what it calls a "rolling laboratory" to determine in real-world operating conditions how a diverse set of approximately 9,300 alternative fuel and advanced technology vehicles perform. Over the next decade and beyond, the logistics industry is poised to take a significant leap forward through the electrification of transportation. UPS expects to continue to lead the charge on electrification of medium-duty vehicles. Within Oregon and as part of their rolling laboratory, UPS deployed 20 plug-in hybrid electric vehicles into their Portland and Tualatin fleets. The PHEVs can run about 50 miles on battery power between recharges, and use a small gas-sipping two-cylinder gasoline range extender engine if necessary to complete a daily route. On many UPS routes, no gasoline use would be necessary at all. A large delivery company like UPS faces unique challenges in electrifying their delivery vehicles – from truck size to charging infrastructure to costs. The rolling laboratory tests in Oregon are just another example of how UPS will achieve its sustainability goals in a way that makes sense for the company and its customers worldwide.

Rogue Waste Inc.'s Dry Creek Landfill produces enough electricity for 3,000 homes annually. But the company is looking at ways to put landfill-generated fuel to a different use – one in which it powers refuse trucks, improves local and regional air quality, and provides a local resource that could build regional energy resilience. Rogue Disposal & Recycling and its sister corporation, Rogue Clean Fuels, have a long-range vision to capture biogas at their Dry Creek Landfill, clean and upgrade it to renewable natural gas, and inject it into their refuse trucks and the natural gas pipeline. By 2023, their entire fleet of 36 trucks will be converted to CNG, and eventually fueled by RNG from their landfill. This closed-loop system means the garbage being conveyed to the landfill via their RNG-powered trucks will one day decompose into RNG distributed at their pumps. More important to Rogue Waste Inc. are the community benefits: cleaner air, reduced diesel fuel consumption, and local resiliency. With increasing attention on how a Cascadia Subduction Zone earthquake could affect Oregon, Rogue Waste Inc. sees the upside of having a local fuel resource that could be tapped by emergency first responders and recovery operations.

The Oregon Department of Transportation's Statewide Transportation Strategy 2018 Monitoring Report found that no single solution was the answer to GHG reductions, and that a multi-faceted and aggressive approach was needed to address overall reductions from the transportation sector.[6]

With that in mind, this chapter begins with an overview of national and state trends in the transportation sector and what the trends tell us about our progress in meeting Oregon's goals. This is followed by a look at the current policies, programs, and strategies at work in the state and, where available, information on how these are helping the state achieve its goals. More energy-related data would help Oregon be able to draw conclusions about the effectiveness of many of these programs. Finally, the chapter will look at what's next for transportation in Oregon. This chapter discusses the strategies for future progress in reducing Oregon's GHG emissions, fuel consumption, and overall transportation costs for Oregonians; especially how adoption of electric vehicles can help the state meet its goals.

Two notes on the data in this chapter: First, because different state agencies focus on different aspects of the transportation fuel sector, they collect and use different sources of information. ODOE, for instance, focuses on data for all types of transportation fuels including the aviation, marine, and railroad segments, among others; Oregon DEQ collects transportation fuel data only for fuels listed in their Clean Fuels Program; while ODOT necessarily looks only at transportation fuels for roadway use that are taxable fuels. Because of these differences, the collection and reporting of data may differ and may not align perfectly. In most instances, ODOE used Clean Fuels Program fuels data as the basis for its calculations in this chapter. Second, because Oregon produces almost no fuel in-state, we analyzed GHG emissions on a life-cycle basis. Life-cycle calculations include all emissions that are associated with that fuel from extraction to combustion regardless of whether they occur in Oregon. This type of analysis is often called a "well-to-wheel analysis." Therefore the amount of GHG emissions in our analysis may differ from those that only assess GHG emissions that occur within the boundaries of the state of Oregon.

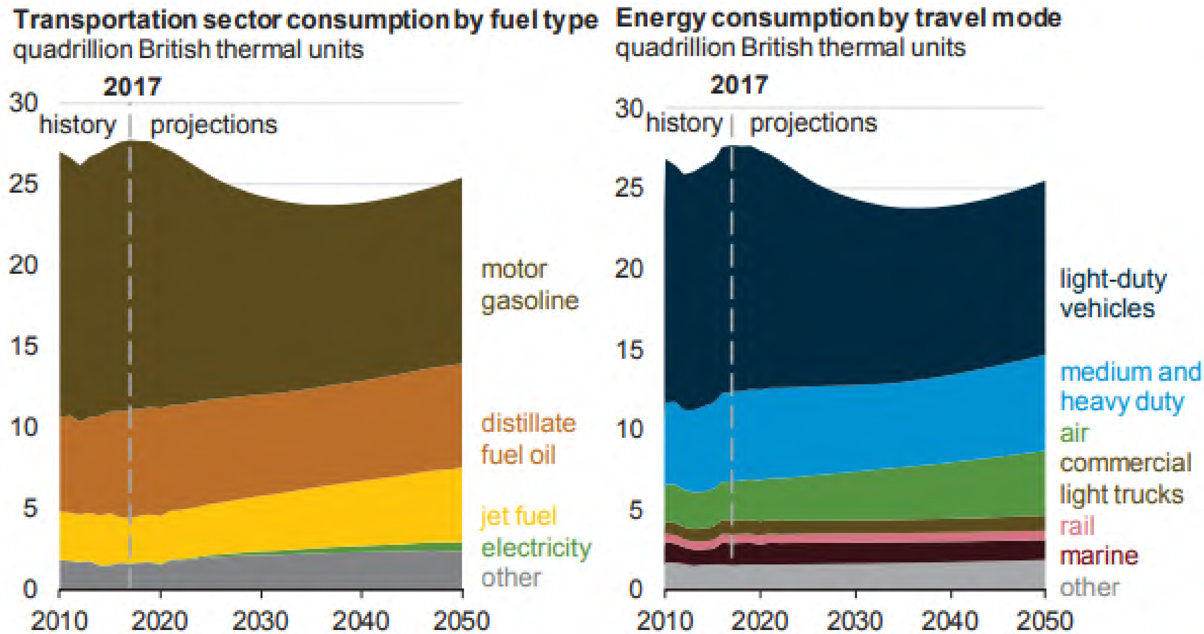
National Transportation Sector Trends

Energy Information Administration's Annual Energy Outlook 2018

The U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2018 (AEO) modeled projections for key metrics using different modes of transportation in the domestic energy markets through 2050. Key metrics include: consumption, miles traveled, average fleet miles per gallon, amount of sales, and fuel prices. The "reference case" projection, which is referred to in this report, assumes some technology improvements and economic and demographic trends. In many cases this information is available only through EIA on a nationwide basis. In order to determine more state-specific information, ODOE used the AEO projections as a baseline for our analysis then incorporated Oregon-specific data and information to forecast the energy picture for Oregon.[7]

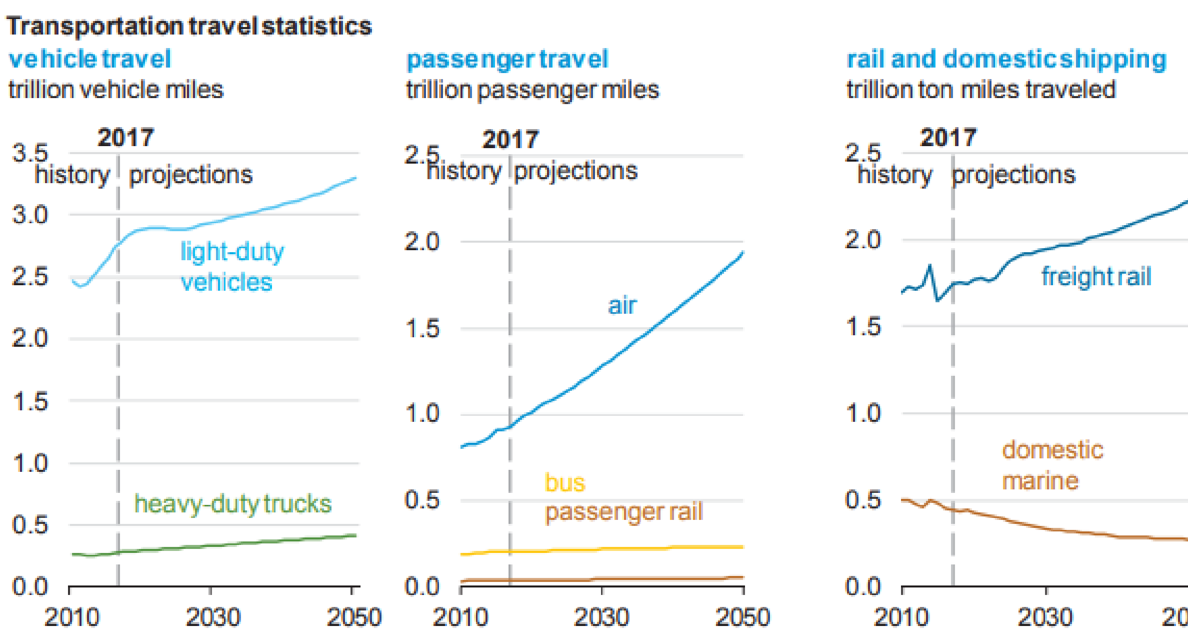
According to AEO projections, gasoline consumption nationwide peaked in 2017 (Figure 4.1). The Outlook projects a downward trend in consumption through about 2035 because of current U.S. vehicle efficiency policies that require efficiency improvements for light-duty vehicles until 2025 and for heavy-duty vehicles until 2027. Consumption begins to increase in 2035 because even though the efficiency standards improve, vehicle miles traveled are projected to increase. Medium- and heavy-duty vehicle energy consumption stays nearly flat and then begins to increase, despite improvements in fuel efficiency standards, because of rising economic activity that increases the amount of heavy-duty truck travel. Jet fuel consumption rises 64 percent over the period, as growth in air transportation outpaces aircraft energy efficiency, and other alternative fuel use increases as different fuels replace traditional gasoline and diesel-powered vehicles. Gasoline and diesel fuels become a smaller part of the overall transportation mix, decreasing from 84 to 70 percent of the total by 2050. Much of the offset is due to the large increase in jet fuels and other transportation fuels such as natural gas. Electricity as a fuel source makes up only one percent of the overall mix by 2050.

Figure 4.1: Energy Consumption in 2017[7]



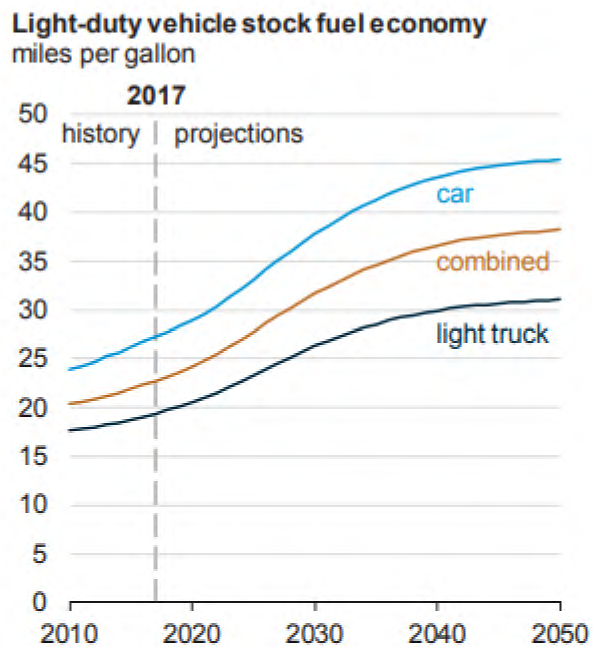
AEO also reports that passenger and vehicle travel will increase across all transportation modes through 2050. Light-duty vehicle miles traveled will increase by 18 percent, and heavy-duty truck vehicle miles traveled (the dominant mode of freight movement) grows nearly 50 percent. Freight rail ton miles grow by 27 percent, and domestic marine shipments decline by nearly half, continuing a historical trend related to logistical and economic competition with other freight modes.

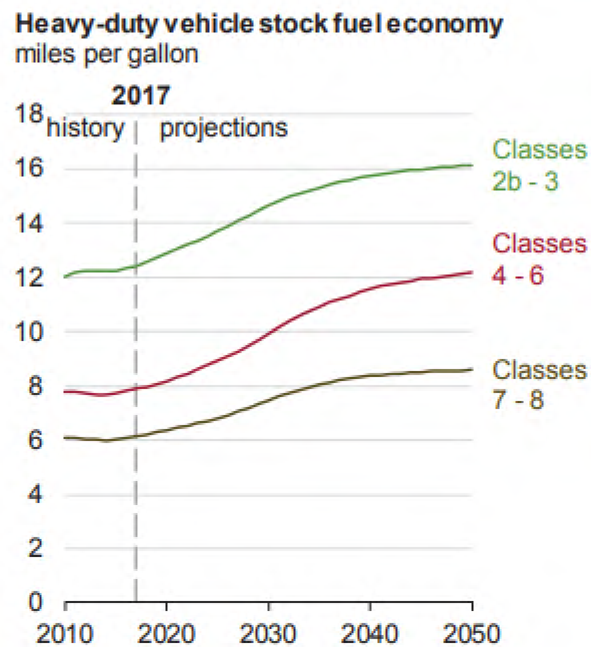
Figure 4.2: AEO Forecasted Transportation Travel Statistics[7]



The AEO reference case assumes fuel efficiency gains for all types of vehicles.

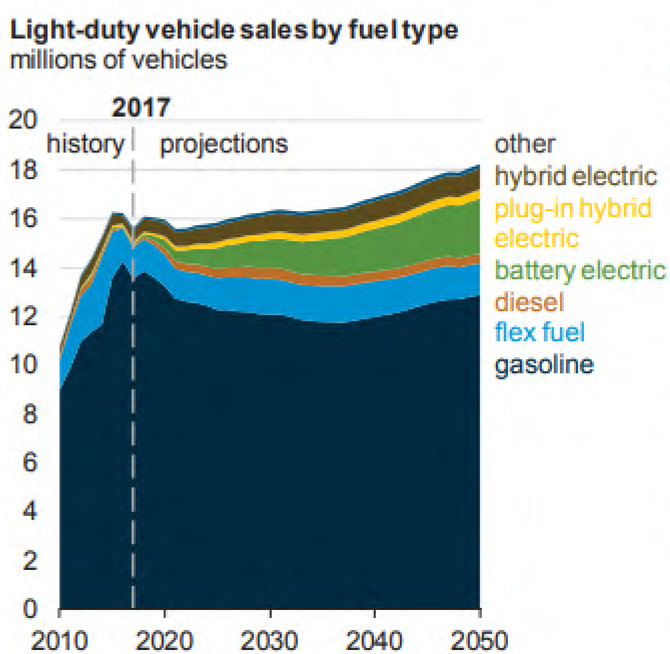
Figure 4.3: AEO Forecasted Fuel Economy[7]

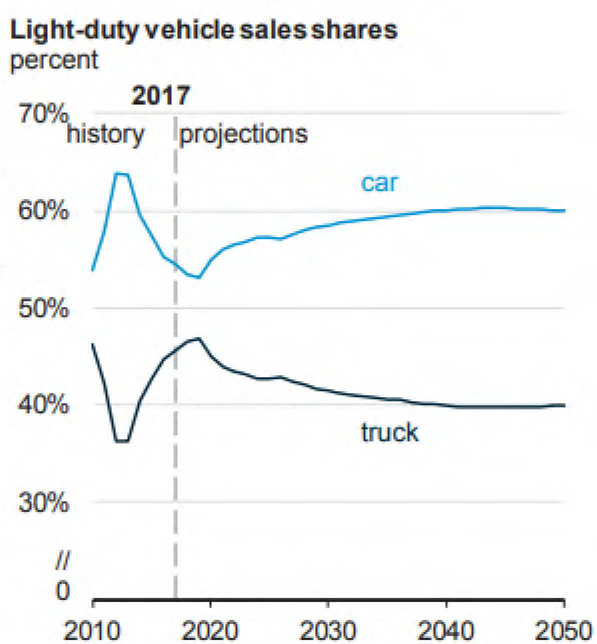




Gasoline vehicles remain dominant, though the market share of electric vehicles increases from four percent in 2017 to 19 percent in 2050. Passenger cars gain more market share over passenger trucks as fuel prices continue to increase.

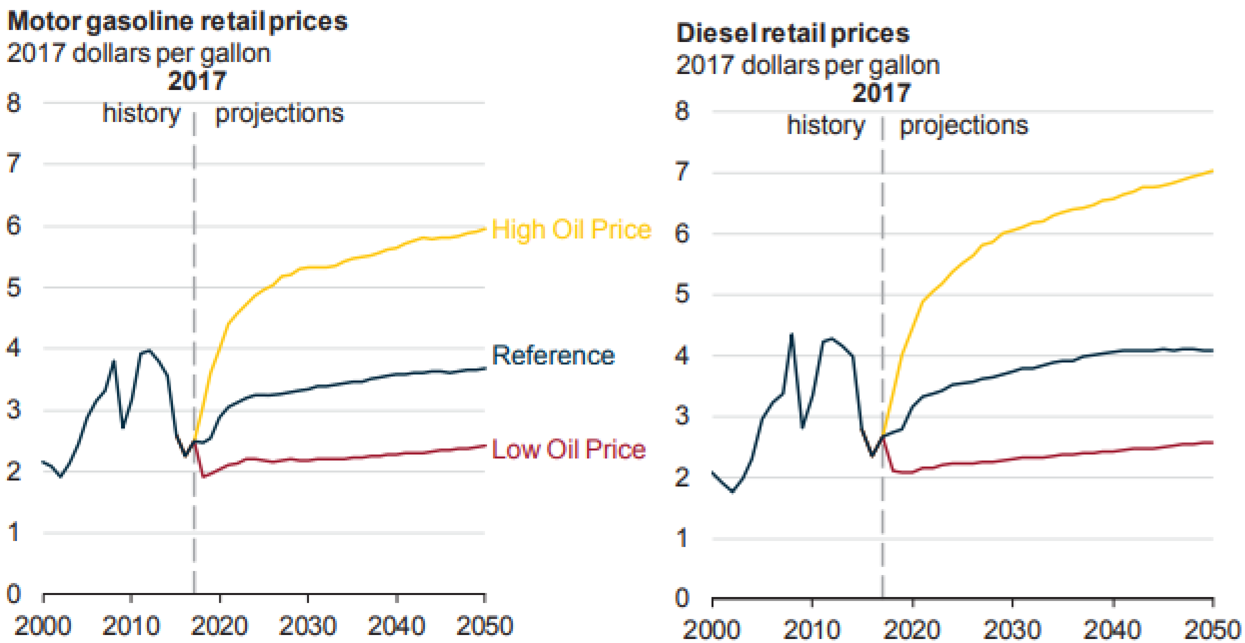
Figure 4.4: AEO Forecasted Light-duty Vehicle Sales[7]





The prices of gasoline and diesel fuel are projected to increase from 2018 to 2050 because of expected increases in crude oil prices. While the spread between diesel fuel and gasoline retail prices on a volume basis has tightened in recent years, this trend reverses through 2041 because of the expected strong growth in global diesel demand for use in transportation and industry. Motor gasoline and diesel fuel retail prices move in the same direction as crude oil prices in the Low and High Oil Price cases. Projected motor gasoline retail prices in 2050 range from $2.41 per gallon to $5.95, and diesel fuel retail prices range from $2.56 per gallon to $7.02 depending on the projected price of oil.

Figure 4.5: AEO Forecasted Fuel Retail Prices[7]



The national AEO report attempts to average prices for the whole country. The country can also be divided by Petroleum Administration for Defense Districts (PADDs), which were created during World War II to help organize the allocation of petroleum products. Oregon is in the northwest region of PADD 5, a large and diverse area and consists of six distinct regional markets.

Figure 4.6: Petroleum Administration for Defense Districts[2]

Oregon is part of the Pacific Northwest regional market. As seen in Figure 4.7, the region is geographically isolated from other U.S. refining centers as no pipelines for crude or refined product cross the Rocky Mountains, Siskiyou Mountains, or Cascade Range.

Figure 4.7: U.S. Energy Mapping System[8]

Typically, PADD 5 has higher prices than the rest of the country. For example, a comparison of the oil price index for the Pacific Northwest (ANS West Coast) to the oil price index for Texas (WTI Crude) on June 7, 2018, showed an eight percent price difference.[9] This difference shows up in the price at the pump. On June 4, 2018, gas prices in Texas were about 20 percent lower than in the Northwest.[10]

Oregon Transportation Sector Trends

The AEO projects that petroleum products, gasoline, and diesel will continue to be the dominant fuels in the transportation sector, and light-duty vehicles will continue to be the largest users of that fuel nationwide. Overall, this is also true for Oregon, but there are significant differences that give an alternative outlook for the state.

As noted, the AEO expects national gasoline consumption to peak in 2017 with a downward trend out to 2035. Oregon's estimated gasoline consumption, and thereby our GHG emissions, for the next few decades looks different than the AEO's projection, primarily due to the following:

1. Annually, Oregon is adding more light-duty vehicles than the national average. From 2001 through 2016, the U.S. saw an annual average of 0.7 percent increase in vehicle registrations, while Oregon had an average 1.1 percent increase per year.[11]

2. Oregonians purchase fewer new cars as a percentage of the statewide vehicle fleet than nationally. The national average of new cars compared to existing registrations from 2004 to 2016 was 6.4 percent. In Oregon, the average is estimated at only 3.6 percent from 2004 to 2016.[11]

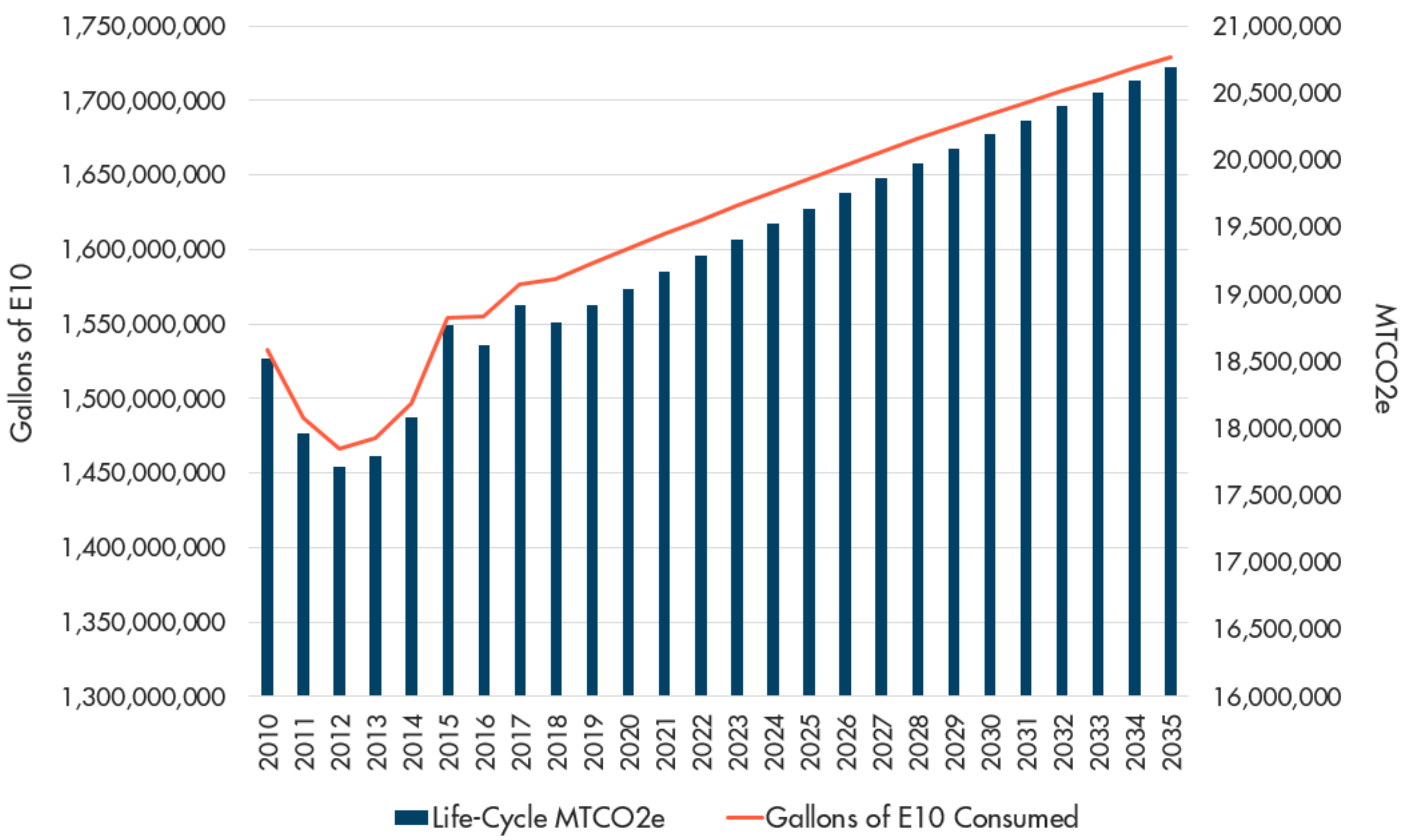
3. The percentage of SUVs and pickup trucks registered in Oregon is greater than the national average. Nationwide, sedan registrations are 8 percent higher than SUV/pickup trucks. In Oregon, truck registrations are 6 percent higher than sedans.[11]

4. Vehicles in Oregon are older than the national average. The Auto Alliance estimates that the average age of Oregon light-duty vehicles is 13.5 years.[12] In comparison, the average age of U.S. light-duty vehicles is 11.6 years.[13]

Oregon may be slower to experience gains from fuel efficiency standards because our vehicle registrations include a smaller percentage of new vehicles, our overall vehicle ages are older, and Oregonians buy a higher percentage of vehicles that use more fuel.

Figure 4.8 is not a state fuel forecast, but uses historical data to show how emissions and fuel consumption will continue to rise, rather than peak in 2017 as the AEO predicts nationally, without additional policies or economic influences. The projection uses multiple state agency fuel data sources, incorporates the AEO 2018 Outlook Reference Case forecast, accounts for the differences listed above in our light duty vehicle fleet, but does not take into account anticipated economic cycle changes, nor does it incorporate high EV adoption rates or other policies that will have an impact on fuel consumption and emissions.

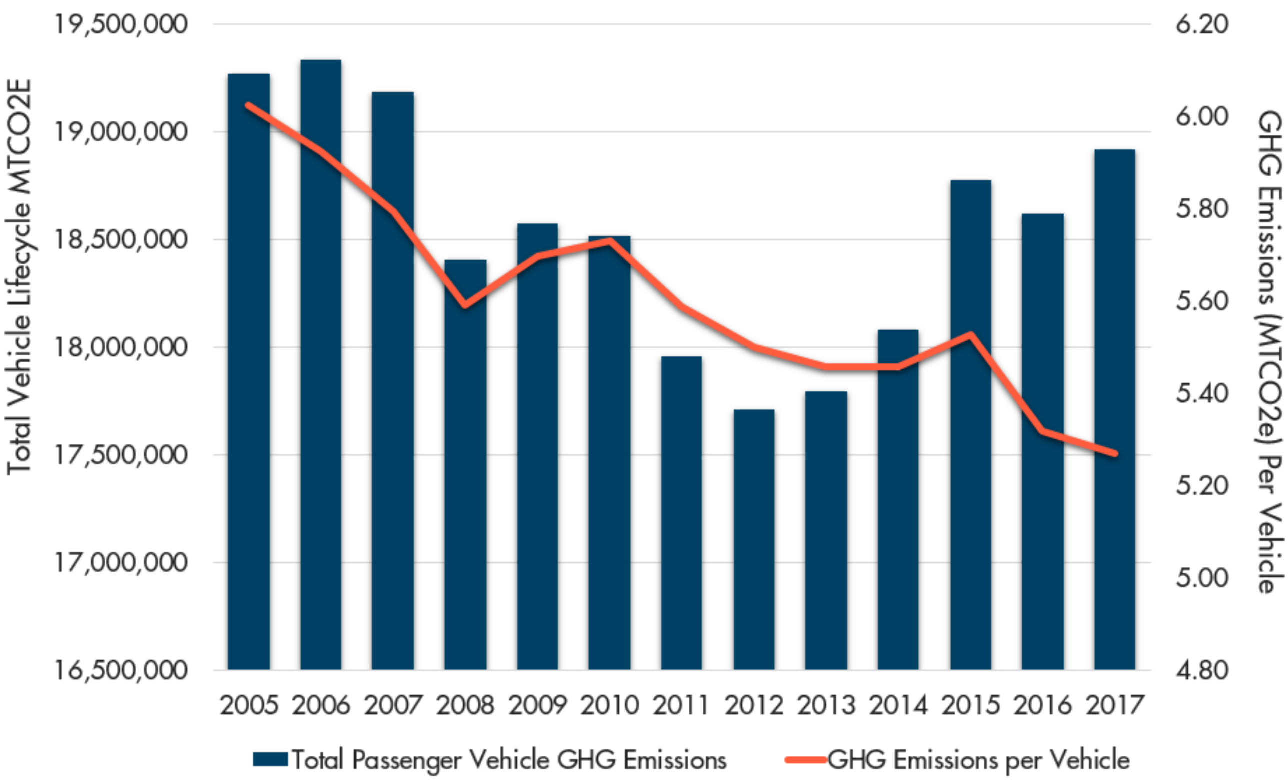
Figure 4.8: Historical and Forecasted Gasoline/Ethanol (E10) Consumption and GHG Emissions (Based on AEO Reference Case)[1,7]



Oregon Fuel Consumption and Emissions: Decreasing on a Per Vehicle Basis

While overall on-road fuel consumption and emissions are on the rise in Oregon, per vehicle consumption and emissions are dropping. Comparing 2005 to 2017, Oregon reduced vehicle GHG emissions by 12.5 percent and fuel consumption by 10 percent in light-duty vehicles due to federal and state policies. In 2005, the typical vehicle consumed 490 gallons of fuel per year and emitted 6 MTCO2e. By 2017, the typical vehicle consumed 439 gallons of fuel and emitted 5.3 MTCO2e.[5]

Figure 4.9: Total and Per Vehicle GHG Emissions (Passenger Vehicles)[5]

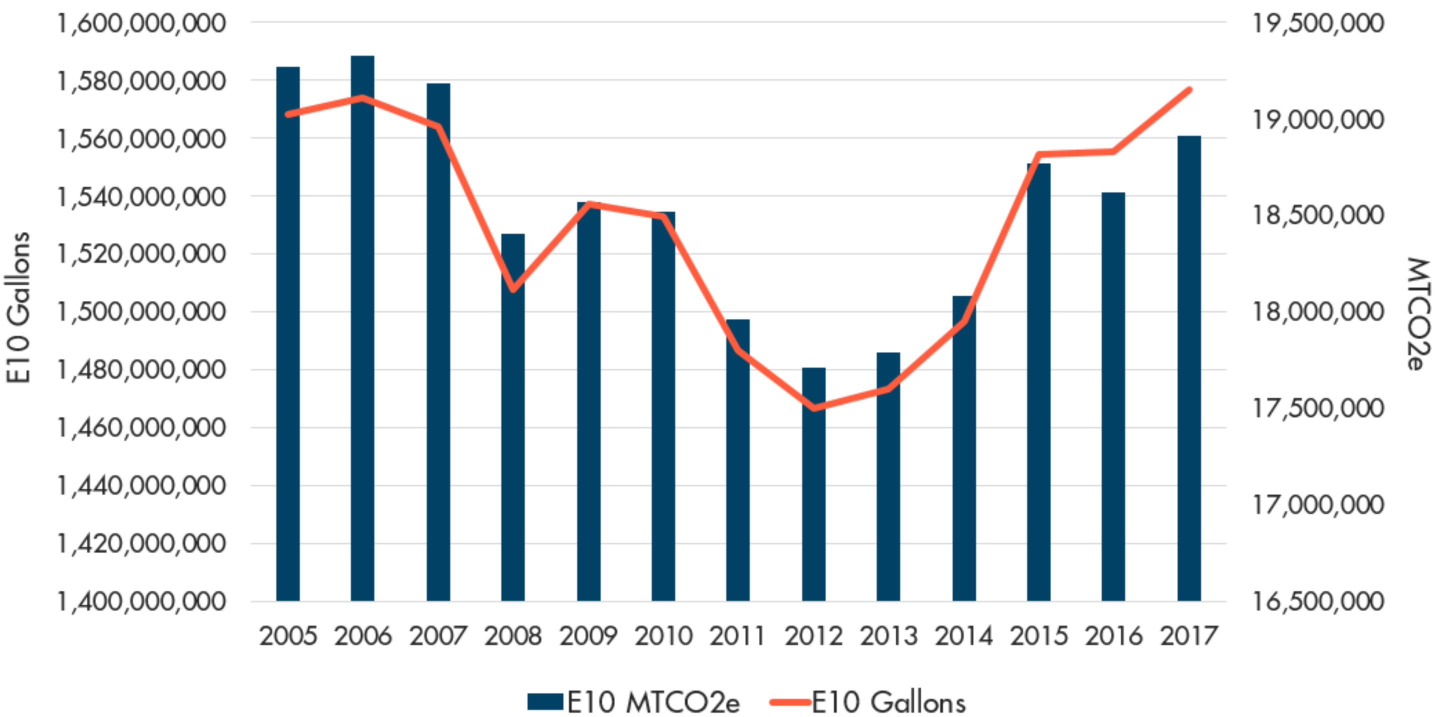


These per vehicle reductions in fuel consumption and emissions have affected Oregon's total light-duty vehicle fuel consumption and emissions. From 2005 to 2017, passenger vehicle registrations went from 3.2 million to 3.6 million, an 11 percent increase. However, E10 (the gasoline/ethanol blend Oregonians generally purchase at the pump) consumption only increased 0.6 percent, thanks primarily to vehicle efficiency gains. GHG emissions fared even better, as gasoline emissions were reduced by two percent from 2005 to 2017, due to vehicle efficiency and lower carbon ethanol blended into gasoline (Table 4.2). The dip in fuel consumption and emissions from 2009 to 2014, shown in Figure 4.10, is due to the economic effects from the Great Recession and high oil prices.[1]

Table 4.2: Gasoline Use and Emissions for Light-duty Vehicles, 2005 and 2017[1]

	2005		2017	
Light-Duty Vehicles	**3.2 Million**		**3.6 Million**	
Fuel Type	**gge**	**MTCO2e**	**gge**	**MTCO2e**
Gasoline	1,536,175,262	18,960,051	1,460,206,893	18,022,421
Ethanol	31,911,377	293,696	116,583,753	892,510
Total for E10	1,568,086,639	19,253,747	1,576,790,646	18,914,931

Figure 4.10: Gasoline/Ethanol (E10) Gallons and MTCO2e Emissions[1]



Current Policies to Reduce Fuel Consumption and GHG Emissions

The *Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reduction* (STS),[6] drafted by ODOT in 2013 and adopted into the Oregon Transportation Plan by the Oregon Transportation Commission in 2018, examines ways that the transportation sector can reduce GHG emissions and help achieve Oregon's GHG reduction goals.

The STS is a comprehensive policy to reducing GHG emissions in the transportation sector and ODOT identified six categories of strategies to help the state reduce GHG emissions:

1. **Vehicle and Engine Technology Advancements**
2. **Fuel Technology Advancements**
3. **Systems and Operations Performance**
4. **Transportation Options**
5. **Efficient Land Use**
6. **Pricing Funding Markets**

Because many of the programs and strategies listed in the STS are not under the authority of ODOT, the agency drafted the STS Short-Term Implementation Plan in 2014. This plan described short-term (2-5 year) activities that ODOT could implement to advance the strategies in the STS. The plan focused on low-cost, existing, and complementary action that are likely to produce fairly rapid GHG reductions including:

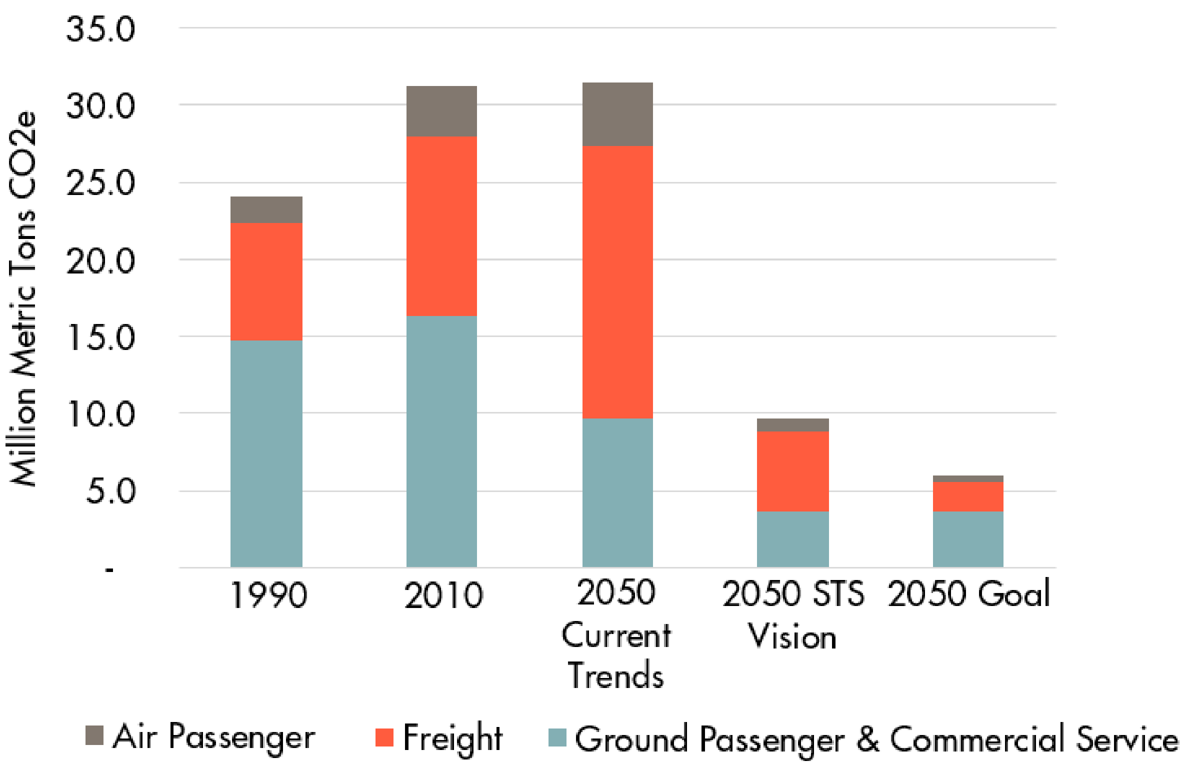
- Supporting the transition to Electric Vehicles and Low-Emission Fuels.
- Implementing the Eco-Driving program, with focuses on a low-cost approach to reducing GHG emissions by providing information to citizens on how to drive in a more fuel efficient way.
- Studying the economic impact of pricing strategies, specifically road-usage fees.
- Partnering with municipal planning organizations to engage in long-range scenario planning efforts that explore local actions for reducing GHG emissions.
- Using Intelligent Transportation Systems (ITS) to reduce emissions in the short-term through operational improvements that reduce congestion and increase the efficient use of fuel.
- Exploring investment programs to support STS implementation.
- Assuring continued coordination with state agencies and other entities working on activities that align with the STS vision.


West Coast Electric Highway Charger in Cascade Locks.

In support of these objectives, ODOT and ODOE funded the installation and maintenance of 44 direct current fast chargers (DCFC) in Oregon and funded two CNG fueling stations in Wilsonville and the Rogue Valley. ODOT has also integrated information on EV charging infrastructure into maps and other publications. The economic analysis of on road usage fees provided data that informed the development of the OReGO program: the nation's first mileage-based revenue program for light-duty vehicles. And many of the strategies in the STS have been incorporated into other ODOT plans, including the Oregon Transportation Options Plan and the Oregon Bicycle and Pedestrian Plan.

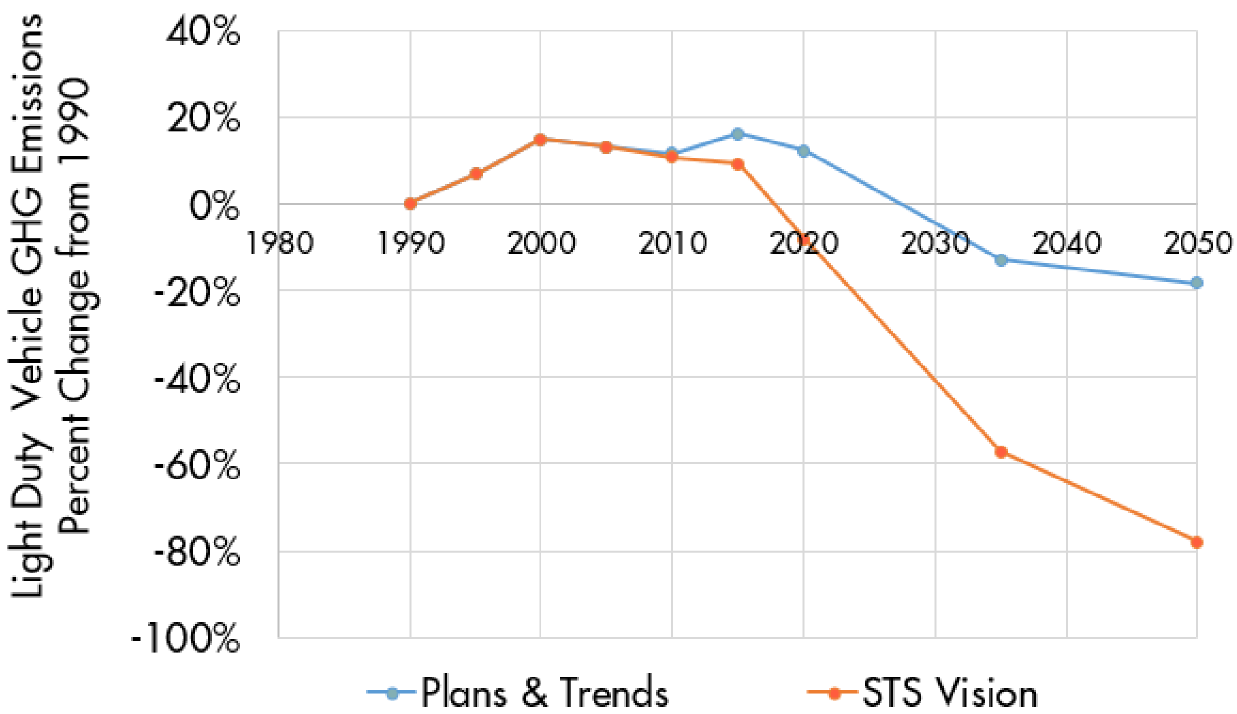
In 2013, ODOT modeled GHG emissions reductions if all strategies in the STS were fully implemented. Figure 4.11 shows that transportation GHG emissions would be reduced by 60 percent in the 2050 STS Vision scenario as compared to 1990 levels. The STS Vision includes 18 distinct strategies with 133 potential elements. Additional efforts to reduce emissions are needed to meet the state goal of 80 percent below 1990 levels by 2050.

Figure 4.11: Historic GHG Emissions and Potential Future Reductions[6]



ODOT published the 2018 Monitoring Report to demonstrate the progress on STS implementation since 2013. The blue line in Figure 4.12 shows GHG emissions reductions in the light-duty vehicle sector using current policies and programs in-place in Oregon. At the time the STS was developed, fuel prices were at an all-time high. Consequently, emissions from the light-duty sector are continuing to rise rather than fall. The takeaway from the chart below is that the STS strategies will reduce light-duty emissions by substantial amounts. Even so, these fall short of the GHG reductions necessary to achieve Oregon's emissions goals.

Figure 4.12: GHG Emissions Reductions in the Light-duty Vehicle Sector[6]



Actions called for in the STS are moving Oregon in the right direction. However, as discussed earlier, increasing population, relatively low gas prices, and a strong economy have contributed to increases in transportation GHG emissions. Transitioning Oregon to low- and zero-emission vehicles and expanding walking, biking, rail, and public transit programs will be challenging and require increased analysis to ascertain what works and what additional actions are needed. As ODOT points out in its 2018 STS Monitoring Report, it is currently not possible to directly measure the emission reductions for some specific activities. More research and analysis into how to measure individual strategy progress is necessary to ensure the state meets our goals efficiently and cost-effectively.[6]

Pathways to reduce GHG emissions resulting from fuel use in the light-duty sector can be categorized into three broad policy categories:

1. **Cleaner Vehicles: transition to vehicle technologies that are more fuel efficient and have fewer emissions.**

2. **Cleaner Fuels: transition to no-emission or low-emission fuels and technologies.**

3. **Lower VMT: reduce drive alone trips and vehicle miles traveled.**

Multiple policies and programs have been implemented at the local, regional, state, and federal levels that support these three areas.

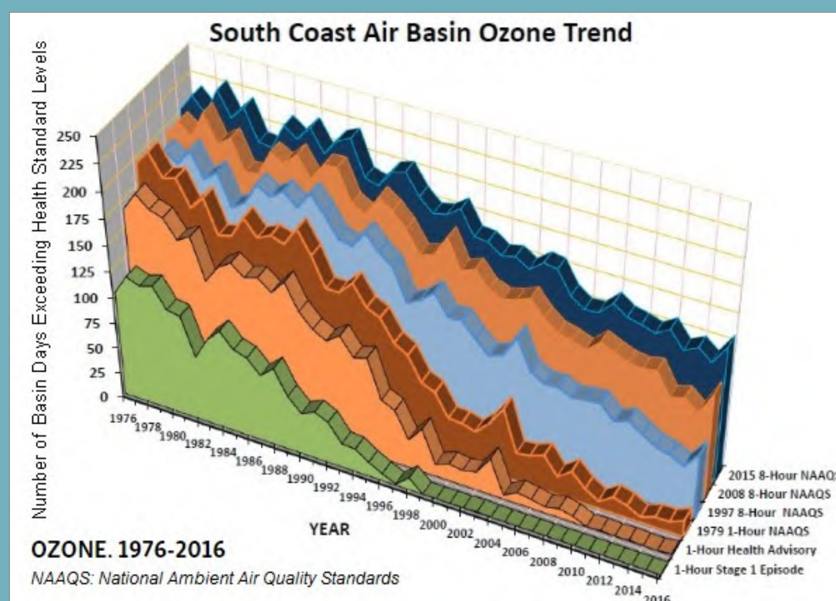
Policies that Promote Cleaner Vehicles

Federal Corporate Average Fuel Economy Standards

Improvements in vehicle fuel efficiency are expressed in miles traveled per gallon and help reduce the amount of fuel we consume per vehicle. The Federal Corporate Average Fuel Economy, or CAFE, standards are the primary policy for improving vehicle fuel efficiency, although technological advances allowing vehicles to communicate with each other and their surroundings could improve vehicle fuel efficiency in the future.

CALIFORNIA'S WAIVER

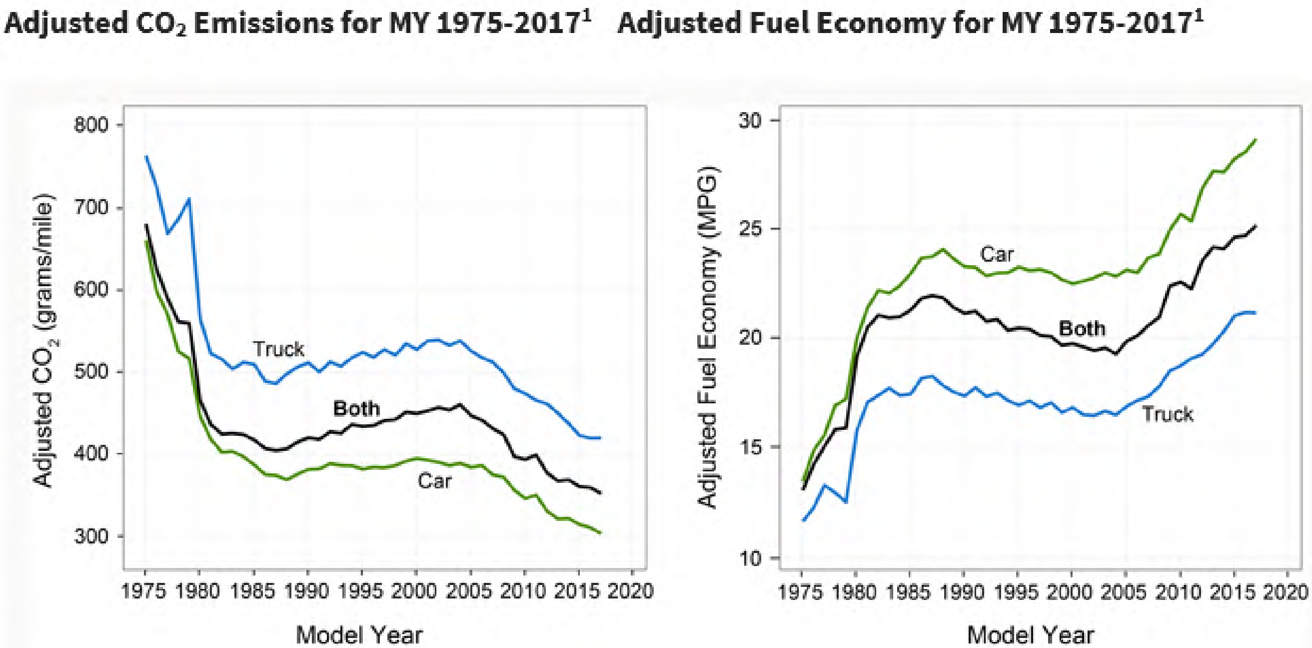
As early as 1943, Los Angeles was experiencing some of the nation's worst smog events. In the early 1950s Dr. Arie Haagen-Smit discovered that the smog was the result of pollutants from automobile exhaust. With the passage of the Federal Air Quality Act in 1967, California was granted a waiver to federal air quality rules in order to combat this growing smog issue in its major cities. The waiver granted the state the ability to set more stringent emissions standards, including: the nation's first tailpipe emissions standards, a regulation requiring more Zero Emission Vehicles be made available for purchase, and the nation's first GHG standards for cars.[15,16] Levels of Ozone, which is created when sunlight interacts with oxides of nitrogen or NOx emissions from vehicles, have steadily decreased in the south coast air basin since 1973.



Established by Congress in 1975, federal CAFE standards set fuel efficiency requirements that automobile manufacturers must achieve, or pay a penalty on a per vehicle basis, in the development of new vehicle models. The National Highway Transportation Safety Administration sets fuel efficiency standards. Although not directly responsible for establishing fuel efficiency standards, the EPA sets emissions standards for vehicles, which are directly related to fuel efficiency. The NHTSA and EPA work together when establishing or updating these regulations. As CAFE standards are updated, new more rigorous targets are established for vehicle manufacturers to meet. Congress granted California a special authority to allow the state to set its own, more stringent, emissions standards to help better manage high levels of air pollution in its major cities. Oregon, along with eight other states, signed on with California and agreed to follow their greenhouse gas standards requiring more efficient vehicles.

Since federal CAFE standards were first enacted, the average fuel economy in vehicles has more than doubled. Figure 4.13 shows trends in vehicle fuel economy since 1975 for cars and trucks.[14]

Figure 4.13: Trends in Vehicle Fuel Economy, 1975-2017[14]

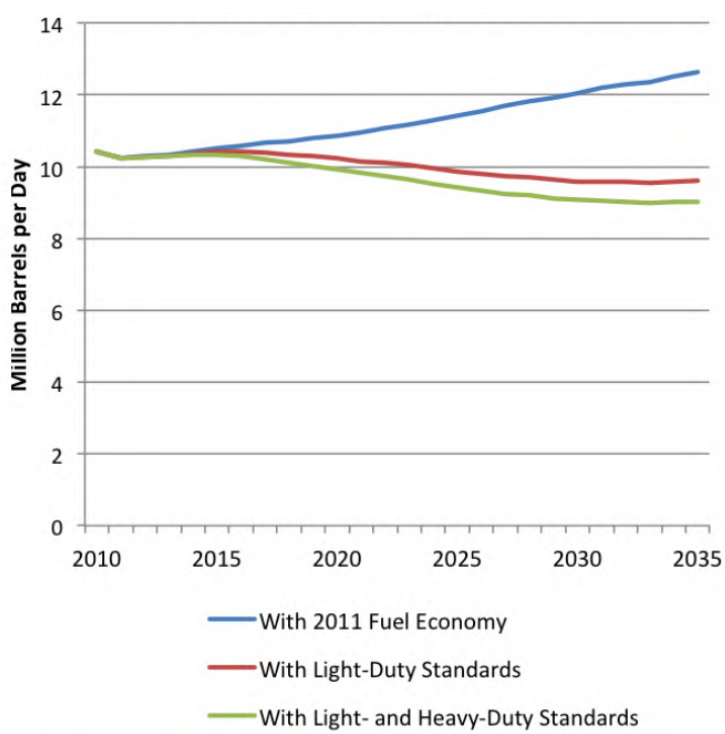


In 2012, the federal government and California adopted harmonized vehicle emissions standards applicable through 2025.[17] On August 2, 2018, the Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) submitted proposed rules to freeze their respective standards to 2020 levels, making them less stringent on fuel efficiency and carbon emissions for vehicle model years 2021 through 2025. The proposed rules would also remove language concerning the California waiver. The overall impact of this change would weaken fuel economy standards and would lead to increased emissions and fuel consumption. Oregon signed on as party to a preliminary lawsuit filed by California against EPA[19] disputing the legality of such a federal action, and in October 2018 joined comments with California and other states and municipalities opposed to the proposed federal actions.[20]

Fuel efficiency standards create benefits that continue through the lifetime of a vehicle, including decreasing petroleum consumption, reducing costs for consumers, and reducing harmful emissions. CAFE standards have dramatic effects on fuel consumption and GHG emissions over extended timelines as vehicles are kept in service for a long time. As noted above, the average vehicle in Oregon is 13.5 years old.

Figure 4.14 shows projected fuel consumption through 2035 for the 2011 standards (blue line) and the current efficiency standards (red and green lines). The current standards are projected to save more than three million barrels a day by 2035

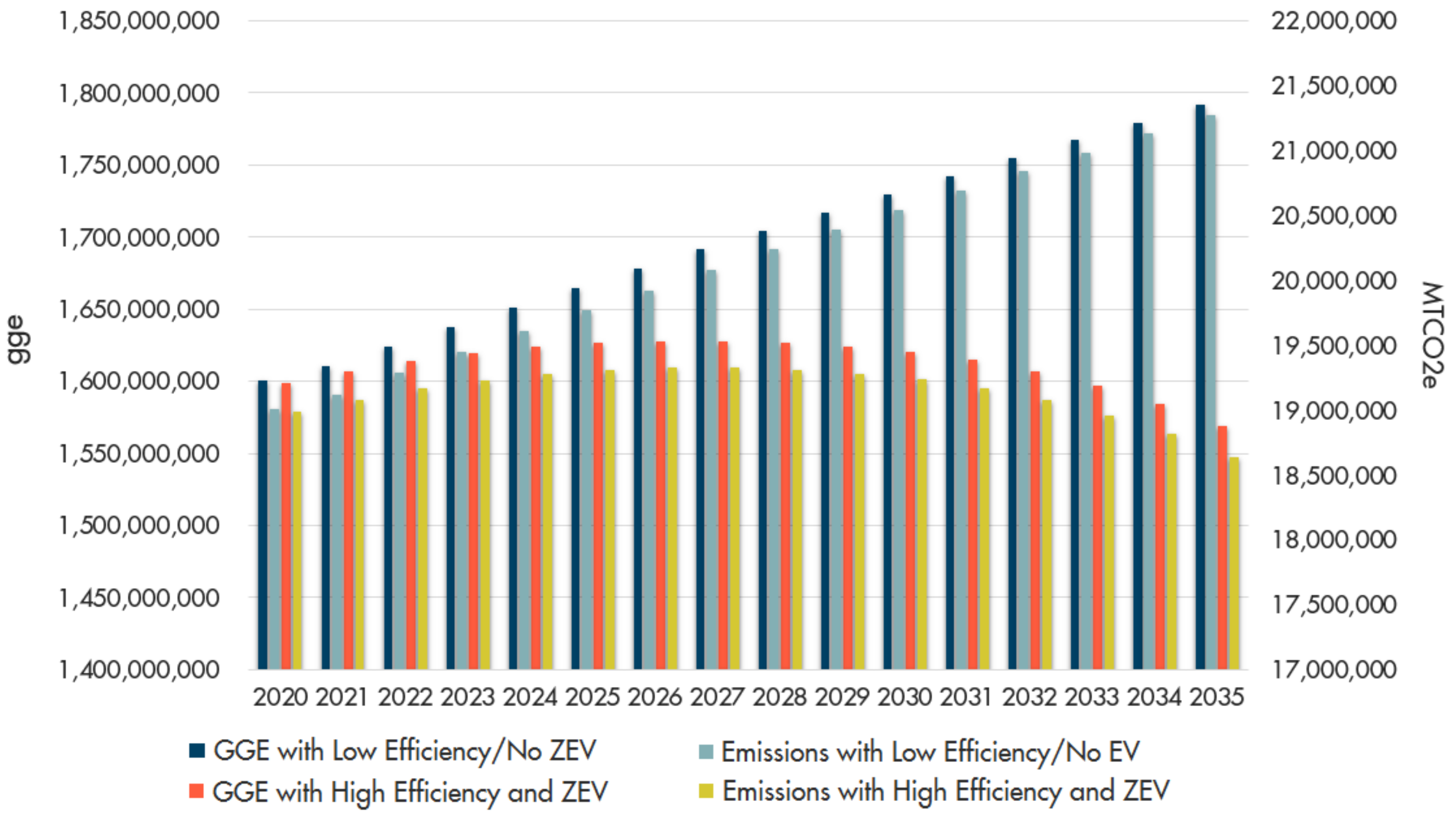
Figure 4.14: Car and Truck Fuel Consumption with and without Recent Fuel Economy Standards[18]



compared to the 2011 standards, and this will increase U.S. energy independence in addition to saving consumer's money and reducing emissions.

Even minor efficiency improvements can greatly affect fuel use, emissions, and consumers' budgets. Figure 4.15 shows how CAFE standards coupled with EV adoption can have large effects on GHG emissions and gasoline consumption. The graph shows fuel consumption peaking in 2027 and GHG emissions peaking in 2028 using the policies in place today. This is in comparison to a scenario with no Zero Emissions Vehicle program (learn more later in this chapter) and reduced fuel efficiency standards, which would create continual increases in consumption and GHGs through 2035 and cost Oregonians an additional $4.8 billion in fuel.[1]

Figure 4.15: Comparison of High Vehicle Efficiency and ZEV Program Benefits to Low Vehicle Efficiency and No ZEV Program Benefits in Oregon[72]



Policies Promoting Cleaner Fuels

A number of policies at the federal and state levels promote the use of cleaner fuels by setting standards for transportation fuels and by promoting adoption of vehicles capable of using cleaner fuels.

To date, biofuels have been the most effective lower carbon alternative for curbing petroleum product consumption and GHG emissions. Other no- or low-carbon alternative fuels (e.g., propane, renewable natural gas (RNG), natural gas products such as compressed natural gas (CNG) and liquefied natural gas (LNG), and electricity) have become increasingly important to diversifying Oregon's fuel supply and reducing emissions. These alternative fuels have the potential to grow for specific applications in the transportation sector.

Biofuels such as ethanol, biodiesel, and renewable diesel require little or no modification to vehicles and fueling infrastructure. Other alternative fuels such as propane, CNG, LNG, and RNG may be used in internal combustion vehicles but require engine modifications and special fueling infrastructure. Finally, electric vehicles and hydrogen fuel cell vehicles are distinct from internal combustion engine vehicles and use designated fueling infrastructure. Because of the integral relationship between fuel and vehicle, this section will discuss programs and policies promoting both cleaner fuels and related vehicle and fueling technologies, where applicable.

Federal and State Renewable Fuel Standards

Congress passed the federal renewable fuels standard (RFS) program in 2005 to reduce the country's reliance on imported fuels by diversifying the transportation fuel mix. This program incentivizes renewable fuels grown and produced primarily in the U.S. In 2007, the RFS was amended to increase the required amount of renewable fuels that must be included in the fuel mix and establish categories for different fuels based on their carbon content. In most cases, categories for lower carbon content fuels can be sold for higher prices in the renewable transportation fuel market.

The Oregon RFS was passed in 2007.[73] The state RFS also sets standards for the amount of renewable fuels, such as biodiesel and ethanol, to be included in most conventional transportation fuels sold in the state. The standard requires Oregon diesel fuel to contain five percent biodiesel and gasoline to contain ten percent ethanol. Although not the primary focus of these programs, the federal and Oregon RFS have greatly reduced emissions from the state's petroleum fuel mix.

Oregon Clean Fuels Program

The Oregon Clean Fuels Program was established by the state legislature in 2009,[22] with the goal of reducing GHG emissions from Oregon's transportation fuels by 10 percent over a 10-year period. However, it was not until the Legislature passed SB 324 in 2015 that the program was allowed to be fully implemented by DEQ. In 2016, DEQ established annual standards through 2025 for all transportation fuels and calculated the carbon intensity (CI) for each of them, measured in grams of carbon dioxide released per megajoule of energy produced. The CIs in Figures 4.16 and 4.17 were updated in 2017. CIs are regularly added and updated by the DEQ CFP. The full list of Oregon-approved CI values is available on their webpage.[21]

Figure 4.16: Carbon Intensities of Fuel Sources[21]

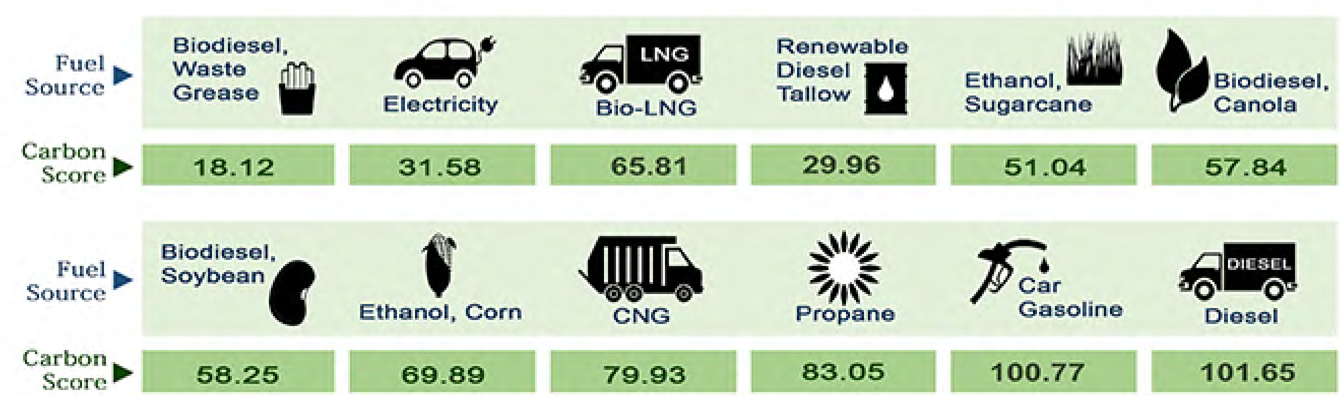
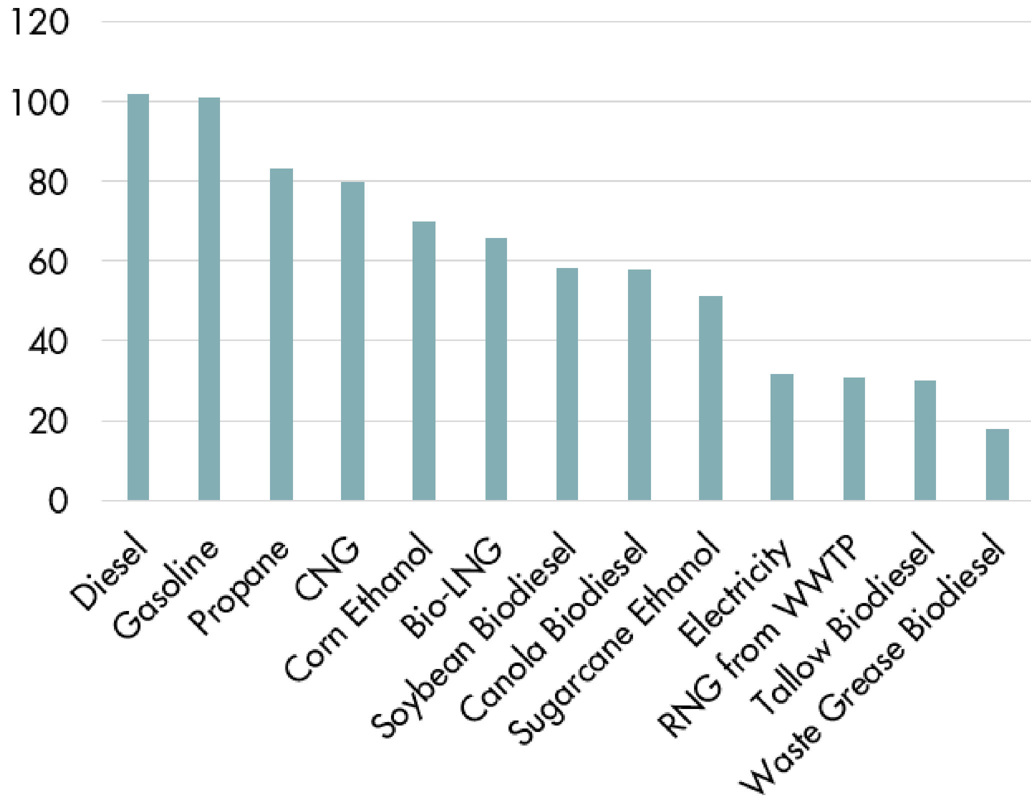


Figure 4.17: Oregon Fuel Source Carbon Intensities[21]



Credits under the program are generated when a fuel's carbon intensity is lower than the annual standard. Fuels that generate credits include: ethanol, biodiesel, renewable diesel, natural gas, propane, electricity, and hydrogen. Deficits are generated when the carbon intensity of a specific fuel – principally fossil gasoline and diesel – exceeds the annual standard. Credits and deficits are both calculated as one metric ton of CO2e. The program requires the importers of liquid transportation fuels into Oregon to meet the annual standards; in other words, they must retire enough credits to offset the number of deficits they incur. Providers of natural gas, propane, electricity and hydrogen to vehicles can voluntarily opt in to the program and generate credits. The program has rules for and monitors the market for credits.[22] The program has been fully operational since 2016, and is generating sufficient credits to meet the needs of the market. Credits are being traded in increasing numbers with little effect on the price of fuel.

OREGON CLEAN FUELS PROGRAM

In its first two years, the Oregon Clean Fuels Program has reduced GHG emissions by 1.75 million MTCO2e and replaced 445 million gallons of gasoline with lower carbon fuels.

Since the program's start, new low-carbon fuels have been introduced into Oregon's transportation fuel mix, including renewable natural gas from wastewater treatment plants and landfills and renewable diesel sourced from a by-product of ethanol production. Some of these fuels are, or can be, produced in Oregon. The program is on track to meet its goal of reducing the carbon intensity of transportation fuels. Overall the federal and state RFS programs, combined with the Clean Fuels program have increased the amount of cleaner alternative fuels used in Oregon's transportation mix from less than two percent in 2005 to 7.3 percent in 2017 on an energy equivalent basis.[1] In 2017, the combined reductions in life-cycle greenhouse gas emissions of blended diesel and gasoline products from the federal and state RFS programs and the Oregon Clean Fuels Program is estimated to be 791,000 MTCO2e in Oregon.[78]

Electricity is a qualifying fuel under the Clean Fuels Program. Utilities are able to receive credits for EVs that charge on their systems. Many utilities have signed up for the program and are receiving credits. For utilities that have not signed up, the non-profit organization Forth was designated as a backstop aggregator for any credits accrued from these territories. The money generated from these credits will be used to promote and support transportation electrification across Oregon.

Alternative Fuel Vehicles

As noted above, little to no change to vehicles is required to use some alternative fuels, while other alternative fuels require distinct vehicle technologies and fueling infrastructure. In the light-duty sector, the focus in Oregon is on electric vehicles, which are fueled entirely or partially by electricity. In the medium- and heavy-duty sector, there have been a range of changes from electric to cleaner-burning natural gas or propane to biodiesel. Many businesses and organizations in Oregon that use medium- and heavy-duty vehicles have already introduced cleaner transportation fuels into their fleets.

Oregon Zero Emission Vehicle Program

Oregon has adopted the California Zero Emission Vehicle (ZEV) Program, which requires most vehicle manufacturers to deliver an increasing percentage of new cars sold in Oregon to be ZEVs such as: battery electric, plug-in hybrids, other hybrids, and gasoline vehicles with near-zero tailpipe emissions.[23] California, under its federal waiver, has the authority to establish standards and rules on vehicle emissions including their ZEV program. Once they are established other states may adopt these rules.[24] Nine states, including Oregon, participate in the California waiver program.

WHAT'S THAT ACRONYM?

The vehicle industry uses a number of acronyms to refer to traditional and alternative fuel vehicle models:

ICE: Internal-combustion engine; runs on gasoline

ZEV: Zero-emissions vehicle

PHEV: Plug-in hybrid electric vehicle; runs on electricity, then switches to gas

EV: Electric vehicle; can refer to all-electric or plug-in hybrid

BEV: Battery electric vehicle; all-electric plug-in

TZEV: Transitional ZEV; plug-in hybrid

BEVX: BEV that also has gas-powered range extender engine technology

FCEV: Fuel cell EV; vehicles use hydrogen to produce electricity

ZEV adoption forecasts for Oregon show considerable EV growth is expected, although the forecasts vary. DEQ anticipates approximately eight percent of all new car sales in Oregon will be ZEVs by 2025, while Bloomberg estimates approximately 30 percent by 2030. Based on that forecast, sales will likely be about 19 percent by 2025.

SEQUENTIAL BIOFUELS

In 2002, Ian Hill was on a college road trip when his car broke down. Looking at the cloud of black smoke billowing from his engine, Ian decided there must be a better, cleaner way to travel. He and his friend, Tyson Keever, started researching biofuels as students at the University of Oregon. Just three years later, their company, SeQuential Biofuels, collaborated with Pacific Biodiesel to open the first commercial biodiesel production facility in Oregon. By Fall 2008, the SeQuential-Pacific Biodiesel facility in Salem was already completing a major expansion, with a new annual capacity of five million gallons (up from one million gallons). In 2017, production reached 8.45 million gallons, and the team expects to increase production by another 40 to 50 percent by the end of 2019.

Biodiesel is made from used cooking oil, which undergoes a chemical process called transesterification. The process separates materials into distinct elements, including mono alkyl esters: the scientific name for biodiesel. The California Air Resources Board ranks the resulting fuel with a carbon intensity of 18.57, about a fifth of the lifecycle emissions of petroleum diesel (which has a carbon intensity of 98.03).

SeQuential Biofuels also works upstream and downstream from production. The company collects used cooking oil from food processors like Kettle Foods, and from restaurants like Burgerville, Taco Time, and McMenamins. Trucks also gather oil from businesses with large cafeterias, like hospitals, schools, and the Nike campus in Beaverton.

The biofuel is sold at 90 locations in Oregon, including two stations in the Eugene area that are owned and operated by SeQuential. SeQuential's stations also demonstrate sustainable building practices, including a living roof and bioswales for stormwater management, renewable solar PV, and even a heathy snack selection at the convenience store.

Enthusiasm, hard work, and good partners – combined with helpful business incentives and good market conditions – have created a unique Oregon alternative fuel business with 221 employees up and down the west coast (138 of them in Oregon).[25,26,27,28,29,30]

Electric Vehicle Purchase Incentives

Incentives can be an effective tool to close the gap between the higher up-front costs of electric vehicles compared to conventional gasoline-powered vehicles. Various incentives are available for the purchase of electric vehicles and in some cases for charging equipment. Auto manufacturers, auto dealerships, utilities, or local governments may also offer incentives. The following incentives were available at the time this report was published.

Federal EV Tax Credit Program

The federal government offers tax credits designed to lower the cost of plug-in vehicles. The amount of the credit is based on the vehicle's battery capacity, and can range from $2,500 to $7,500 for EVs purchased in the U.S. The tax credits are available until 200,000 eligible EVs have been sold by a manufacturer, and then the credit will phase out over 12 to 18 months for that manufacturer's plug-in EV products. The credit is available based on a manufacturer eligibility basis. In 2018, Tesla was the first manufacturer to hit the 200,000 vehicle mark.[31] General Motors is also expected to exceed the cap in the fourth quarter of 2018.[32]

Oregon Clean Vehicle Rebate and Charge Ahead Rebate

The Oregon Legislature enacted House Bill 2017,[74] the "Keep Oregon Moving" Act, in 2017 which, among other things, established a rebate of up to $2,500 for qualifying BEVs and PHEVs. The bill also included a companion Charge Ahead Rebate program, which offers a separate rebate up to $2,500 for low- and moderate- income households for the purchase or lease of a new or used BEV. Both programs are administered by the Oregon Department of Environmental Quality and are currently taking applications.

Oregon DEQ Clean Vehicle Rebate Program

	Standard Rebate	Charge Ahead Rebate
Who Qualifies?	All Oregonians	Low– or moderate-income households. DEQ has not finalized qualification levels for the Charge Ahead Rebate. See DEQ's website for more information.
Vehicle Type	Purchase or lease of new BEV or PHEV	Purchase or lease of new or used BEV or PHEV
Rebate Amount	• $2,500 for EVs with battery capacity of 10 kWh or higher • $1,500 for EVs with battery capacity less than 10 kWh	$2,500 for new or used BEV
Eligibility Requirements	• Applicant must maintain vehicle registration in Oregon for at least two years • Manufacturer's suggested retail price cannot exceed $50,000 • Applicant must submit Phase I Application within six months of the date or purchase or lease • Must be purchased or leased from a licensed dealer	

More information: www.oregon.gov/deq/aq/programs/Pages/ZEV-Rebate.aspx

Utility-Specific Incentives

Some Oregon utilities also offer rebates for EVs purchased by their customers.

- Eugene Water and Electric Board currently offers a $300 Clean Ride Rebate on the purchase or lease of a new or used EV.
- City of Ashland's Municipal Utility offers up to $300 rebates on qualifying EVs.
- Emerald People's Utility District offers $100 for registering an electric vehicle.
- EWEB and Pacific Power are partnering with Nissan to offer a $3000 rebate on the purchase of a 2018 Nissan Leaf.

VW Environmental Mitigation Trust

VW mitigation funds can help Oregon meet its GHG emissions goals by funding alternative fuel vehicle projects that clean up dirty diesel emissions. In addition, up to 15 percent of the funds can be used for light-duty EV infrastructure. Oregon DEQ administers these funds as authorized by the Oregon Legislature. The 2017 legislature approved VW Mitigation funds to clean up approximately 450 diesel school buses by either installing diesel emission control devices or by purchasing clean diesel or other alternative fuel buses, such as propane, natural gas, or electricity. Future legislation is needed to approve spending the remainder of the VW Mitigation fund.[33] Approved projects eligible for these funds have different impacts on emissions. Clean diesel engines significantly reduce toxic air pollutants. Clean fuel technologies such as RNG, propane, or electricity reduce both toxic air pollutants and GHG emissions.

DIESELGATE

Volkswagen and its affiliated corporations violated the Federal Clean Air Act when the EPA discovered in 2015 that the automaker had programmed several of its turbocharged direct injection diesel engines to activate emissions controls only during laboratory testing, and to revert to normal operation during on-road driving. The difference in air pollutant emissions was substantial, with up to 40 times NOx emissions in real-world driving scenarios. About 11 million Volkswagen cars worldwide[34] feature this programming software and are affected, of which 500,000 were sold in the U.S. for model years 2009 through 2015.[35]

Through Volkswagen and its affiliated corporations' settlement agreement with the EPA and the California Air Resources Board, Volkswagen and its affiliated corporations' must buy back or compensate owners for their affected vehicles. Buybacks range in value from $12,475 to $44,176, or between $5,100 to $9,852 for those opting for emissions fixes approved through the EPA. The company will also pay $2.7 billion for environmental mitigation and another $2 billion for clean-emissions infrastructure.[36]

States, territories, and tribes will receive funds designated for mitigating excess emissions of nitrogen oxides from Volkswagen diesel vehicles. States will receive between $8 and $423 million in the initial allocations, with Oregon receiving $72.9 million. Each state will develop a plan to use the funds for eligible mitigation actions including diesel engine upgrades or replacements, and installing EV charging infrastructure.[37]

ELECTRIFY AMERICA

Electrify America charger in Huntington, OR
Photo: PlugShare.com

VW launched Electrify America as part of its settlement with the EPA and CARB over the "Dieselgate" scandal. The company is spending $2 billion on a nationwide electric vehicle charging network and on EV education. The company will use these funds to install 50- to 150-kW urban chargers, as well as highway stations with as much as 350 kW of power.

Electrify America will install charging infrastructure over the next 10 years, in four 30-month investment cycles. The company is currently in the process of implementing Investment Cycle 1, which includes the installation of more than 150 long-distance highway fast chargers across the country, and more than 300 chargers in 11 designated urban areas in the U.S., including Portland. As of the date of this report, three highway stations are now operational in Oregon in Huntington, Albany, and Grants Pass, with six more in process.[38]

The Cycle 2 investment period will be from July 2019 through December 2021. As it did with Cycle 1, Electrify America is accepting proposals and input from governments and other entities on data that would inform station siting, current or expected community or state EV policies and charging infrastructure plans, and perspectives on fuel cell electric vehicles. Oregon, in partnership with Washington State, submitted proposals to Electrify America for the first two cycles of project approvals. Electrify America is also accepting suggestions on its approach to educating the public on EVs and promoting access to EVs.[39]

Executive Order 17-21

Looking for every opportunity to reduce Oregon's contributions to GHG emissions, Governor Kate Brown signed EO 17-21, "accelerating zero emission vehicle adoption in Oregon to reduce greenhouse gas emissions and address climate change," on November 6, 2017.[40] The transportation sector is the leading contributor to greenhouse gas emissions in Oregon. Putting more zero emission vehicles on Oregon roads is a key strategy to reducing these emissions.

This EO sets a goal of 50,000 registered EVs in Oregon by 2020, and encourages the adoption of zero-emission vehicles by:

- **Increasing Oregonians' access to EVs and EV chargers.**
- **Providing technical expertise and information on EV use and functionality.**
- **Recognizing businesses and organizations that are early leaders in EV adoption.**
- **Enabling State of Oregon agencies to lead by example by reducing barriers to procuring EVs in fleets and EV chargers at State facilities.**

EO 17-21 is being implemented by the Zero Emission Vehicle Interagency Working Group, comprised of five core agencies: the Oregon Department of Energy, Oregon Department of Environmental Quality, Oregon Department of Transportation, Oregon Public Utility Commission, and the Department of Administrative Services. The ZEVIWG works with other agencies and external partners to drive EV adoption in Oregon and help the state achieve its GHG reduction goals.

Utility Transportation Electrification Plans

Legislation passed in 2016 has enabled Portland General Electric, Pacific Power, and Idaho Power to implement plans to increase electric vehicle use in their respective service territories after approval by the Oregon Public Utility Commission. The Commission has approved pilot programs submitted by Pacific Power, PGE, and Idaho Power aimed at increasing transportation electrification in their areas. Pacific Power will implement a public charging pilot, an outreach and education pilot, and a demonstration and development pilot. PGE will implement pilots for public charging stations, electrified mass transit with TriMet, and an outreach and demonstration pilot. Idaho Power will be providing educational material, showcasing its EV fleet, and providing training on EVs for electricians, first responders, and auto dealers:

- PGE Docket UM 1811[41]
- Pacific Power UM 1810[42]
- Idaho Power Docket UM 1815[43]

PGE and Pacific Power are also developing plans to spend the revenues earned by selling clean fuels credits under the Oregon Clean fuels Program generated on behalf of their EV-owning customers. Principles in monetization and on how to spend the revenue were approved by the PUC on October 9, 2018, and initial plans are to be submitted by March 31, 2019.

- UM 1826[44]
- AR 609[45]

Utility-Specific Charger Incentives

Consumer-owned utilities are offering incentives to customers who install EV charging infrastructure. For example:

- Central Lincoln People's Utility District offers a $250 rebate for installing a level 2 charger.
- City of Ashland Municipal Utility offers up to $500 to install workplace charging

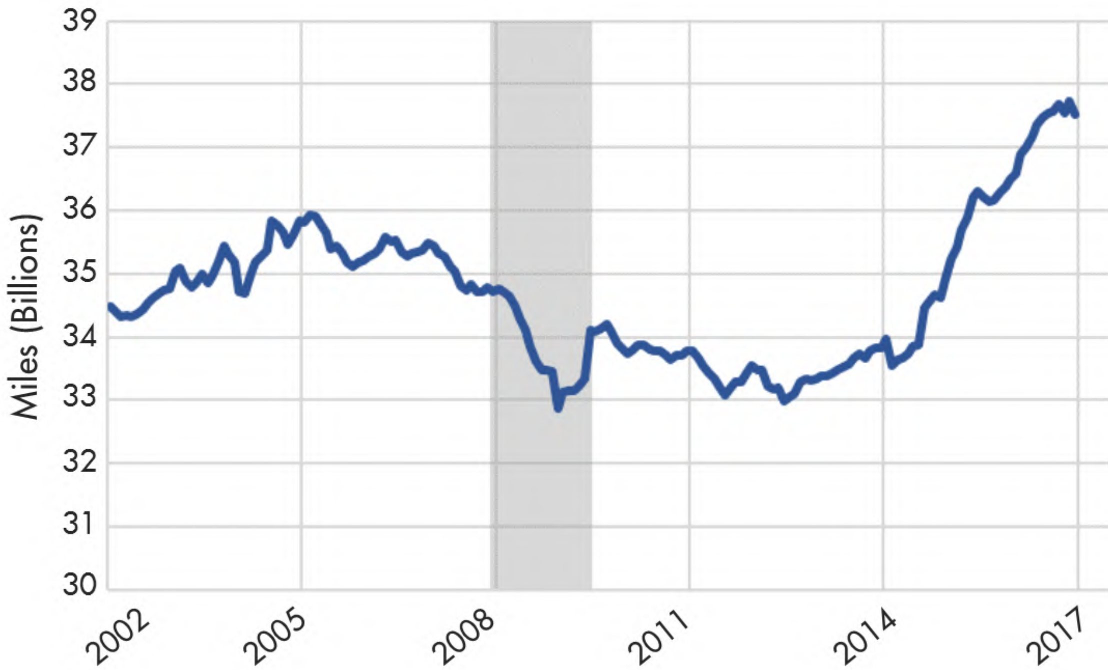
Policies for Reducing Vehicle Miles Traveled

While vehicles are becoming more efficient and fuels are becoming cleaner, these gains are being offset by the increasing number of vehicles in Oregon[79] and the number of vehicle miles traveled (VMT) per vehicle. Figure 4.18 shows that statewide VMT decreased from 2005 through 2013 due to economic effects of high oil prices and the Great Recession. Since 2014, VMT has risen in the state as the economy rebounded and gas prices fell and remained relatively low. GHG emissions are rising with increased VMT as well. Until a sufficient number of Oregon vehicles are no- or low-emissions, rising VMT will continue to be the most significant driver in rising GHG emissions.

Current trends of increasing VMT aside, Oregon's integration of land use planning and transportation investments, in addition to a growth strategy that emphasizes more compact, pedestrian, and transit friendly development within existing urban areas, have kept VMT lower than they might otherwise have been. Oregon has long been a leader in transportation and land use planning, recognizing that community planning that makes the now-obvious connection between them will reduce VMT and yield more livable communities.

Comprehensive planning by cities and counties to achieve statewide planning goals began in earnest following the passage of Oregon's landmark Senate Bill 100 in 1973.[75] In the early 1990s, the Department of Land Conservation and Development, which oversees implementation of that law, adopted rules to require local governments and state agencies to consider the effects of their zoning decisions on transportation facilities, and the effects of their transportation decisions on land use patterns. In 2009 (House Bill 2001[76]) and 2010 (Senate Bill 1059[77]) the legislature called for Metro and the Central Lane Metropolitan Planning Organization (MPO) to develop planning scenarios that integrated transportation and land-use so that the light duty sector met its share of the overall transportation sector's GHG reduction targets. Modelling was done using ODOT's Regional Strategic Planning Model (formerly the "GreenSTEP" model), and the Integrated Transport and Health Impact Modeling Tool developed by the United Kingdom Public Health Research Center. The preferred scenario in the Central Lane MPO plan, even with a 25 percent expected increase in population over the next 20 years, anticipates significant benefits, such as: a 20 percent reduction in GHG emissions, a 15 percent reduction in VMT per person, no increase in congestion over today's condition, household driving costs as a percentage of income would stay about the same as today, annual fuel expenses could be reduced by as much as $50 million per year, common air pollutants could decrease by two-thirds, and overall community health care savings that could exceed $22 million per year.[46]

Figure 4.18: Oregon Statewide Total Annual Vehicle Miles Traveled, 2002-2017[47]



Single occupancy vehicles (SOV) as a primary mode of transportation is one of the leading factors increasing VMT, which increases fuel use and air pollution, including GHGs. Rising use of SOVs also creates more traffic congestion and longer times spent in traffic. According to the 2017 INRIX Traffic Scorecard, people in Portland spend 11 percent of their commute time driving in congested traffic, 10 percent in Bend, and five percent in Salem. Although this does not take into account the reduced VMT resulting from compact urban growth, the stop-start movement during congested times of the day burns fuel at a higher rate, increasing fuel consumption and emissions. More time spent in traffic also results in higher transportation costs for individuals and businesses that rely on transportation.[48]

Oregon Transportation Plan

Multiple state agencies have policies, programs, and strategies designed to reduce statewide VMT, including advancing walking, biking, transit, and shared transportation. The overarching guidance document for transportation in Oregon is the Oregon Transportation Plan, or OTP. Created and implemented by ODOT, it is the long-range transportation system plan for the state. It establishes a vision and policy foundation to guide transportation system development and investment. The OTP and its associated focus-area plans guide decisions by ODOT and other transportation agencies statewide,

THE COST OF TRAFFIC

The INRIX Global Traffic Scorecard ranks Portland congestion as the 12th worst in the U.S. The report estimates that the congestion cost $1,648 per driver and **$3.9 billion** to the City of Portland in 2017.[48]

and is reflected in the policies and decisions explained in local and regional plans. Several of the focus-area plans such as the Oregon Public Transportation Plan, the Transportation Options Program, and the Oregon Bike & Pedestrian Plan discuss reducing VMT and conserving energy.

OPTP VISION

"In 2045, public transportation is an integral, interconnected component of Oregon's transportation system that makes Oregon's diverse cities, towns, and communities work. Because public transportation is convenient, affordable and efficient, it helps further the state's quality of life and economic vitality and contributes to the health and safety of all residents, while reducing greenhouse gas emissions."[49]

Recognizing that an increasing population has changed the transportation landscape for many Oregonians, the Oregon Transportation Commission adopted the 2018 Oregon Public Transportation Plan (OPTP) on September 20, 2018.[49] The OPTP is one of several mode and topic plans that refine, apply and implement the Oregon Transportation Plan. The new OPTP establishes a shared statewide vision for public transportation and provides strategies to achieve the vision. The plan acknowledges that developing a robust public transportation system advances Oregon's efforts to reduce transportation-related GHG emissions and conserve energy. Goals include increasing accessibility and connectivity, improving the user experience, and strategic land use and investments. The OPTP does not discuss specific projects but helps to provide a policy and strategy framework to inform decisions for local, regional, and state agencies.[50]

Transportation Options Program

When comparing auto trips to transit trips, even a fairly empty bus with seven or eight passengers emits less per passenger mile than an average car trip.[51] As transit agencies integrate more energy efficient and low-carbon fuel vehicles into their fleet, transit-related emissions will continue to decrease. The Oregon Transportation Options Plan identifies opportunities to expand transportation choices; looks to increase funding opportunities for transportation options programs and activities; and provides direction to better integrate transportation options into local, regional, and state transportation planning.

The program administers federal grant funds and collaborates on planning activities with local transit agencies, counties, or Metropolitan Planning Organizations. The program also helps mitigate congestion for major construction projects, safety corridors, and other congestion points. The program manages Drive Less Connect, which helps connect Oregonians with multi-user travel options, as well as the Drive Less Challenge, that encourages the public to become familiar with other transit options such as carpooling, biking, walking, and transit.

Oregon Bike and Pedestrian Plan

The Oregon Bike and Pedestrian Plan examines walking and biking from an infrastructure and user perspective and recognizes issues, opportunities, and needs. It includes all aspects of delivering a transportation system, including policies and strategies that cover planning, investing, constructing, and maintaining walking and biking facilities and programs. When fully implemented, the Plan envisions a future that builds upon Oregon's strong existing foundation by further increasing walking and biking connections to critical destinations and other modes of transportation. In turn, this will help bring about a safer system for all users that leverages opportunities to enhance the system and creates more equitable access for all users.

It is difficult to estimate actual energy and emissions reductions from biking and walking, but it is widely acknowledged that using these options alone or combining these modes with transit options can reduce VMT from single occupancy vehicles and thereby fuel consumption and emissions.[52]

2017 Transportation Bill – HB 2017

The "Keep Oregon Moving" Act[74] included provisions that enable state agencies to build on or start new programs and analyses that promote walking, biking, and transit options in our transportation system. The Act includes provisions that can help some of the programs mentioned above to meet their goals. A statewide transit tax through employee deductions will finance local investments in and improvements to local public transportation with the goal to increase ridership that will thereby reduce fuel consumption and emissions. Light rail projects are excluded from the program. The bill also includes developing a traffic congestion relief program that will manage travel demand and ease traffic congestion which has potential to reduce fuel consumption and emissions. Such a congestion relief program is subject to federal approval.

Transportation & Growth Management Plan

The Transportation & Growth Management (TGM) program is a partnership of the Oregon Department of Land Conservation and Development and ODOT. The program helps local and county governments across Oregon with skills and resources to plan long-term, sustainable growth in their transportation systems in line with other planning for changing demographics and land uses. TGM encourages governments to take advantage of assets they have, such as existing urban infrastructure, and walkable downtowns and main streets.[53]

While there is significant action at the state level to reduce VMT, many strategies to increase walking, biking, and public transportation are pursued at the local level. Many of these activities are coordinated and implemented by Metropolitan Planning Organizations, that are responsible for developing the transportation plan for a metropolitan area. While this report does not look at local actions in detail, the Metro Regional Transportation Plan is a key example of steps being taken by local jurisdictions.

Metro 2018 Regional Transportation Plan / Climate Smart Strategy

The Metro Regional Transportation Plan[54] is a blueprint to guide investments for all forms of travel such as motor vehicles, transit, bicycles, and walking; as well as the movement of goods and freight throughout the Portland metropolitan region, and is the main tool for implementing the region's Climate Smart Strategy. The plan identifies current and future transportation needs, investments needed to meet those needs and what funds the region expects to have available over the next 25 years to make those investments a reality.

As directed by the Oregon Legislature in 2009, the Metro Council and the Joint Policy Advisory Committee on Transportation (JPACT) developed and adopted a regional strategy to reduce per capita greenhouse gas emissions from cars and small trucks (light-duty vehicles) by 2035 to meet state targets. Adopted by the Metro Council and JPACT in December 2014 with broad support from community, business and elected leaders, the Climate Smart Strategy relies on policies and investments that have already been identified as local priorities in communities across the greater Portland region. Metro, in partnership with ODOT, conducted a detailed modeling analysis of various greenhouse gas scenarios and identified the types of transportation-related mitigation strategies that would have the greatest potential for reducing greenhouse gas emissions in the long term.

Analysis of the draft 2018 RTP found the plan makes satisfactory progress towards implementing the Climate Smart Strategy and, if fully funded and implemented, can reasonably be expected to meet the state-mandated targets for reducing per capita greenhouse gas emissions from cars and small trucks (light-duty vehicles) for 2035 and 2040. By 2040, the plan, together with advancements in fleet and technology, is expected to reduce total annual greenhouse gas emissions from all on-road vehicles by 19 percent (compared to 2015 levels) and annual per capita greenhouse gas emissions from all on-road vehicles by 40 percent (compared to 2015 levels). The findings also demonstrate that more investment, actions and resources will be needed to ensure the region achieves the mandated greenhouse gas emissions reductions defined in OAR 660-044-0060. In particular, additional funding and prioritization of Climate Smart Strategy investments and policies will be needed. The Metro Council is anticipated to adopt the 2018 Regional Transportation Plan on December 6, 2018.[54]

Even with all these programs, policies, and plans, VMT continues to rise in Oregon. Efforts to reduce single occupancy vehicles are being offset by a growing population of people who are driving more. Increases in VMT and associated traffic congestion will increase overall fuel use and air emissions. Offering viable travel options for those who don't have a car or want options other than car travel reduces VMT which lowers GHG emissions per passenger mile. As long as gasoline and diesel powered vehicles are the primary vehicle on Oregon roads VMT will also drive up the state's GHG emissions. These strategies will do far more than reduce greenhouse gas emissions. Properly designed and implemented, they will also improve the quality of life in our rural and urban communities, improve public health,

Figure 4.19: Climate Smart Strategy: Strategies Evaluated and Findings[55]

Strategies Evaluated and Findings

Climate Smart Strategy | Largest potential carbon reduction impact*

Vehicles and Fuels (Investment)
- Newer, more fuel efficient vehicles
- Low- and zero-emission vehicles
- Reduced carbon intensity of fuels

Pricing (Policy)
- Carbon pricing
- Gas taxes
- Per-mile road usage charges (e.g., OReGO)
- Parking management and pricing
- Pay-as-you-drive private vehicle insurance

Community Design (Policy with Investment)
- Walkable communities and job centers facilitated by compact land use in combination with walking, biking and transit connections

Transit (Investment)
- Expanded transit coverage
- Expanded frequency of service
- Improvements in right-of-way to increase speed and reliability of buses and MAX

Climate Smart Strategy | Moderate potential carbon reduction impact*

Active Transportation (Investment)
- New biking and walking connections to schools, jobs, downtowns and other community places

Travel Information and Incentives (Investment)
- Commuter travel options programs
- Household individualized marketing programs
- Car-sharing and eco-driving techniques

System Management and Operations (Investment)
- Variable message signs and speed limits
- Signal timing and ramp metering
- Transit signal priority, bus-only lanes, bus pull-outs
- Incident response detection and clearance

Climate Smart Strategy | Low potential carbon reduction impact*

Street and Highway Capacity (Investment)
- New lane miles (e.g, general purpose lanes, auxiliary lanes)

Source: *Understanding Our Land Use and Transportation Choices Phase 1 Findings* (January 2012), Metro.

and help Oregon compete in the national and global economy.

Data on these programs and their impact on GHG emissions is limited. Measuring the impact of walking, biking, and transit on energy use and GHG emissions is challenging, but can help prioritize where to focus policies, programs, and funding to have the greatest impact on GHG emissions.

Potential Future Strategies

As detailed throughout this chapter, Oregon has a long history of pursuing policies that reduce greenhouse gas emissions and fuel use in the transportation sector, but these must be expanded upon and accelerated if the state is going to achieve its goals. The state will need to prioritize building on the progress made in the Statewide Transportation Strategy and focusing on a three-pronged approach of promoting cleaner vehicles, cleaner fuels, and lower VMT.

One trend that is gaining increasing attention from transportation experts and has the potential to change how Oregonians travel in the future is Connected and Autonomous Vehicles (CAVs). As automated driving technology continues to evolve, smart sensors and cloud networking may allow vehicles to connect to one another and the surrounding infrastructure. The effects of these technologies are the subject of recent studies and analysis, but results so far are often broad and inconclusive. Some studies have indicated that CAVs may reduce per-vehicle emissions while increasing VMT, which could result in an overall increase in greenhouse gas emissions and fuel use.[56] More research is needed to determine how these technological advancements will impact fuel efficiency, congestion, and safety. For example, ODOT led an Autonomous Vehicle Task Force in 2018 that looked into how CAVs intersect with licensing and registration, insurance and liability, law enforcement and accident reporting, and cybersecurity.[57]

EVs – The Future of Transportation?

Electric vehicles offer Oregon a cost-effective and efficient pathway to reduce greenhouse gas emissions, reduce fuel use in the transportation sector, and can leverage the increasingly clean electricity mix in Oregon to help reduce GHG and eventually help reduce costs for consumers. Not only are the tailpipe emissions from an EV much lower than an internal combustion engine (ICE) vehicle (and in the case of battery electric vehicles it is zero), but as the electricity grid continues to become cleaner the lifecycle emissions of EVs will continue to drop. The opportunities to reduce GHGs are dramatic. The operation and maintenance costs of an EV are also lower than an ICE vehicle, and because many EVs can be fueled at home or the workplace, the cost for fueling infrastructure is lower than other transportation alternatives — though DCFC is still necessary to accommodate longer trips. The cost of electricity used to fuel an EV is regulated, making annual costs easier to predict and allows the public to engage in the process that establishes the rates for that electricity fuel.

Electric cars have been around since the late 1800s, but were historically unable to compete with ICE vehicles due to range limitations – primarily because battery technology was insufficient. Battery technology has matured and is continually improving, allowing for increased vehicle ranges. Today the major barriers to EV adoption are the upfront cost of the EV, primarily driven by the cost of the batteries themselves, as well as the costs to install and maintain charging infrastructure.

The EV of the Near Future Is Not the EV You Saw Just A Few Years Ago

As recently as a few years ago, EVs were limited to ranges under 100 miles and there were few models available from a limited number of manufacturers. Today, many new EVs have ranges over 200 miles, and vehicles with 300-mile ranges will be available in the near future.

Electric Vehicle Trends

Typical EV (model year)	2015	2020
Total Range in Miles	80	300+
DC Fast Charge: Miles Charged in 15 Minutes	44	134

The Technology

Electric vehicles are about four times more efficient than their ICE counterparts, meaning an EV can go the same distance on 20 to 25 percent of the energy used in an ICE vehicle. EVs convert about 59 to 62 percent of the electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 17 to 21 percent of the energy stored in gasoline to power at the wheels.[58]

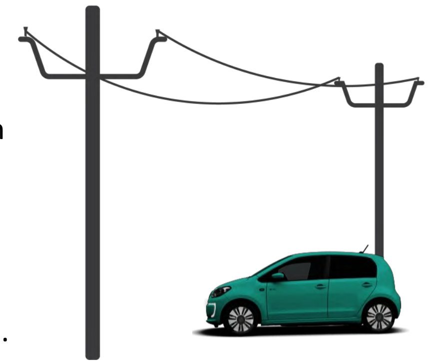
Table 4.3 compares energy use and costs for a typical gasoline-powered vehicle and an electric vehicle. Assuming 12,000 miles traveled in a year, the EV uses far less energy – with an equivalent savings of 373 gallons of gasoline and $1,044 per year. Fueling the EV is 28 percent of the cost to fuel the ICE.

Table 4.3: Efficiency, Fuel, and Costs for Gas-powered Vehicle vs. Electric Vehicle[5]

12,000 Miles/Year	Gasoline-powered Vehicle	Electric Vehicle
Efficiency (typical 2017 model)	25 mpg	3.33 miles/kWh
Fuel Needed	480 gallons gasoline	3,600 kWh
Fuel Equivalency	= 16,200 kWh	= 107 gallons gasoline
Cost per Mile	$3/gallon or $0.12 per mile	$0.11/kWh[59] or $0.03 per mile
Annual Fuel Costs	$1,440	$396
Annual Savings	**—**	**373 gallons gasoline** **$1,044**

EVs also cost less to maintain, with no engine oil, belts, transmission oil, differential oil, spark plugs, etc. to replace. Regenerative braking on an EV means brakes will last about twice as long as they would on an ICE vehicle because an electric motor contributes a percentage of the energy to stop the vehicle, rather than the brakes doing 100 percent of the job. Because most EV charging happens at home, about 90 percent on average, time going to a gas station is also saved.

The Fuel - Electricity



In Oregon, electricity is generated from diverse resources, many of which are domestically generated, including hydropower, natural gas, wind, coal, solar, nuclear, and others. Unlike petroleum, electricity prices are regulated and rarely experience supply and cost volatility. An electrified transportation sector increases flexibility and diversity, and decreases dependence on imported petroleum products.

The backbone of electrical energy already exists: the generation, transmission, and distribution of electricity can be found almost everywhere. Generally, all an EV needs is the final connection from the EV to the electric grid. The electric power sector is essentially designed as an on-demand system, and has been built to handle scenarios of high demand.

As more of Oregon's transportation sector becomes electrified, electricity demand will increase. Based on an average annual VMT of 11,343 miles per vehicle and 3.3 miles traveled per kWh of electricity consumed, it is estimated that the average battery electric vehicle will add approximately 3,347 kWh of annual energy demand. Generally the region should have sufficient energy available to meet expected EV demand in the short term. As an example, according to BPA, even in years with low hydropower output, the Pacific Northwest is expected to have a surplus of both available energy (average MW) and of capacity (MW) for operating year 2019.[60] Even in the month with the least amount of surplus energy expected (January), there will be sufficient energy available to meet the charging needs of large numbers of EVs across the Pacific Northwest.

A bigger constraint will be the availability of surplus capacity during heavy demand times. According to the same data from BPA, January will also have the smallest amount of available capacity, limiting the volume of battery electric vehicles that could charge at a given time during the month, particularly during the overall system peak. This trend is likely to bear out across the region as EV adoption increases in coming years—making it more important for utilities to consider ways to incentivize or otherwise encourage battery electric vehicles to charge at times most optimal for the grid to avoid system capacity constraints. With the ability to shift charging to off-peak hours Oregon could add significant numbers of EVs without needing to build or procure additional generation resources.[61]

In addition to the need for generation to supply the needed electricity for EV charging, there may be a need to strengthen local distribution systems to account for the higher loads that EVs draw. For example, transformers can fail when the local electric demand on their circuit becomes too great. If utilities know where these vehicles are being garaged in their networks, they can plan their transformer upgrades and replacements to accommodate the larger loads as needed.

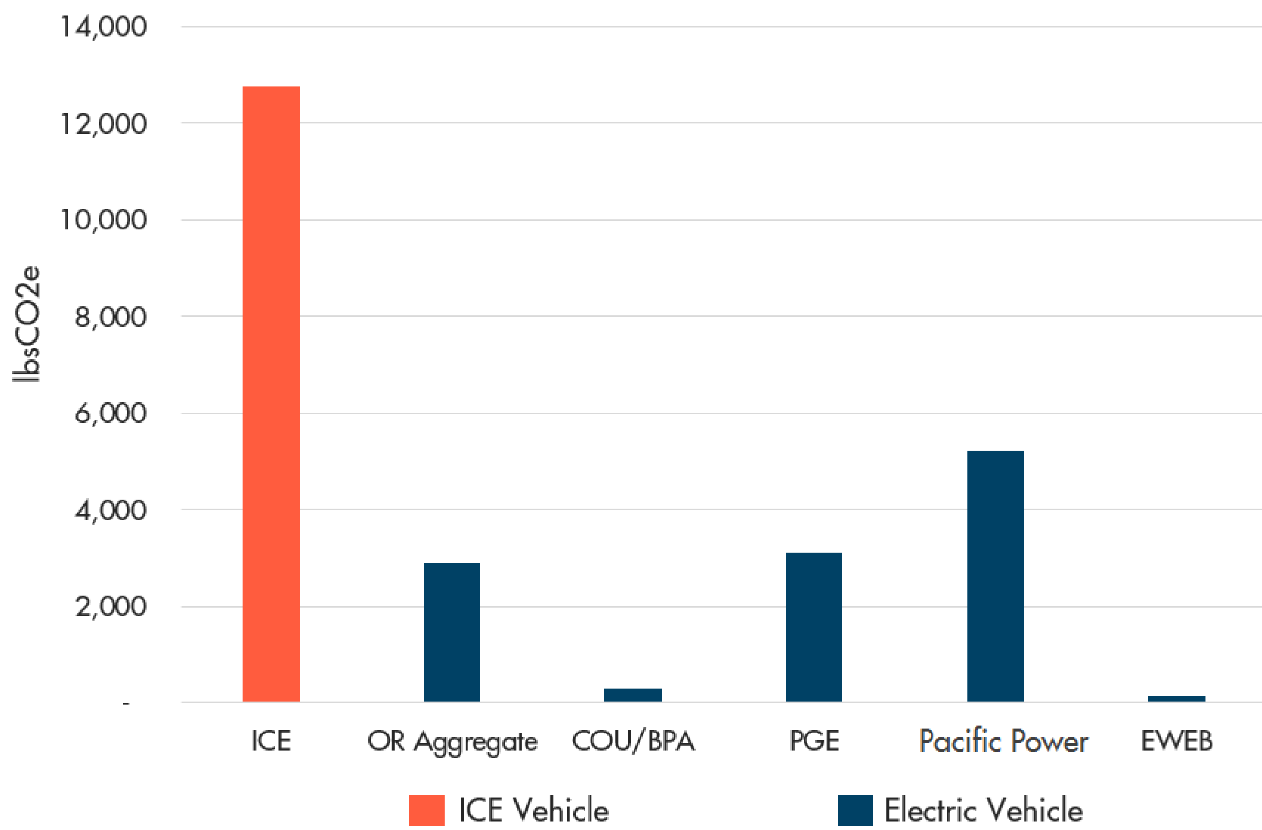
Emissions

Because EVs do not combust fuel, they have no tailpipe emissions. High levels of EV adoption would improve air quality in urban and high-traffic areas around the state. Improving air quality will improve health outcomes, as air pollution has been found to be associated with increased risk of asthma and lung and heart disease.

GHG emissions associated with driving an EV are largely influenced by what type of generation resources are used to produce the electricity. Overall, emissions from Oregon's electricity sector have been trending downward, and are expected to continue to become less carbon-intensive over the next few decades. Because the electricity generation is the source of emissions (not the EVs themselves), decarbonizing the electricity grid will further reduce emissions from an EV as it ages. In contrast, the fuel source for ICE vehicles is gasoline, which is much more difficult to decarbonize.

Figure 4.20 illustrates the comparison of a Ford Fusion (internal combustion engine or ICE vehicle) versus a Chevy Bolt (EV) charged at five different utility service territories traveling on average 11,343 miles over the course of one year. The EV has anywhere from a 60 percent to more than 95 percent improvement over the ICE counterpart, and as Oregon's utilities invest in cleaner technologies to produce electricity, overall emissions from the transportation sector will also improve with the growth of EV adoption.

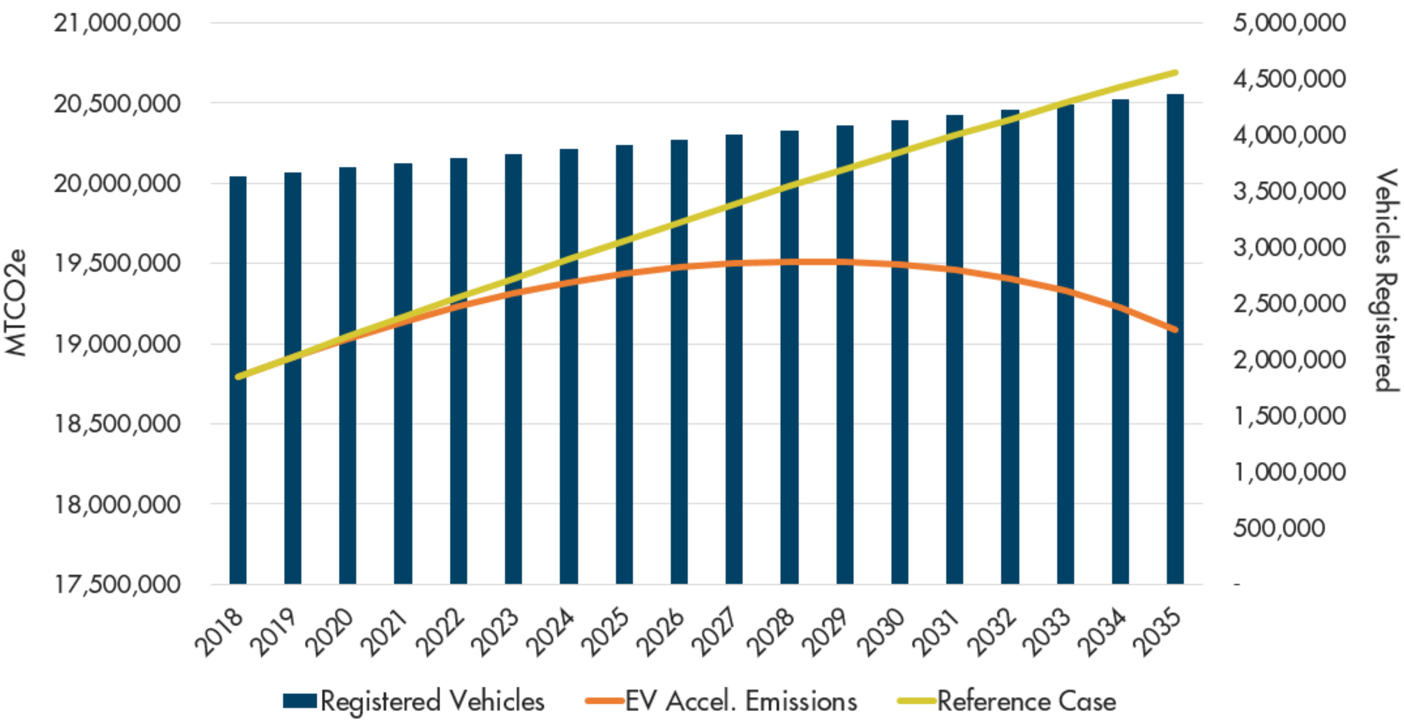
Figure 4.20: Annual Vehicle GHG Emissions in Oregon — ICE vs. EV[78]



The Role for EVs in Achieving Oregon's Climate Goals

Finding significant reductions in emissions in the transportation sector is key to the state achieving its GHG emissions reduction goals. Using the U.S. DOE's Annual Energy Outlook assumptions, ODOE compared the baseline EV growth in the reference case with an enhanced EV growth scenario based on anticipated impacts of state policies and goals currently in place. The baseline scenario assumes EV adoption at about 12 percent of new car sales by 2035, while the enhanced scenario puts EV adoption at 48 percent. Without the level of EV adoption indicated in the enhanced scenario, GHG emissions continue to rise through 2035. The enhanced EV scenario shows emissions plateauing in the late 2020s and beginning to drop by 2030.

Figure 4.21: GHG Emissions with Accelerated EV Growth vs. AEO Reference Case[5,7]



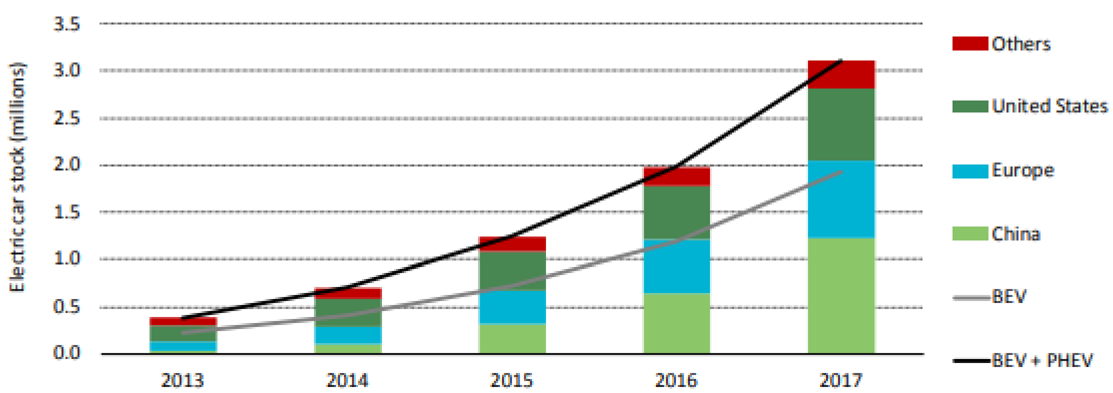
EVs and the Future of the Grid

EVs have the potential to add other benefits to the electrical system, such as the ability to store and pull energy from batteries in order to better manage the electricity grid. EVs do most of their charging overnight when energy demand is low and electricity generation resources are not being used to their full potential. EVs can help balance electricity production and demand by storing this plentiful nighttime energy during periods of low demand. Although not yet available, Vehicle-to-Grid (V2G) technology has the potential to make it possible to store surplus electricity generated from intermittent renewable resources like solar and wind in EV batteries during non-peak periods and also feed power back to the grid when needed. U.S. DOE's National Renewable Energy Laboratory is working on many facets of this technology, including testing facilities that work on grid-vehicle interactions as well as investigating how energy efficiency, renewable energy, and sustainable transportation technologies can increase the capacity, efficiency, and stability of the grid.[62] Not only can EV batteries help Oregon more fully utilize its renewable electricity resources, but using EV batteries to store and deliver electricity when needed can enhance grid stability, reduce electricity costs at peak hours, or increase resiliency by allowing the batteries in EVs to act as a power source in case of an emergency grid failure.

EV Trends

According to the International Energy Agency's Global EV Outlook 2018 report, more than one million electric vehicles were sold in 2017, with more than half sold in China. Europe and the U.S. had the next highest EV sales. Overall, there were more than 3 million electric passenger cars on the world's roads at the end of 2017, with 40 percent of those in China and 25 percent each in the U.S. and Europe.

Figure 4.22: Passenger Electric Car Stock in Major Regions and the Top Ten EVI Countries[63]

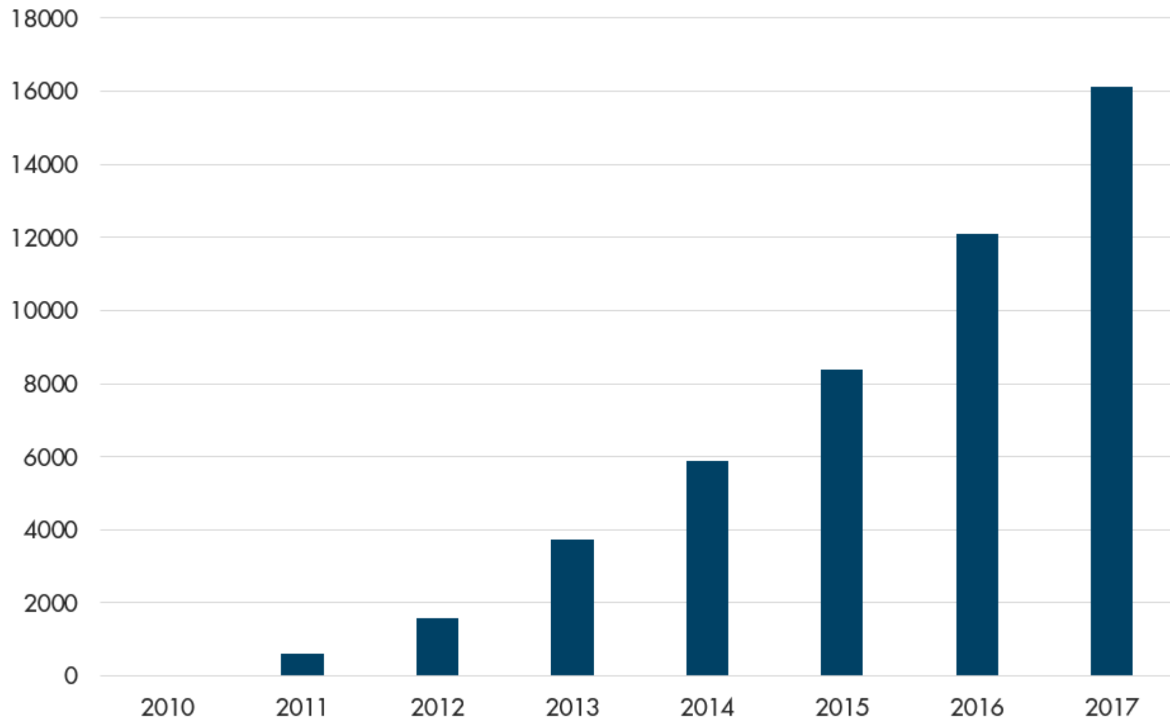


Since 2010, electric vehicles have shown steady growth, as the sales chart below from Inside EVs illustrates.

Figure 4.23: U.S. Plug-in Car Sales[64]

The Oregon Department of Transportation tracks registrations of EVs, which show similar steady growth trends in Oregon. As of June 30, 2018, Oregon had 17,893 registered electric vehicles – an over 31 percent year-over-year increase since 2014.

Figure 4.24: Cumulative Total EV Registrations by Year in Oregon[79]

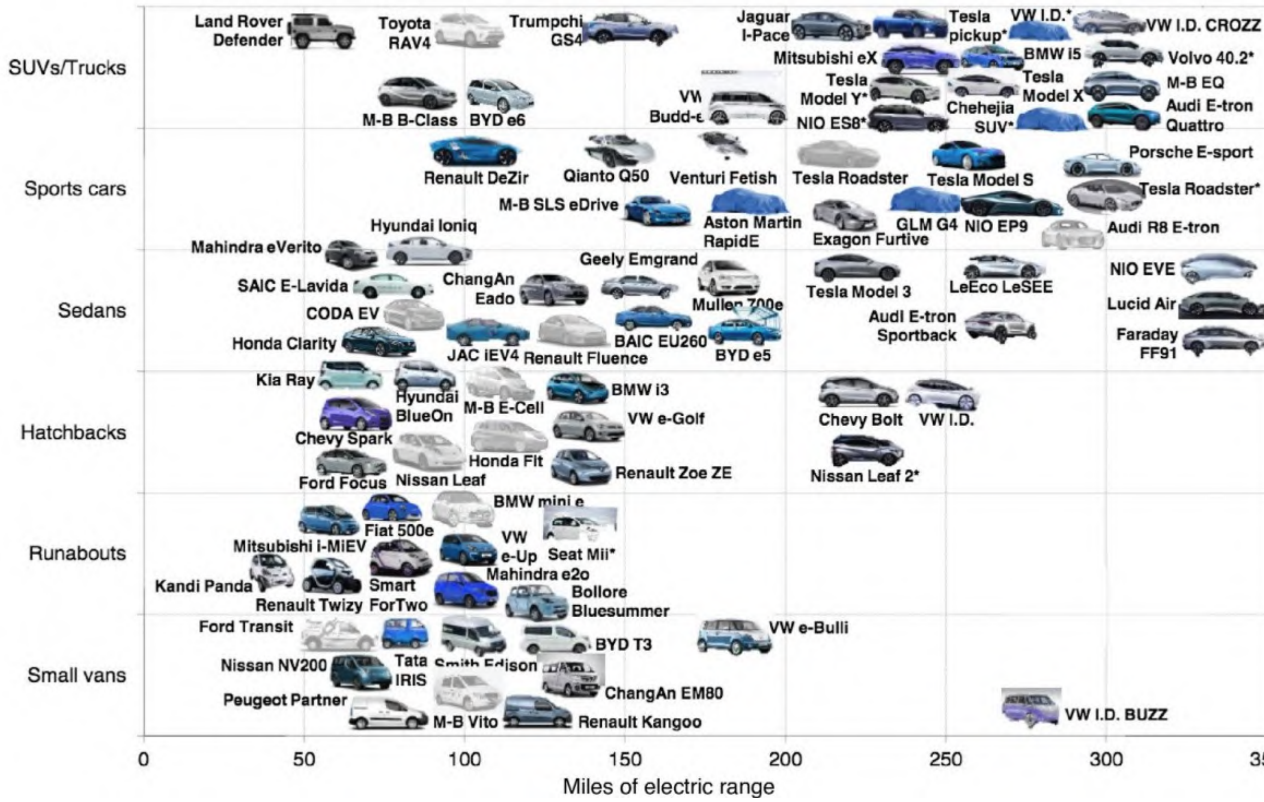


EV Model Availability

Most of the major automobile manufacturers have EV models available, and even more models are coming in the next few years. In Oregon, based on DMV registration information, the highest selling vehicles today are pickups, SUVs, and compact SUVs, which are not currently available as EV models, or are only available in the luxury vehicle segment. Many manufacturers have committed to providing these EV models in the coming years, and with them comes a new pool of potential EV adopters.

Figure 4.25 illustrates what car manufacturers have committed to producing. No vehicle manufacturer has yet committed to the production of an EV pickup truck, however. Because pickups make up one of the highest sales segment of light-duty automobiles in Oregon, the development of an EV pickup truck is vital to the state moving to a high EV adoption future. In the chart, vehicles that are grayed out are models no longer in production. Used vehicles are available.

Figure 4.25: Electric Vehicle Models by Style and Range Available Through 2020[65]

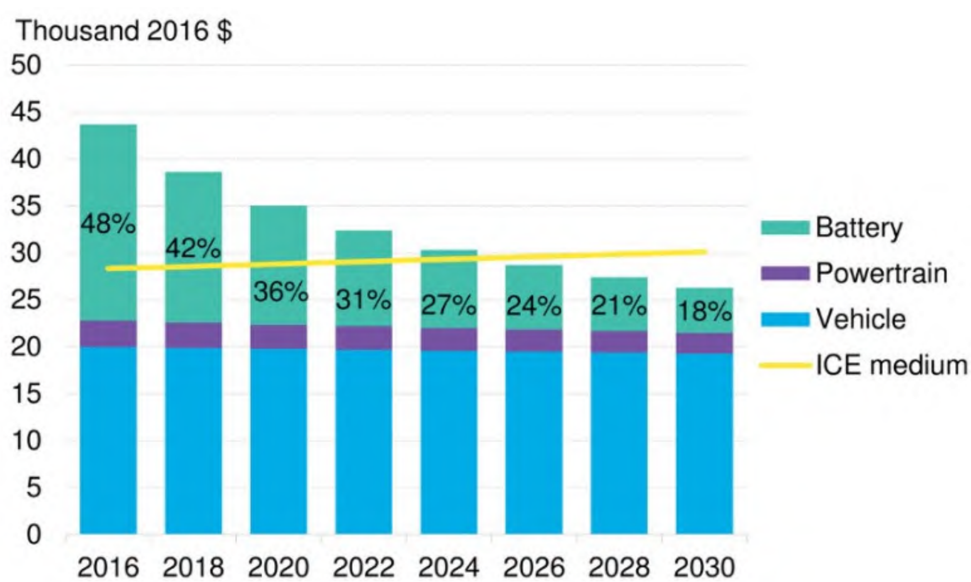


Cost Parity with ICE Vehicles

EVs today are generally more expensive than their internal combustion engine counterparts, mostly due to the cost of EV batteries. Although EV incentives can help offset the expense, the cost differential is still sufficiently high that it prices many people out of the EV market.

EV battery costs are declining. According to Bloomberg New Energy Finance, battery pack prices have gone from $1,000/kWh in 2010 to an average price of $209/kWh at the end of 2017 – a 79 percent drop in 7 years. Bloomberg estimates the price of a battery per kWh should reach $100 by 2025. $100 is the price that many in the industry point to as the parity price point, or the point at which the costs to produce ICE and electric vehicles will be the same. Beyond 2025, EVs will likely be less expensive than comparable ICE models.

Figure 4.26: Cost Parity for Battery Vehicles vs. Internal Combustion Engines[66]



Until parity is reached, incentives can be an effective tool to reduce the price gap, increase sales, and help the industry get to scale more quickly and drive the price down. For example, looking at some of the incentives discussed earlier in the chapter the cost of an EV could be reduced by more than $10,000.

Figure 4.27: Sample EV Cost After Incentives

$37,495	**Kelly Blue Book MSRP**
- $7,500	Federal Tax Credit
- $2,500	Oregon Clean Vehicle Rebate
- $300	Local Rebates*
$27,195	**Cost After Stacked Incentives**

**Could include City of Ashland Empower EV Incentive Pilot Program or Eugene Water & Electric Board Clean Ride Rebate*

All incentives are subject to eligibility requirements, such as the type of EV purchased. In addition, not everyone will be able to use all of the incentives even if they are eligible. For example, the Federal Tax Credit can only be used by individuals who have a sufficient tax liability, which could exclude many low-income individuals. Many incentives are lower for PHEVs compared to full BEVs, and some incentives are only available to the customers in a specific utility service territory. Most incentives, however, can be used together which may have the impact of making an EV purchase more financially viable.

As discussed earlier the federal tax credit phases out once manufacturers sell 200,000 vehicles, and several manufacturers have reached or are about to reach the limit. Bills to extend or broaden the tax credit have been introduced in Congress. The Electric Cars Act of 2018, sponsored by Senator Jeff Merkley of Oregon and others would extend the tax credit for 10 years. A second bill proposed by Senator Dean Heller of Nevada would lift the cap and extend the credit for four years.

EV Charging at Home

If EVs are driven the way typical conventional gasoline vehicles are driven, where 70 percent of daily driving is under 40 miles and 95 percent is under 100 miles,[67] EV charging can be completed at home, provided parking and power are readily available. Most EVs can be plugged into a standard outlet to charge, or the plug can be upgraded to a 220 V connection, enabling faster charge times. Figure 4.28 illustrates the theoretical miles of range that can be attained by an EV that averages 3.33 miles/kWh and has a battery large enough to accept the example power capacities over the time frames in the example.

Figure 4.28: Charging Times for Level 1 and Level 2 Chargers[80]

Charger Type	Power Level	Distance After One Hour Charging*	Distance After Eight Hours Charging*
Level 1	1.75 kW	5.78 Miles	46.2 Miles
Level 2	6.6 kW	21.78 Miles	174.24 Miles

**Based on an average of 3.3 miles/kWh*

There are many Oregonians, such as renters, who live in areas without dedicated parking or where parking areas lack charging capabilities, and this constitutes a significant barrier to EV adoption. About 25 percent of Oregonians live in multi-family rental housing statewide; in Portland that percentage grows to 47 percent.[68,69] Portland General Electric has committed to investigating a fueling station model for charging EVs that could be located in parts of the Portland metropolitan area that lack EV-capable parking.[41] In her Executive Order referenced earlier in this chapter, Oregon Governor Kate Brown directed the Building Codes Division of the Department of Consumer and Business Services to ensure that all newly-constructed residential and commercial buildings have parking with the electric infrastructure necessary to install a Level 2 EV charger by October 1, 2022.[40]

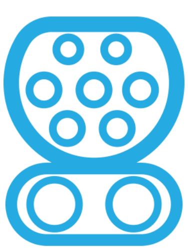
EV Charging on the Road

In addition to providing adequate charging infrastructure for people to charge at or near their homes, it is also necessary to ensure that sufficient charging infrastructure is in place for travelers who need to travel further or for longer periods of time than the battery range of their vehicle. Unlike home charging, which can generally occur overnight, chargers for extended travel need to be able to recharge a vehicle's battery in a relatively short amount of time so that the traveler can get back on the road quickly.

At the time of this publication, Oregon has 1,272 public charge points at 528 locations or stations.[70] A station can have several charge points, just as a gas station has several pumps. Because several PHEVs can only use Level 1 or 2 charging, a station may have several charge capacities including AC Level 1 and Level 2, as well as DC Fast Charging.

DC Fast Charge (DCFC) stations charge quickly. 109 stations at the 504 statewide public charging sites at the time of this report have DCFC capabilities. However, many of the DCFC stations have multi-charge ports, for a total of 242 DCFC charge points in Oregon. Over 90 percent of these are on the west side of the Cascades.

DCFCs come in three different charging standards: Tesla, CHAdeMO, and Combined Charging Standard (CCS).



Combination Plug (CCS)

CHAdeMO Plug

Tesla SC Plug

Tesla's standard works only on their vehicles. Thirteen of the DCFC stations are Tesla Supercharger sites, with eight charge ports each. The CHAdeMO standard is used primarily for Asian vehicle manufacturers' EVs, such as Nissan, Toyota, and KIA. This is currently the most common standard found in Oregon, at 87 sites. The CCS standard is used primarily by European and North American vehicle manufacturers, although Hyundai has said that a soon-to-be-released all electric model will use this standard rather than the CHAdeMO standard used on some of its earlier models. Thirty locations in the state have the CCS standard. Twenty-one locations have both the CHAdeMO and CCS standards. It is becoming common to include both of these standards at a station, and several manufacturers of charging equipment now manufacture dual-standard equipment. Electrify America has committed to installing both of these standards at all DCFC stations they build.

The rate or speed that that an EV can take on energy is limited by the charger or the EV. In the case of the EV, it is battery size that will determine charge rate; smaller batteries charge more slowly than larger batteries. The first generation of EVs typically had small batteries. Using a DCFC rated up to 50 kW, these could get about 80 miles of range in 30 minutes. Newer, larger capacity batteries allow for much faster charging times. Because of how large capacity batteries are designed, they can be charged quickly, up to 80 percent of the total charge. Additional charging beyond this is tapered or slowed.

The chargers themselves are rated by how much current they can supply. The larger the kW on the charger, the faster it can charge. However, there are also limits depending on the cell's chemistry as to how much current can be applied. Individual batteries may have a limit on the amount of current they can accept. Currently, only the Tesla Supercharger network has chargers over 100 kW in Oregon. Like many other aspects of EVs, this is rapidly changing as Electrify America, PGE, and Pacific Power all plan to install higher powered chargers in the near future. In the next few years, charge rates for vehicles will increase, batteries will be larger, and charge time will decrease dramatically as the theoretical Table 4.4 illustrates.

Table 4.4: Miles Per Charging Rate and Time for DCFC, For EV Going 3.57 Miles per KWh[80]

DCFC (kW)	Miles / Min	Miles / 15 Min	Miles / 30 Min
24	1.43	21.42	42.84
50	2.98	44.63	89.25
80	4.76	71.40	142.8
100	5.95	89.25	178.5
150	8.93	133.88	267.75
300	17.85	267.75	535.5*
350	20.83	312.38	624.75*

*Charges for 300 and 350 kW would require large batteries to charge for 30 minutes, such as those in heavy-duty vehicles.

At this time, there are eight private networks offering EV charging services in the state. Each network has its own payment model and typically offers a monthly subscription plan or one-time payment. Costs can vary widely and can be dependent on what subscription service is used. Standardizing EV chargers and their transactions would simplify public charging and support increased EV adoption.

Barriers to EV Adoption

Key barriers to EV adoption include cost, lack of access, and consumers with limited knowledge about this new technology. Incentives can help reduce the initial cost of purchasing the vehicle, as has been discussed in this chapter. In order to make EVs a viable option for Oregonians who are not able to charge at home, state and private investment in public charging infrastructure may be necessary. In rural Oregon, where consumers may have to drive longer distances, this public charging infrastructure along highways and in rural towns is critical.

A companion to incentives and building out a charging network in Oregon is outreach and education. Oregonians have questions about how these vehicles work, whether they will meet their travel needs, and what incentives and support are available to them as they consider purchasing an EV. The state has taken on this education role in response to Governor Brown's executive order on electric vehicles discussed earlier this chapter, using tools such as social media, stakeholder outreach, and a joint website.

GO ELECTRIC OREGON

In 2018, a collaborative of State of Oregon agencies launched ***Go Electric Oregon***, a website dedicated to helping Oregon achieve our goal of 50,000 registered EVs on our roads by the end of 2020.

In addition to details about Governor Brown's EO 17-21, the website shares details about buying EVs, charging at home and on the go, incentives, and more.

goelectric.oregon.gov

CONCLUSIONS

Transitioning to a **cleaner, more fuel efficient transportation system** will involve increasing vehicle efficiency, switching to alternative fuels, and reducing vehicle miles traveled. In the Statewide Transportation Strategy, developed by ODOT and informed by DLCD, DEQ, and ODOE, as well as an advisory committee, the state has articulated a long-term vision for reducing transportation-related greenhouse gas emissions that identifies several specific strategies to achieve that vision. ODOT has taken a first step in implementing several activities that fall under their purview. In order to realize significant reductions in this sector all the strategies in the STS need to be implemented. Many of the remaining strategies require engagement and cooperation among state agencies. Development of a clear plan to coordinate the activities of all state agencies, along with strategic engagement with stakeholders, is necessary to implement the remaining activities in the STS.

Implementation of the STS as well as other policies and programs that support **reducing fuel use and emissions in the transportation sector** requires measuring results and the development of key metrics to assess program success. There are challenges in directly measuring GHG emissions or even fuel reductions for many programs that do not have easily measurable activities, such as increasing the amount of biking pathways in a community. Additionally, many strategies to reduce fuel usage are highly dependent on the transportation needs and activities in different regions of the state. There are currently few tools available to collect localized data on vehicle model, vehicle age, vehicle sales, fuel consumption, and vehicle miles traveled. Strategies may need to be specifically designed to accommodate regional differences in Oregon. This information can be used to develop GHG reduction policies or programs designed to target and address the unique needs in different areas in the state.

The state is not on track to achieve the state's GHG emissions reduction goals for 2020, largely due to increases in emissions from the transportation sector. **EV adoption is a key strategy** for the state to reduce GHG emissions from the light-duty transportation sector, which is the largest contributor of GHG emissions. Not only does the initial change to electricity reduce emissions from the tailpipe of the vehicles, but the GHG **benefits to Oregon** of electrifying the transportation sector will continue to grow as the electric grid becomes cleaner.

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