# Nevada Clean Trucks Program

An Analysis of the Impacts of Zero-Emission Medium- and Heavy-Duty Trucks on the Environment, Public Health, Industry, and the Economy

ERM

# Acknowledgments

Lead Authors: David Seamonds, Ellen Robo, Sophie Tolomiczenko, and Miranda Freeman.

This report was developed by ERM for the Natural Resources Defense Council and the Union of Concerned Scientists.

## About ERM, formerly M.J. Bradley & Associates

ERM partners with the world's leading organizations, creating innovative solutions to sustainability challenges, and unlocking commercial opportunities that meet the needs of today while preserving opportunity for future generations. Our diverse team of world-class experts supports clients across the breadth of their organizations to operationalize sustainability, underpinned by our deep technical expertise in addressing their environmental, health, safety, risk, and social issues. M.J. Bradley & Associates (MJB&A) was acquired by ERM Group company in 2022. For more information we encourage you to visit our website, www.erm.com or www.sustainability.com.

© ERM Group company, 2022

### For questions or comments, please contact:

Dave Seamonds
*Principal Consultant*
ERM
dave.seamonds@erm.com

Patricio Portillo
*Senior Advocate*
*Climate & Clean Energy*
Natural Resources Defense Council
pportillo@nrdc.org

Sam Wilson
*Senior Vehicles Analyst*
Union of Concerned Scientists
swilson@ucsusa.org

Katherine Stainken
*Senior Director, EV Policy*
Electrification Coalition
kstainken@electrificationcoalition.org

This report is available at ERM.com.

# Contents


# Introduction

ERM was commissioned by the Electrification Coalition, the Natural Resources Defense Council and the Union of Concerned Scientists to evaluate the costs and benefits of state-level requirements for manufacturers that Nevada could adopt to increase sales of no- and low-emission medium- and heavy-duty (M/HD) trucks and buses. The analysis examines all on-road vehicles registered in Nevada with greater than 8,501 pounds gross vehicle weight, encompassing vehicle weight classes from Class 2b though Class 8. This is a diverse set of mostly commercial vehicles that includes heavy-duty pickups; school and shuttle buses; sanitation, construction, and other types of work trucks; and freight trucks ranging from local delivery vans to tractor-trailers that weigh up to 80,000 pounds when loaded.

Collectively the Nevada M/HD fleet includes 161,200 vehicles that annually travel more than 3.1 billion miles and consume almost 352 million gallons of petroleum-based fuels.

In Nevada, M/HD vehicles are currently responsible for a disproportionate amount of pollution from on-road vehicles. Despite making up only 7 percent of the on-road fleet, M/HD vehicles emit estimated 4.1 million metric tons (MMT) of greenhouse gas (GHG) emissions annually—approximately 27 percent of all GHGs from the on-road vehicle fleet.[1] In Nevada M/HD vehicles are also responsible for 57 percent of the nitrogen oxide (NOx) and 50 percent of the fine particulates (PM)[2] emitted by on-road vehicles, both of which contribute to poor air quality and resulting negative health impacts in many urban areas, including low-income and communities of color that are often disproportionately affected by emissions from freight movement due to their proximity to transportation infrastructure.

1 The remainder of emissions are from passenger cars and light trucks. This includes tailpipe emissions and "upstream" emissions from fuel production and transport.

2 In this report all references to PM are particulate matter with mean aerodynamic diameter less than 2.5 microns ($PM_{2.5}$).

Prior work by ERM (2020) conducted in consultation with the New Jersey Environmental Justice Alliance and members of the Coalition for Healthy Ports NY NJ demonstrated that emissions from diesel trucks and buses produce higher levels of air pollution compared to other types of transportation, which can lead to greater health concerns in populations exposed to diesel emissions.[3] Communities located adjacent to goods-movement infrastructure (e.g., warehouses, intermodal terminals, logistics centers, rail yards, etc.) experience higher levels of truck traffic, both from surrounding thruways and on local streets, which exacerbates negative health outcomes. Since these emissions are local in their effects, policies to reduce transportation emissions from medium- and heavy-duty vehicles can improve the health and well-being of communities in urban areas or around transportation corridors, which are often home to people of color, low income, or those who are otherwise vulnerable or disadvantaged. But to ensure reductions in those communities, program requirements on truck manufacturers, such as a Federal Advanced Clean Truck Rule discussed below, would need to be accompanied by additional policies designed specifically with these communities in mind.

For the study of Nevada, ERM modeled three Clean Truck policy scenarios with increasing levels of ambition. Under the least aggressive scenario—adoption of California's Advanced Clean Truck (ACT) rule (allowable under the Clean Air Act)—estimated cumulative net societal benefits total almost $4.4 billion (in constant 2020$) through 2050, compared with the baseline scenario.[4] These net societal benefits include the monetized value of climate and public health benefits resulting from reduced GHG, NOx, and PM emissions in the state, including up to 32 fewer premature deaths and 25 fewer hospital visits from breathing polluted air through 2050. Net societal benefits also include net cost savings to fleets from operating zero-emission trucks, and savings to all residential and commercial electricity customers due to lower electric rates made possible by the additional electricity sales for electric vehicle charging. Under the ACT scenario, by 2050 annual cost savings for Nevada fleets are estimated to be $354 million, and annual bill savings for electric utility customers in the state could reach an estimated $5.0 million.[5]

The most aggressive policy scenario (100 x 40 ZEV + Clean Grid, discussed below) results in turnover of virtually the entire Nevada M/HD fleet to zero-emission vehicles (ZEVs) by 2050, together with a shift to cleaner electricity generation sources. Cumulative net societal benefits through 2050 increase to more than $9.6 billion under this scenario, and there will be an estimated 98 fewer premature deaths and 71 fewer hospital visits. In 2050 estimated annual fleet cost savings also increase, to $642 million, and electric customer annual bill savings increase to an estimated $9.3 million.

Implementing the modeled scenarios will hasten ongoing changes in the national economy, such as shifting from manufacturing internal combustion engine vehicles to manufacturing electric and fuel cell vehicles and increasing the production and sale of electricity and hydrogen production instead of petroleum fuels. This analysis indicates that this transition will have positive macroeconomic effects, including increased net jobs and gross domestic product (GDP), as well as increased wages for the new jobs that will be added, relative to the jobs that will be replaced.

Compared with the baseline scenario, net national job gains under the most aggressive policy scenario total 189 in 2035. This will be accompanied by a $46 million increase in 2035 GDP. By 2045, there is a net job and GDP loss due to total fleet fuel and maintenance cost savings. Average wages for the new jobs created under the ZEV transition are expected to be, on average, almost twice as high as average wages for the jobs that will be replaced.

3 Allen, Paul et al. *Newark Community Impacts of Mobile Source Emissions: A Community-Based Participatory Research Analysis. M.J. Bradley & Associates*. November 2020. http://www.njeja.org/wp-content/uploads/2021/04/NewarkCommunityImpacts_MJBA.pdf.

4 All values cited in this report are in constant 2020$, unless otherwise stated.

5 The modeling tools used for this analysis could not apportion these estimated benefits to individual communities within Nevada.

# Policy Scenarios

This report summarizes the projected environmental and economic effects of Nevada adopting policies requiring manufacturers to sell a greater number of M/HD low- and no-emission vehicles over the next 30 years. Three specific Clean Truck policy scenarios, representing increasing levels of ambition, were evaluated.

- **ACT Rule:** Nevada adopts requirements analogous to those adopted by California under the Advanced Clean Trucks Rule, which requires an increasing percentage of new trucks purchased in the state to be ZEVs beginning in the 2026 model year. The percentage of new vehicles that must be ZEV varies by vehicle type, but for all vehicle types the required ZEV percentage increases each model year between 2026 and 2035 (see Figure 1).

- **ACT Rule plus NOx Omnibus Rule:** In addition to adopting the ACT Rule, Nevada adopts requirements analogous to those adopted by California under the Heavy-Duty Omnibus Rule (referred to herein as the NOx Omnibus Rule). This rule requires an additional 75 percent reduction in nitrogen oxide (NOx) emissions from the engines in new gasoline and diesel trucks sold between model year 2025 and 2026, and a 90 percent reduction for trucks sold beginning in the 2027 model year.[6]

- **100 x 40 ZEV + Clean Grid:** In addition to adopting the ACT and NOx Omnibus Rules, Nevada takes further actions to ensure more rapid and continued increases in new ZEV sales, such that virtually all new trucks are ZEV by 2040 (see Figure 1), with Class 2b–3 achieving 100 percent ZEV sales in 2038 and Class 4–8 (non-tractors) achieving 100 percent ZEV sales in 2035. In addition, an aggressive federal Clean Energy Standard is assumed to ensure that electricity generation in the state is carbon free and over 90% renewable by 2050. State-specific, renewable portfolio standards that could increase the renewable electricity levels even more were not analyzed as part of this study.

All three of these Nevada policy scenarios are compared with a baseline "business as usual" scenario in which all new trucks sold in the state continue to meet existing EPA NOx emission standards and ZEV sales increase only marginally, never reaching more than 1 percent of new vehicle sales each year.[7]

The analysis assumes that M/HD annual vehicle miles traveled (VMT) in Nevada will continue to grow by approximately 1.2 percent annually through 2050, as projected by the Energy Information Administration (EIA), as the economy and population continue to grow. The modeled policy scenarios do not include freight system enhancements or mode shifting to slow the growth of, or reduce, M/HD truck miles; this would be expected to provide additional emission reductions.

The analysis was conducted using ERM's STate Emission Pathways (STEP) Tool. The climate and air quality impacts of each policy scenario were estimated on the basis of changes in M/HD fleet fuel use and include both tailpipe emissions and "upstream" emissions from production of the transportation fuels used in each scenario. These include petroleum fuels used by conventional internal combustion engine vehicles (gasoline, diesel, natural gas) and electricity and hydrogen used by ZEVs, which are assumed to include both battery electric (EV) and hydrogen fuel cell electric (FCV) vehicles.

6 Reductions are relative to current federal EPA new engine emission standards. This rule does not require additional PM reductions but includes anti-backsliding provisions to ensure that PM emissions do not increase compared with engines designed to meet current federal standards.

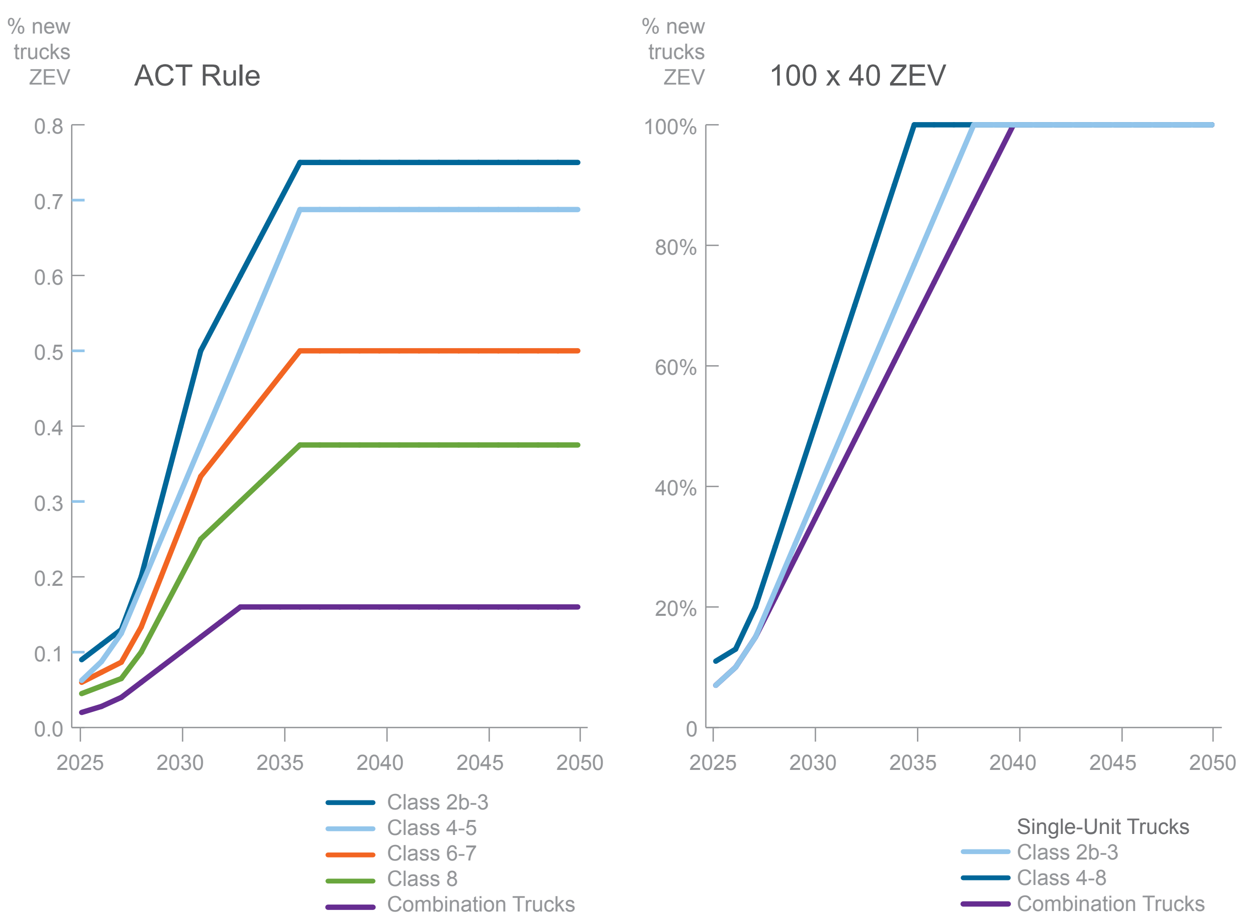
7 The baseline ZEV sales assumptions are consistent with projections in the Energy Information Administration's Annual Energy Outlook 2021.

To evaluate climate impacts, the analysis estimated changes in all combustion related GHGs, including carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). To evaluate air quality impacts, the analysis estimated changes in total nitrogen oxide (NOx) and particulate matter (PM) emissions and resulting changes in ambient air quality and health metrics such as premature deaths, hospital visits, and lost workdays.

The economic analysis estimated the change in annual M/HD fleet-wide spending on vehicle purchase, charging/fueling infrastructure to support ZEVs, vehicle fuel, and vehicle and infrastructure maintenance under each scenario. Currently ZEVs are more expensive to purchase than equivalent gasoline and diesel vehicles, but they have lower fuel and maintenance costs. Over time the incremental purchase cost of ZEVs is also projected to fall. Technologies required to meet the more stringent NOx standards of the NOx Omnibus Rule are also projected to increase purchase costs for compliant vehicles.

On the basis of estimated changes in fleet spending, the analysis estimated the macroeconomic effects of each scenario on national jobs, wages, and gross domestic product (GDP).

Figure 1 Annual Zero-Emission Vehicle Sales in Clean Truck Policy Scenarios



The analysis also estimated the impact of each scenario on Nevada's electric utilities, including the total state change in power demand (kW) and energy consumption (kWh) for M/HD EV charging, as well as the additional revenue and net revenue that would be received by the state's electric utilities for providing this power. On the basis of projected utility net revenue, the analysis estimates the potential effect on state electricity rates for residential and commercial customers.

In addition, the analysis estimated the total number of vehicle chargers that will be required to support the increase in M/HD EVs under each scenario—both depot-based chargers and shared public chargers—compared with the existing charging network in the state.

For a full description of the modeling approach and sources of assumptions used for this analysis, see the report: *Clean Trucks Analysis: Costs & Benefits of State-Level Policies to Require No- and Low-Emission Trucks, Technical Report—Methodologies and Assumptions*, May 2021.[8]

The Nevada electric grid mix and energy cost assumptions used can also be found in the Appendix to this report.

8 MJB&A. "Clean Trucks Analysis: Costs & Benefits of State-Level Policies to Require No- and Low-Emission Trucks, Technical Report—Methodologies and Assumptions." May 2021. https://www.mjbradley.com/reports/clean-trucks-analysis-costs-benefits-state-level-policies-require-no-and-low-emission-trucks.

# Nevada Results

The sections below detail the results of the Nevada Clean Trucks analysis, beginning with a description of the current Nevada M/HDV fleet and the projected fleet under each modeled policy scenario. This is followed by a summary of the environmental and public health benefits of each scenario and the economic impacts of the modeled fleet transitions.

## Nevada M/HD Vehicle Fleet

Table 1 summarizes the current M/HD fleet in Nevada, broken down by the four major vehicle types used to frame the Clean Trucks analysis.

Table 1 Current Nevada M/HD Fleet

| Vehicle Type | | No. of Vehicles | Annual VMT (billion miles) | Annual Fuel (million gallons) |
|---|---|---|---|---|
| **Heavy-Duty Pickup and Van**<br>**Class 2b** |  | 77,295 | 0.87 | 46.5 |
| **Bus**<br>**Class 3–8** |  | 11,176 | 0.20 | 25.4 |
| **Single-Unit Work and Freight Truck**<br>**Class 3–8** |  | 49,455 | 0.61 | 75.0 |
| **Combination Truck**<br>**Class 7–8** |  | 23,249 | 1.39 | 204.8 |
| **TOTAL** | | **161,175** | **3.07** | **351.7** |

Approximately 48 percent of the in-use M/HD fleet are Class 2b vehicles (8,500–10,000 in gross vehicle weight rating, GVWR), which are mostly heavy-duty pickup trucks and vans.[9] These vehicles account for 28 percent of annual M/HD miles and 13 percent of annual fuel use. Approximately 7 percent of the fleet are buses, which account for 7 percent of annual VMT and 7 percent of annual fuel use. This includes relatively small shuttle buses (class 3–5) as well as school buses, transit buses, and intercity/charter coach buses.[10] Thirty-one percent of the fleet are single-unit freight and work trucks, which account for 20 percent of annual VMT and 21 percent of annual fuel use. These vehicles come in a wide variety of sizes (Class 3–8) and have a wide variety of uses, from vans and box trucks used to deliver freight, to sanitation and construction trucks, to boom-equipped utility trucks. Only 14 percent of the fleet are combination truck-tractors, but these vehicles account for 45 percent of annual VMT and 58 percent of annual fuel use, since approximately two-thirds of these vehicles are used primarily for long-distance freight hauling and typically log many more daily and annual miles than other M/HD vehicles.

Today less than 1 percent of the national M/HD fleet is powered by electricity or alternative fuels (natural gas and propane). Approximately 64 percent of the fleet have diesel engines and 36 percent use gasoline.[11] The largest Class 7 and 8 vehicles are almost all diesel, while almost 50 percent of the smaller Class 2b–5 trucks have gasoline engines, with most of the remainder diesel.

Figure 2 summarizes the modeled turnover of the Nevada in-use fleet to zero-emission and low-NOx trucks under the three Clean Truck policy scenarios. Fleet turnover to new trucks is based on historical average turnover rates and projected fleet growth rates, along with the new vehicle ZEV purchase percentages shown in Figure 1. Approximately 6.1 percent of existing Class 2b trucks and 4.7 percent of Class 3–8 trucks and buses are retired each year and replaced with new vehicles.[12] The ACT + NOx Omnibus scenario and the 100 x 40 ZEV + Clean Grid scenario further assume that all new vehicles purchased in 2024 and later years that are not ZEV will have low-NOx engines compliant with the NOx Omnibus standards.

As shown, under the ACT Rule policy scenario, 38 percent of the in-use M/HD fleet will turn over to ZEV by 2040, and 61 percent are ZEV by 2050; all of these ZEVs are assumed to be electric vehicles. Under the ACT + NOx Omnibus policy scenario, the same percentage of the fleet turns over to ZEV, but the remaining internal combustion engine vehicles in the fleet turn over to low-NOx engines by 2043. Under the 100 x 40 ZEV + Clean Grid policy scenario, 57 percent of the in-use fleet turns over to ZEV by 2040 and 97 percent do so by 2050. This scenario assumes that new ZEVs will include both EV and fuel cell vehicles powered by hydrogen. In 2050, 6 percent of in-use ZEVs are assumed to be FCV and 9 percent are EV.

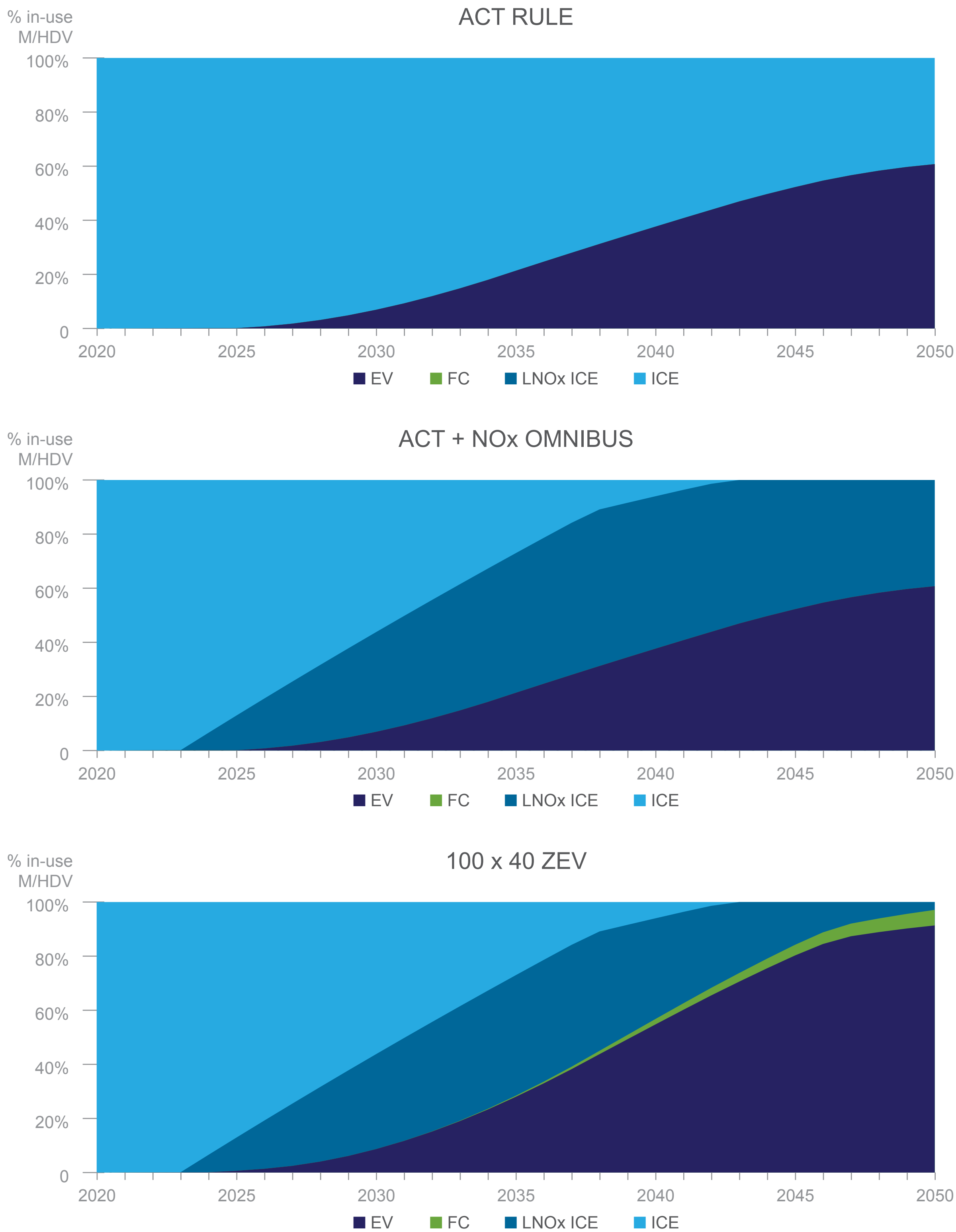
9 A very small percentage of these vehicles are large SUVs.

10 Note that the ACT Rule does not include ZEV requirements for transit buses, as these vehicles are covered by a separate Innovative Clean Transit regulation in California.

11 These figures are based on state registration data collected by IHS Markit.

12 This is a long-term average. Actual annual turnover is highly correlated to economic conditions and can vary widely from year to year.

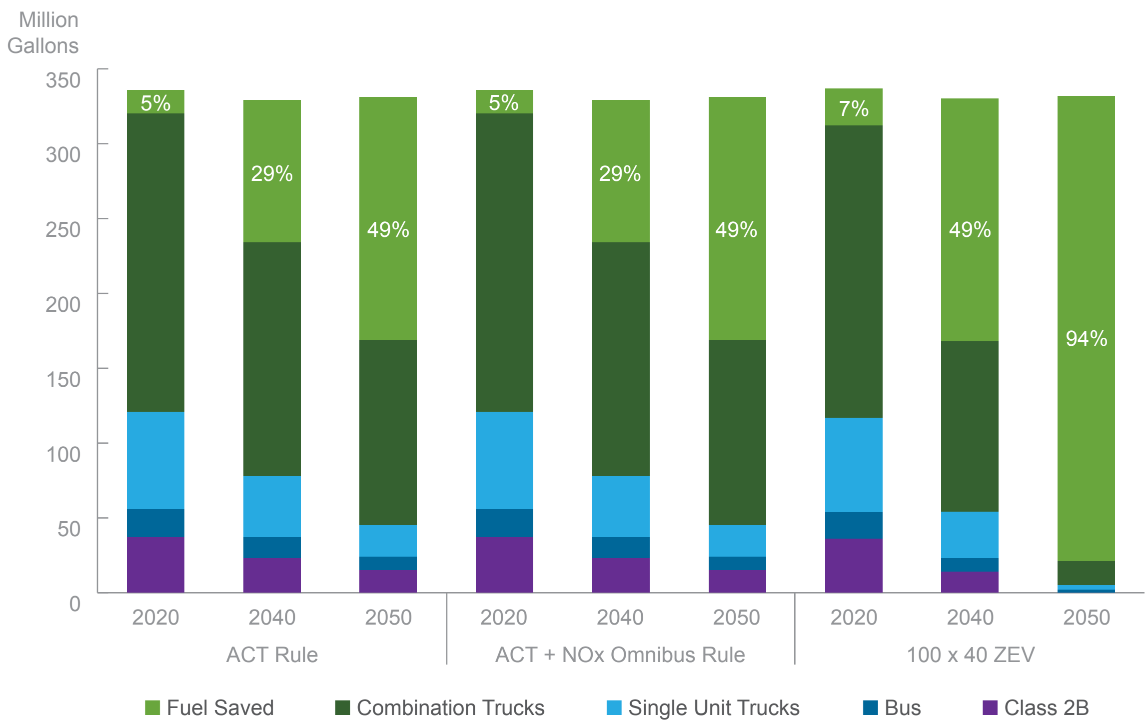
Figure 2 Fleet Turnover to Low-NOx and Zero-Emission Vehicles in Clean Truck Policy Scenarios



## Changes in Fleet Fuel Use

Under all modeled Clean Truck policy scenarios, a significant portion of the Nevada M/HD fleet is assumed to turn over to EV and FCV trucks and buses. This will result in replacement of petroleum fuels—primarily gasoline and diesel fuel—with electricity and hydrogen.[13] Moving away from fossil fuels, such as diesel and gasoline, means less reliance on oil—a commodity priced on a global market that is extremely volatile in price—in favor of regionally produced and more stably priced grid electricity or hydrogen.

Figure 3 Petroleum-Based Fuel Use for Each Clean Truck Policy Scenario




As shown in Figure 3, total petroleum fuel use by the Nevada M/HD fleet in 2050 is projected to be 337 million gallons. Under the ACT Rule policy scenario, petroleum fuel use in 2050 falls to an estimated 172 million gallons (–49 percent), and cumulative reductions in diesel and gasoline use by the M/HD fleet total 2.0 billion gallons between 2020 and 2050. This petroleum fuel is replaced by 35.6 million megawatt-hours (MWh) of electricity between 2020 and 2050. Electricity use for M/HD EV charging in 2050 is estimated to be 3.1 million MWh, a 9 percent increase to estimated baseline electricity use by Nevada residential and commercial customers that year (34.6 million MWh).

Adding the NOx Omnibus Rule to the ACT Rule does not result in additional reductions in petroleum fuel use.

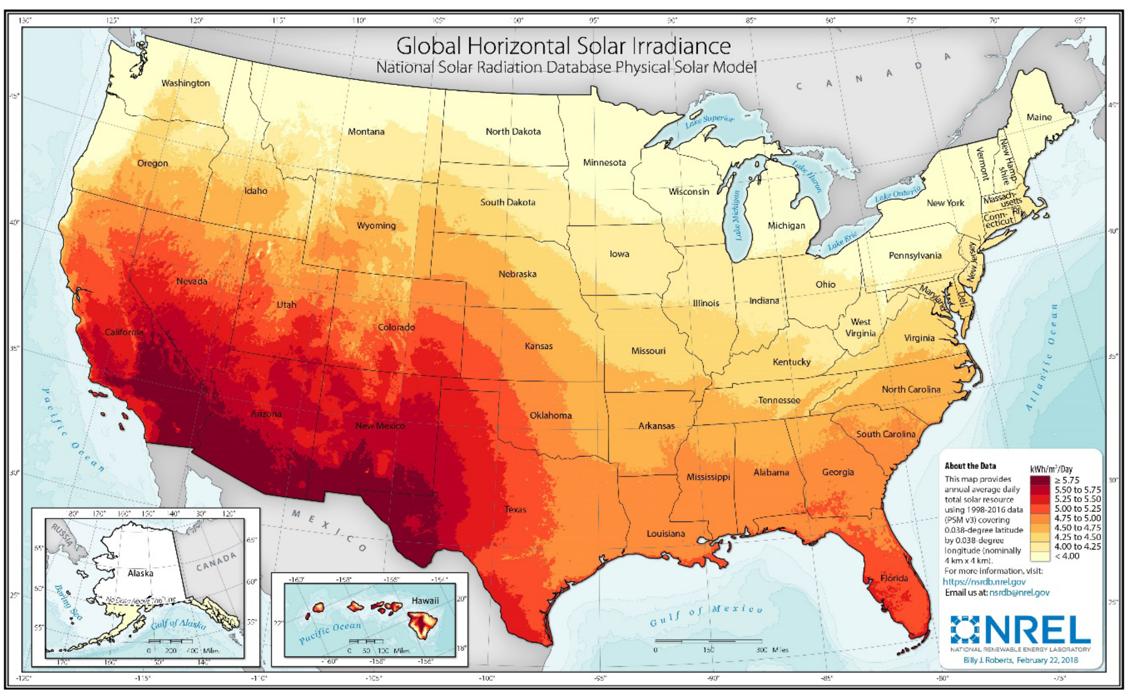
13 A small number of M/HD trucks and buses in Nevada currently use natural gas.

Under the 100 x 40 ZEV + Clean Grid scenario, estimated petroleum fuel use by the M/HD fleet in 2050 falls to 21 million gallons (–94 percent), and cumulative reductions in diesel and gasoline use by the M/HD fleet total 3.6 billion gallons between 2020 and 2050. This petroleum fuel is replaced by 53.9 million MWh of electricity and 550 million kilograms of hydrogen between 2020 and 2050. Electricity use for M/HD EV charging in 2050 is estimated to be 4.8 million MWh, a 14 percent increase to estimated baseline electricity use by Nevada residential and commercial customers that year. To put this into perspective, from 2010 to 2020 alone, Nevada saw a 13 percent increase in demand.[14]

## *Solar Power Generation Opportunities*

As petroleum use decreases with rising ZEV adoption, the electricity demand within Nevada will increase. To maximize the climate and health benefits of ZEVs, it is important to meet the ZEV electricity required with zero-emitting generation. Nevada is well situated to be a major solar energy producer in the U.S. - already, the number of solar power plants in Nevada have been growing rapidly over the past 10 years. Nevada's climate conditions, specifically the large desert landscape, dry climate, and low cloud cover, make the state well-suited for solar power. Using generating capacity and electricity generation data from EIA, Nevada ranked 5th in the country for solar generating capacity (2,520 MW) and solar electricity generation (5.53 million MWh). By 2025, the EIA estimates that the planned solar generating capacity of Nevada will increase by 1,830 MWs reaching an estimated 4,397 MW generating capacity.

**Figure 4** Global Horizontal Solar Irradiance of the United States




14 U.S. Energy Information Administration. "Table CT3. Total End-Use Energy Consumption Estimates, 1960-2020, Nevada." https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/tx/use_tx_NV.html&sid=NV.

The National Renewable Energy Laboratory's (NREL's) National Solar Radiation Database (NSRDB) uses hourly meteorological data including cloud properties, water content, aerosols, and surface reflectivity to estimate the amount of solar energy historically available at any given point and location in the U.S. Figure 4 shows the average annual global horizontal solar irradiance (GHI) in the United States modeled for 1998-2016. The higher the GHI, the larger amount of solar energy that can be converted into electricity. As seen in Figure 4, the U.S. southwest, including Nevada, has a particularly high GHI making it ideal for solar power production. Nevada has a GHI ranging between 4.25-5.75 kWh/$m^2$/day with much of the state over 5 kWh/$m^2$/day. As a comparison, all of New York has a GHI below 4 kWh/$m^2$/day.

From this data, NREL also calculated the likely annual average capacity factor that could be achieved by a utility-scale solar plant based on its location.[15] NREL's capacity factor represents a long-term average over the lifetime of the solar power plant. Nevada's potential capacity factor for solar ranges between 24.6 and 31.8 percent with the majority of the state above 26.8 percent.[16] Once again, as a comparison, all of New York has a capacity factor below 23.6 percent. While the differences may seem small, a solar plant with a 31 percent capacity factor will produce one-third more electricity than a solar plant with a 23 percent capacity factor. This significantly lowers the levelized cost of solar energy in locations like Nevada.

## Petroleum Production, Consumption, and Distribution in Nevada

As of March 2022, Nevada produces, on average, approximately one thousand barrels of crude oil per day, which ranks 26$^{th}$ among all US states.[17] Nevada consumes about 48 million barrels of fossil-based petroleum fuels per year, ranking 35$^{th}$ out of all US states.[18] The majority of this consumption is for transportation (85%), with the remainder being used for power generation, industrial, residential, or commercial use.

Since much of Nevada's consumption comes from outside of the state's production capability, pipelines are used to bring fuels into the state. Nevada's petroleum infrastructure consists of three pipelines with supply coming from Northern and Southern California, and a small portion coming from Utah. These pipelines supply most of Nevada's petroleum usage, approximately 230,000 barrels per day on average. The majority of this petroleum is imported from Southern California. Most fuel manufactured and consumed within the West Coast comes from its own supplies, making the area principally self-sufficient. However, because oil is a globally priced commodity, such self-sufficiency will do little to insulate Nevada from the price volatility that occurs due to events beyond U.S. borders.

Figure 5 illustrates the interconnection of pipelines within the West Coast including fuel flowing into Nevada.[19]

15 NREL. "Utility-Scale PV." https://atb.nrel.gov/electricity/2022/utility-scale_pv. Sengupta, M., Y. Xie, A. Lopez, A. Habte, G. Maclaurin, and J. Shelby. 2018. "The National Solar Radiation Data Base (NSRDB)." Renewable and Sustainable Energy Reviews 89 (June): 51-60.

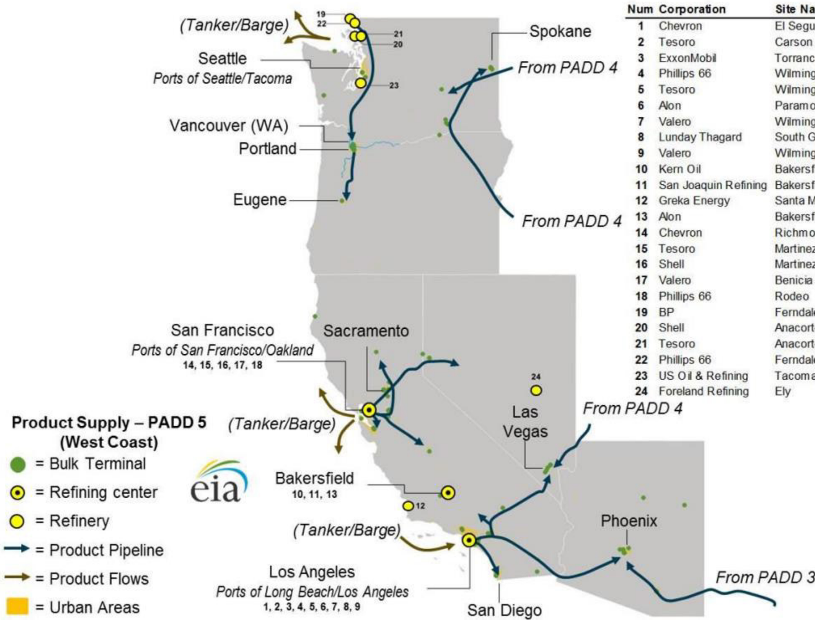
16 NREL. "Utility-Scale PV". https://atb.nrel.gov/electricity/2022/utility-scale_pv.

17 US Energy Information Administration. Rankings: "Crude Oil Production, March 2022 (thousand barrels per day)." Mar 2022. https://www.eia.gov/state/rankings/?sid=US#/series/46.

18 US Energy Information Administration. "Table F16: Total Petroleum Consumption Estimates, 2020." 2020. https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_pa.html&sid=US.

19 Cambridge Systematics, Inc. "HazMat Analysis: Petroleum Supply Chain Nevada Hazardous Commodity Flow Study." *Nevada Department of Transportation*, Mar 2019. https://www.dot.nv.gov/home/showdocument?id=16424#:~:text=2.,oils%20from%20locally%20sourced%20crude.

**Figure 5** West Coast Refineries and Petroleum Product Distribution




| Num | Corporation | Site Name | Capacity (b/cd) |
|---|---|---|---|
| 1 | Chevron | El Segundo | 269,000 |
| 2 | Tesoro | Carson | 251,000 |
| 3 | ExxonMobil | Torrance | 149,500 |
| 4 | Phillips 66 | Wilmington | 139,000 |
| 5 | Tesoro | Wilmington | 104,500 |
| 6 | Alon | Paramount | Idle |
| 7 | Valero | Wilmington | 78,000 |
| 8 | Lunday Thagard | South Gate | 8,500 |
| 9 | Valero | Wilmington (asphalt) | 6,300 |
| 10 | Kern Oil | Bakersfield | 26,000 |
| 11 | San Joaquin Refining | Bakersfield | 15,000 |
| 12 | Greka Energy | Santa Maria | 9,500 |
| 13 | Alon | Bakersfield | No CDU |
| 14 | Chevron | Richmond | 245,271 |
| 15 | Tesoro | Martinez | 166,000 |
| 16 | Shell | Martinez | 156,400 |
| 17 | Valero | Benicia | 132,000 |
| 18 | Phillips 66 | Rodeo | 120,200 |
| 19 | BP | Ferndale | 225,000 |
| 20 | Shell | Anacortes | 145,000 |
| 21 | Tesoro | Anacortes | 120,000 |
| 22 | Phillips 66 | Ferndale | 101,000 |
| 23 | US Oil & Refining | Tacoma | 40,700 |
| 24 | Foreland Refining | Ely | 2,000 |

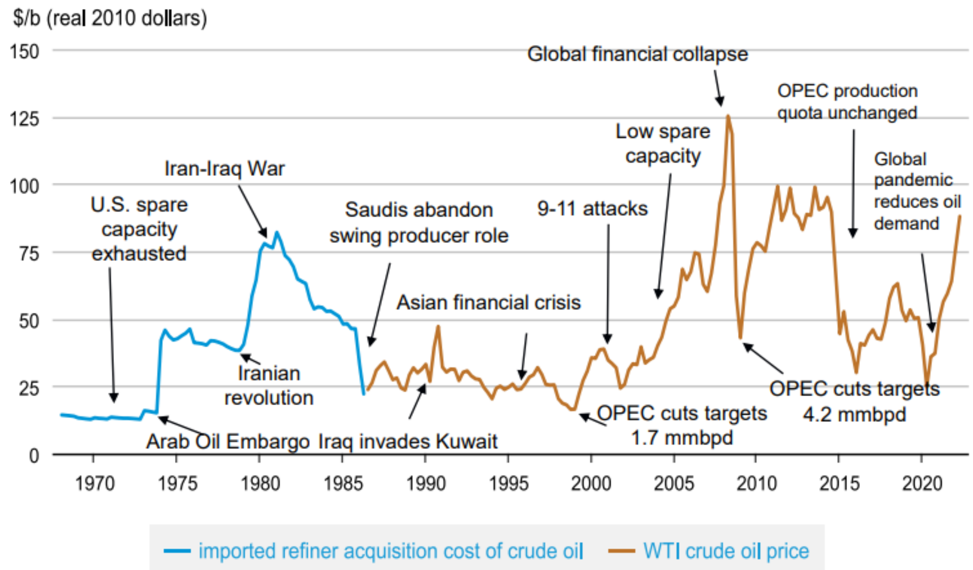
*Source:* "HazMat Analysis: Petroleum Supply Chain Nevada Hazardous Commodity Flow Study," p 2-4, March 2019

## *Economic and National Security Impacts of Oil Dependence*

By increasing the population of M/HD ZEVs, the United States can reduce its dependence on oil and enhance its energy security. One of the U.S.'s main energy security vulnerabilities are its reliance on a single fuel source, crude oil, to power 90 percent of the transportation sector.[20] Oil prices are heavily influenced by events that disrupt the flow of oil to the market, including geopolitical, economic, and extreme weather events, as shown in Figure 6. When coupled with the inelasticity of oil demand in the short-term, this can lead to higher volatility in prices that significantly impact both consumers and producers. Additionally, most of the world's crude oil reserves are located in regions that have been prone to instability or have had their oil production repeatedly disrupted due to political events. The oversized importance of oil in the world economy hinders the ability of countries, including the U.S., to conduct effective foreign policy. Recent events such as the Russian-Ukraine conflict have produced supply and demand imbalances and spikes in oil prices, illustrating the economic and energy security ramifications of oil dependency. All these factors highlight the vulnerability of the oil market which is costly to the U.S. economy.

20 U.S. Energy Information Administration. "Use of energy explained: Energy Use for Transportation." *Monthly Energy Review*. April 2022. https://www.eia.gov/energyexplained/use-of-energy/transportation.php#:~:text=Petroleum%20is%20the%20main%20source,U.S.%20transportation%20sector%20energy%20use.

Figure 6 Geopolitical and Economic Events Impacts on Crude Oil Prices (1970–2020)




*Source:* EIA, July 2022. https://www.eia.gov/finance/markets/crudeoil/reports_presentations/crude.pdf

The U.S. was the leading global oil producer in 2021, but it was also the leading oil consumer.[21,22,23] Since the oil market is globalized, the most effective way to limit its negative impacts is to stop using it as a source of fuel. Making the transition to ZEVs reduces the impact of the economic inefficiencies present in the crude oil market and removes the influence of that market on fleet owners' costs.

## Public Health and the Environment

The modeled Clean Trucks policy scenarios produce significant reductions in NOx, PM, and GHG emissions from the M/HD fleet, even after accounting for the emissions from producing the electricity and hydrogen needed to power ZEVs. NOx and PM reductions will improve air quality resulting in public health benefits from reduced mortality and hospital visits.

### *Air Quality Impacts*

Figures 7 and 8 show estimated annual M/HD fleet NOx and PM emissions, respectively, under the baseline scenario and the modeled Clean Truck policy scenarios. Under the baseline scenario, annual M/HD fleet NOx emissions are projected to fall by 42 percent and annual fleet PM emissions are projected to fall 70 percent through 2045, as the current fleet turns over to new gasoline and diesel trucks with cleaner engines that meet more stringent EPA new engine emissions standards. After 2045 baseline annual NOx and PM emissions are then projected to start rising again as annual fleet VMT continues to grow.

21 U.S. Energy Information Administration. "Frequently Asked Questions: What countries are the top producers and consumers of oil?." 10 May 2022. https://www.eia.gov/tools/faqs/faq.php?id=709&t=6.

22 One barrel of crude oil equals 42 US gallons

23 U.S. Energy Information Administration. "Oil and petroleum products explained." 21 April 2022. https://www.eia.gov/energyexplained/oil-and-petroleum-products/imports-and-exports.php. Some of the crude oil the U.S. imports is refined in the U.S. and then exported.

Figure 7 Projected M/HD Fleet NOx Emissions

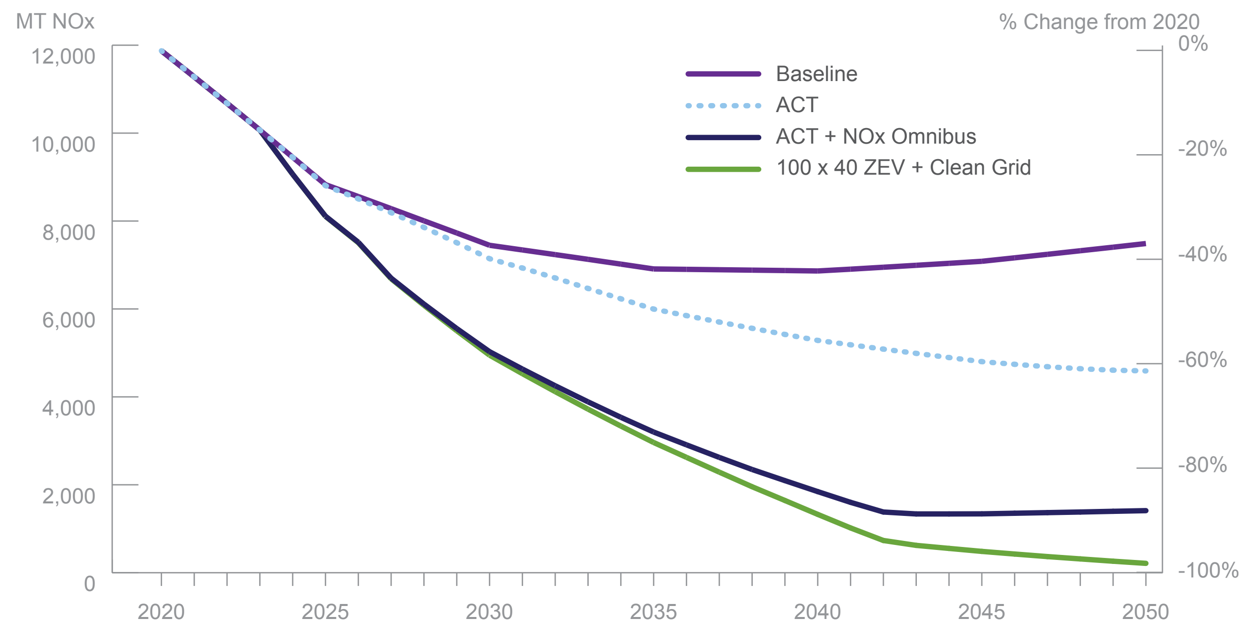
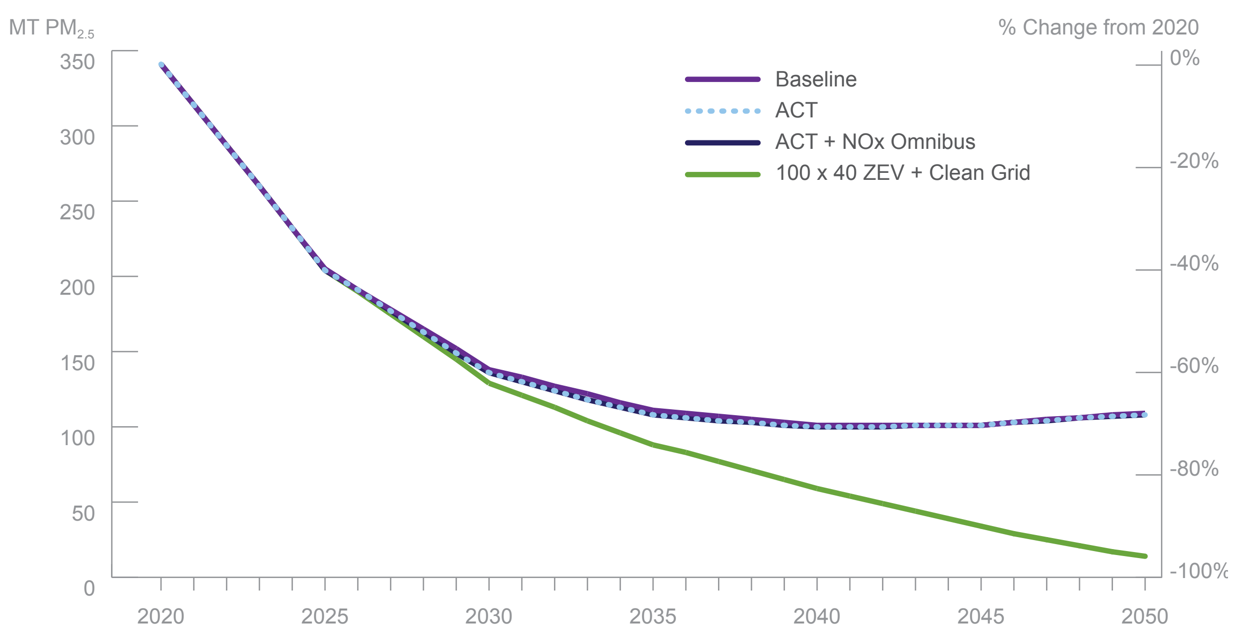



Figure 8 Projected M/HD Fleet PM Emissions



Compared with the baseline, by 2050 the ACT rule is estimated to reduce annual fleet NOx and PM emissions by 39 percent and 1 percent, respectively, as diesel and gasoline trucks are replaced with electric vehicles. Adding the NOx Omnibus Rule will further reduce annual fleet NOx emissions due to turnover of the diesel and gasoline portion of the fleet to new vehicles with low-NOx engines; by 2050 annual NOx emissions are projected to be 81 percent lower than under the baseline if both the ACT and NOx Omnibus Rules are implemented.

As shown in Figures 7 and 8, the 2050 emission levels are dramatically lower for all scenarios compared to today's (2022) levels. The ACT + NOx Omnibus scenario, for example, contributes to reductions that are 87 percent lower in nitrogen oxide (NOx) and 62 percent lower in PM in 2050 compared to today's levels. The 100 x 40 ZEV + Clean Grid scenario has the lowest fleet emissions due to replacement of virtually all gasoline and diesel trucks and buses with EVs and FCVs by 2050, when annual NOx and PM emissions are estimated to be 97 percent and 88 percent lower, respectively, than baseline emissions.

Over the next 30 years, cumulative NOx and PM emission reductions from the ACT Rule (compared with the baseline scenario) total 34,100 metric tons (MT) and 40 MT, respectively. Additional cumulative NOx reductions from the NOx Omnibus Rule are estimated at 72,500 MT over the same time. Cumulative NOx and PM emission reductions from the 100 x 40 ZEV + Clean Grid scenario (compared with the baseline) are projected to total 118,800 MT and 1,020 MT, respectively.

## *Public Health Benefits*

The reduced annual NOx and PM emissions under the Clean Truck policy scenarios will reduce ambient particulate levels in the air, which will reduce the negative health effects on Nevada residents breathing in these airborne particles.[24] Estimated public health impacts include reductions in premature mortality and fewer hospital admissions and emergency room visits for asthma. There will also be reduced cases of acute bronchitis, exacerbated asthma, and other respiratory symptoms, and fewer restricted activity days and lost workdays. Cumulative estimated reductions in these health outcomes in Nevada under the modeled Clean Truck policy scenarios are shown in Table 2; these benefits were estimated using the U.S. Environmental Protection Agency's CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool.

Table 2 Cumulative Public Health Benefits of Clean Truck Policy Scenarios, 2020–2050

| Health Metric | ACT Rule | ACT + NOx Omnibus | 100 x 40 ZEV + Clean Grid |
|---|---|---|---|
| Avoided Premature Deaths | 32 | 76 | 98 |
| Avoided Hospital Visits[a] | 25 | 53 | 71 |
| Avoided Minor Cases[b] | 18,066 | 43,206 | 56,005 |
| Monetized Value, 2020$ (millions) | $373 | $885 | $1,145 |

a Includes hospital admissions and emergency room visits.

b Includes reduced cases of acute bronchitis, exacerbated asthma, and other respiratory symptoms, and reduced restricted activity days and lost workdays.

24 PM is directly emitted to the atmosphere from combustion sources as solid particles. NOx is emitted from combustion sources as a gas but contributes to the formation of secondary particles via chemical reactions in the atmosphere. Both direct and secondary particles have negative health effects when taken into the lungs.

The monetized value of cumulative public health benefits from the ACT Rule over the next 30 years totals more than $373 million. Adding the NOx Omnibus Rule would increase the monetized value of cumulative net public health benefits to $885 million. The monetized value of cumulative public health benefits under the 100 x 40 ZEV + Clean Grid policy scenario totals $1.15 billion through 2050.

## *Climate Benefits*

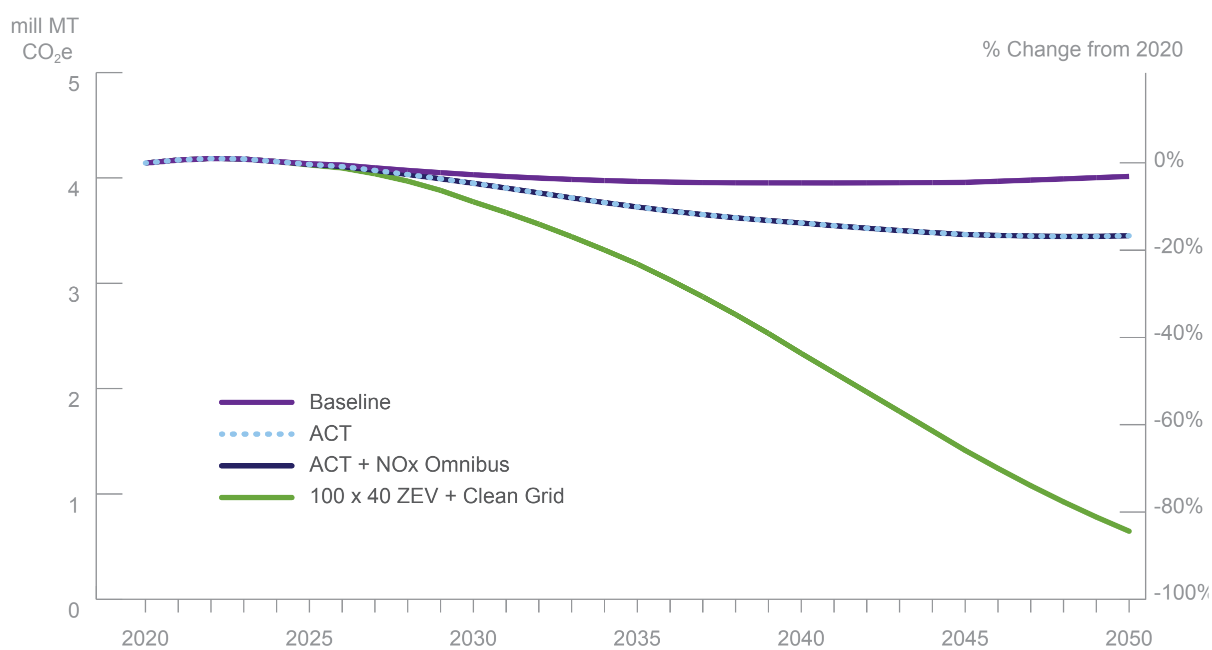
Figure 9 illustrates estimated annual M/HD fleet GHG emissions under the baseline scenario and the modeled Clean Truck policy scenarios. As shown, under the baseline scenario annual M/HD fleet GHG emissions are projected to fall by 3 percent through 2050 as the current fleet turns over to new, more efficient gasoline and diesel trucks that meet more stringent EPA new engine and vehicle emission standards.

Compared with the baseline, by 2050 the ACT rule is estimated to further reduce annual fleet GHG emissions by 14 percent, as diesel and gasoline trucks are replaced with electric vehicles; adding the NOx Omnibus Rule does not produce additional fleet GHG emissions beyond those achieved by the ACT Rule.

As shown in Figure 9, the 2050 GHG emission level for the ACT + NOx scenario is 18 percent lower compared to today's (2022) levels.

The 100 x 40 ZEV + Clean Grid scenario has the lowest fleet emissions due to replacement of virtually all gasoline and diesel trucks and buses with EV and FCV by 2050, when annual fleet GHG emissions are estimated to be 84 percent lower than baseline emissions.

Figure 9 Projected M/HD Fleet GHG Emissions



Over the next 30 years, cumulative GHG emission reductions from the ACT Rule (compared with the baseline scenario) total 7.7 million MT. Cumulative GHG emission reductions from the 100 x 40 ZEV + Clean Grid scenario (compared with the baseline) are projected to total 35.8 million MT. These estimates of GHG reductions from each policy scenario account for reductions in petroleum fuel use (gasoline, diesel fuel) by the M/HD fleet, the decreased upstream emissions from gasoline and diesel production, as well as increased emissions from electricity and hydrogen production to fuel the EVs and FCVs that will replace gasoline and diesel trucks and buses.

Using the social cost of greenhouse gases as estimated by the federal government's Interagency Working Group, these estimated cumulative GHG reductions have a monetized value of $745 million for the ACT Rule policy scenario and $3.1 billion for the 100 x 40 ZEV + Clean Grid policy scenario.[25] The social value of GHG reductions represents potential societal cost savings from avoiding the negative effects of climate change, if GHG emissions are reduced enough to keep long-term warming below 2 degrees Celsius from preindustrial levels.[26]

The assumed grid mix for electricity production each year is shown in the Appendix for Nevada. For the baseline, ACT Rule, and ACT+ NOx Omnibus scenarios, this analysis conservatively uses a business-as-usual (BAU) grid mix, while the 100 x 40 ZEV + Clean Grid scenario assumes a "decarbonized" grid mix. In 2020, the BAU grid mix is 3 percent coal-fired generation, 69 percent natural gas-fired generation, and 28 percent renewably generated. By 2050 the renewable portion of the BAU grid mix increases to 30 percent while the coal portion decreases to 1 percent and natural gas increases slightly to 69 percent.

Under the 100 x 40 ZEV + Clean Grid scenario, renewable generation increases to 89 percent in 2030, 93 percent in 2040, and 100 percent in 2050. It is noted that additional state policies, such as Renewable Portfolio Standards, could potentially increase the renewable percentages even higher, but these were not considered in this analysis.[27]

## Economic Impacts

This section summarizes projected economic impacts of the modeled Clean Truck policy scenarios, including changes in annual operating costs for Nevada fleets; impacts to Nevada electric utilities and their customers; net societal benefits; and macroeconomic effects on jobs, wages, and gross domestic product from the transition to low-NOx and zero-emission trucks and buses. This section also estimates the required public and private investment in electric vehicle charging infrastructure to support the electric M/HD fleet under each scenario.

### *Costs and Benefits to Fleets*

For all the modeled Clean Truck policy scenarios, this analysis estimated annual incremental costs associated with purchase and use of M/HD ZEVs compared with baseline conventional vehicles with combustion engines that operate on petroleum fuels (gasoline, diesel). These costs include the incremental purchase cost of the new ZEVs added each year (instead of new combustion vehicles), the cost of installing the charging

25 For the social cost values used, see MJB&A, *Clean Trucks Analysis: Costs & Benefits of State-Level Policies to Require No- and Low-Emission Trucks, Technical Report—Methodologies & Assumptions*, May 2021, https://mjbradley.com/clean-trucks-analysis.

26 The Interagency Working Group developed GHG social cost estimates using a range of discount rates. These values are based on the average 3 percent discount rate, which is in the middle of the range of estimated values. The monetized value of cumulative GHG reductions under each policy scenario would be 72 percent lower if using the lowest published social cost values, and three times greater if using the highest published values.

27 A Renewable Portfolio Standard (RPS) is a regulatory mandate to increase production of energy from renewable sources (i.e. wind, solar, biomass and other alternatives to fossil and nuclear electric generation).

and hydrogen fueling infrastructure required by these new ZEVs, and net fuel and maintenance costs for all ZEVs in the fleet, both those newly purchased each year and those purchased in prior years and still in use.

Net fuel costs include reductions in purchases of diesel fuel and gasoline (due to fewer combustion vehicles), offset by the increased purchase of electricity and hydrogen to power ZEVs. Net maintenance costs include net savings in annual vehicle maintenance for the ZEVs in the fleet compared with combustion vehicles, offset by annual costs to maintain the charging and hydrogen fueling infrastructure needed to support in-use ZEVs.

Figure 10 Projected Lifetime Incremental Costs for Nevada ZEVs Compared with Combustion Vehicles

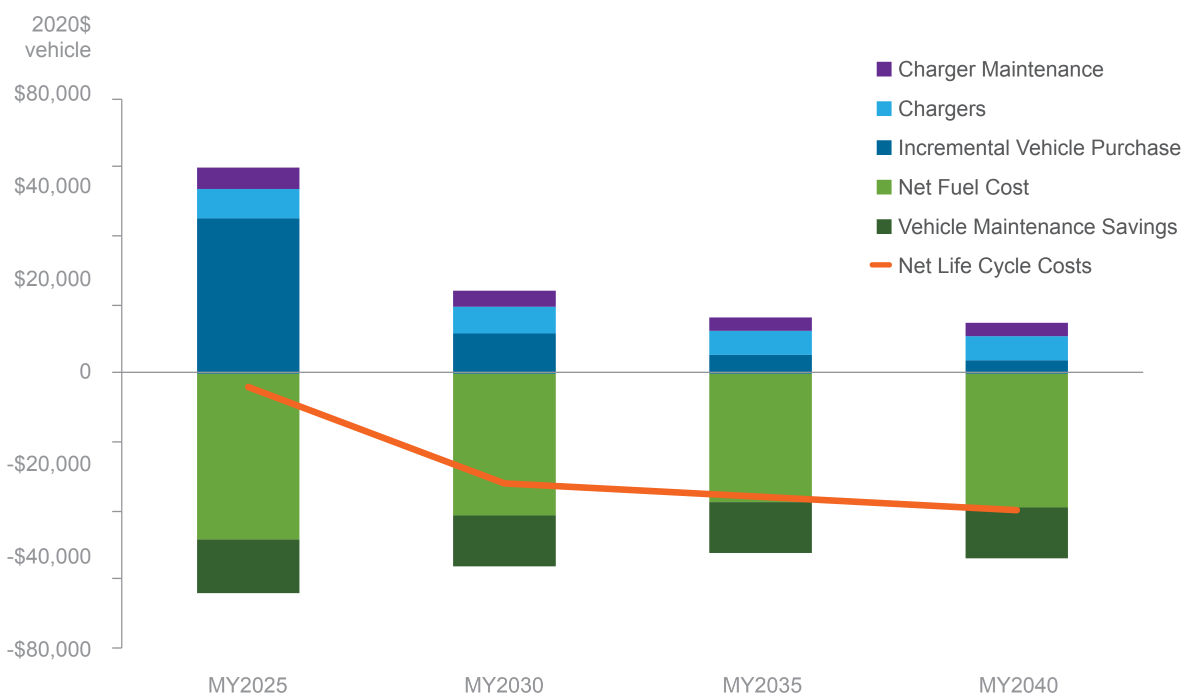



Figure 10 shows projected average lifetime incremental costs for new ZEVs purchased in Nevada compared with lifetime costs for combustion vehicles purchased in the same model year; the bars show fleet average values for all Class 2b–8 ZEVs purchased each year under the 100 x 40 ZEV scenario. Incremental fuel and maintenance costs are discounted lifetime costs, assuming 21-year vehicle life, and 6 percent annual discount rate. Vehicle financing, which is often used by fleets when purchasing vehicles, was not considered in this analysis.

As shown, the average M/HD ZEV in Nevada is projected to produce over $52,000 in discounted fuel and maintenance cost savings over its lifetime. For ZEVs purchased in the very near term, this savings may not be enough to offset the projected incremental cost of vehicle purchase and fueling infrastructure for some ZEVs, resulting in net increased lifetime costs compared with those of combustion vehicles. However, by

2030 incremental ZEV purchase costs are projected to fall significantly, such that the average ZEV will reach lifetime cost parity with combustion vehicles, when discounted lifetime fuel and maintenance savings are considered. By 2040, the average ZEV purchased that year is projected to produce almost $40,000 in discounted lifetime net savings (2020$) compared with the costs of an equivalent combustion vehicle.

It is important to reiterate that the values in Figure 10 are fleet average values, which mask a significant amount of variability across vehicle types and among different fleets of the same vehicle type. Also note that the utility impact analysis (in the next section) indicates that the cost of providing power to charge M/HD EVs is lower than expected utility revenue under current rate structures. This suggests that Nevada could consider changes to rates that would not only be fairer for fleets, but also lower electricity costs for M/HD EV charging, thus reducing net fleet operating costs further than estimated here. However, this would reduce the potential benefits that would accrue to other ratepayers from M/HD vehicle charging (see discussion below).

M/HD ZEVs in some fleets will likely achieve lifetime cost parity with combustion vehicles much earlier than 2030, while others may lag. In addition, this analysis, and the values shown in Figure 10, assume no government incentives for vehicle purchase or development of fueling infrastructure. If existing and potential incentives are considered, or policies such as improved electricity rates for fleets, then actual net costs to fleets will be lower, resulting in cost parity sooner.

## *Electric Utility Impacts*

Current annual electricity sales to residential and commercial customers in Nevada total 26.2 million MWh and are projected to grow to 34.6 million MWh in 2050.[28]

Under the ACT Rule policy scenario, additional annual electricity sales for M/HD EV charging are estimated to total 0.3 million MWh in 2030, rising to 3.1 million MWh in 2050. This incremental load represents 1 percent and 11 percent of the total electricity demand in 2030 and 2050, respectively. Incremental monthly peak charging demand under this scenario is estimated at 76 MW in 2030, rising to 998 MW in 2050.

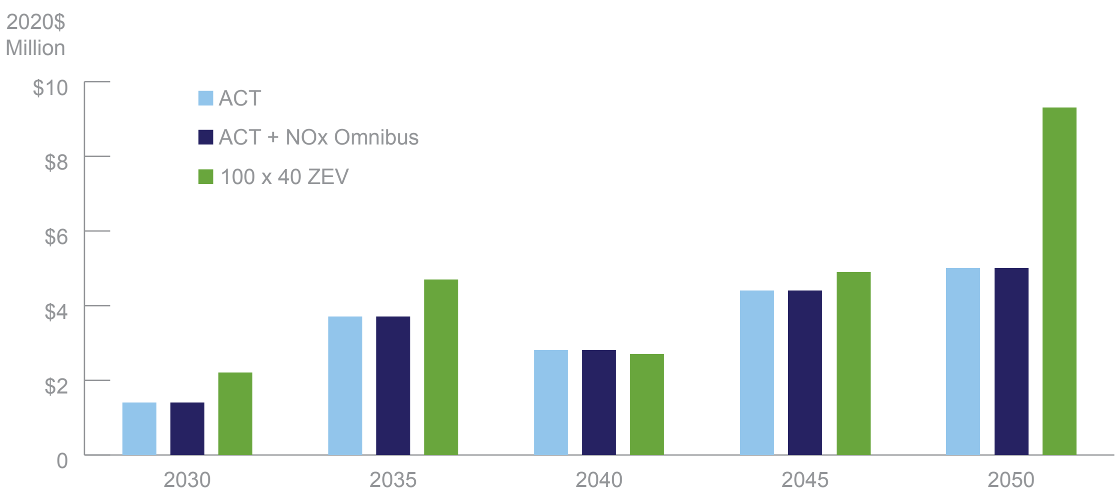
Under the 100 x 40 ZEV policy scenario, incremental peak charging demand is estimated at 116 MW in 2030, rising to 1,544 MW in 2050, and annual incremental electricity sales are estimated to be 0.4 million MWh in 2030, rising to 4.8 million MWh in 2050 (1 percent and 14 percent of the total electricity demand, respectively).

This analysis estimated the revenue that Nevada electric utilities would receive from these incremental electricity sales, the marginal generation and transmission costs of providing this power, and the net revenue that utilities would earn (net revenue = revenue – marginal cost). The estimated marginal cost includes costs associated with procuring the necessary additional peak generation and transmission capacity to serve the load ($/MW) as well as marginal generation and transmission energy costs ($/MWh).

Figure 11 summarizes estimated annual utility net revenue from M/HD EV charging under the modeled Clean Truck policy scenarios. Under the ACT Rule scenario, annual utility net revenue is projected to be $1.4 million in 2030, rising to $2.8 million in 2040 and $5.0 million in 2050. Under the 100 x 40 ZEV scenario, utility net revenue is projected to be $2.2 million in 2030, rising to $2.7 million in 2040 and $9.3 million in 2050.

28 This growth assumption is from the EIA 2021 Annual Energy Outlook. It does not include sales to large industrial customers.

Figure 11 Projected Annual Utility Net Revenue From M/HD EV




In general, a utility's costs to maintain its distribution infrastructure increase each year with inflation, and these costs are passed on to utility customers in accordance with rules established by the Nevada Public Utility Commission via periodic increases in residential and commercial electric rates. However, projected utility net revenue from increased electricity sales for M/HD EV charging would lower distribution rates ($/kWh), since fixed annual distribution system costs would be spread over a larger base of energy sales.

This analysis indicates that under the 100 x 40 ZEV scenario, by 2050 incremental utility net revenue from M/HD EV charging could potentially reduce average residential and commercial electricity rates in Nevada by as much as 0.35 percent ($0.0005/kWh in 2020$). This could save the average Nevada household $4 per year and the average commercial customer $16 per year on their electricity bills (2020$).[29]

## *Jobs, Wages, and GDP*

The transition from gasoline and diesel M/HD vehicles to ZEVs will have significant impacts on the U.S. economy, with substantial job gains in many industries (e.g., battery and electric component manufacturing, charging infrastructure construction, electricity generation), accompanied by fewer jobs in other industries (e.g., engine manufacturing, oil exploration and refining, gas stations, auto repair shops).[30]

This analysis used the IMPLAN model to estimate these macroeconomic effects of the modeled Nevada Clean Truck policy scenarios based on estimated changes in spending in various industries (relative to the baseline scenario). These estimates of spending changes by industry were developed from the fleet cost analysis. For example, under the modeled Clean Truck policy scenarios, more money will be spent to manufacture batteries and electric drive components for ZEVs, but less will be spent to manufacture gasoline and diesel engines, and transmissions. Similarly, less money will be spent by fleets to purchase petroleum fuels, but more will be spent to purchase electricity and hydrogen.

29 Figures are based on average annual electricity use of 10,679 kWh per housing unit and 51,464 kWh per commercial customer in Nevada.

30 For example, in-state charging infrastructure is estimated to increase by 317 jobs in 2045 under the most aggressive scenario.

The IMPLAN analysis also includes the effects of induced economic activity due to consumers having more money to spend, thanks to return of utility net revenue in the form of lower electric rates, and net fleet cost savings returned as lower shipping costs for goods, resulting in lower consumer prices for those goods.

The IMPLAN analysis was run at the national level, but assuming only the industry spending changes (from application of the policy scenarios) occurring due to M/HD vehicle purchase and use in Nevada. Estimated national effects would be significantly greater if the modeled policy scenarios were applied to the entire U.S. M/HD fleet.

Table 3 offers a summary of estimated macroeconomic effects of the modeled Clean Truck scenarios on jobs, GDP, and wages at the national level.

Compared with the baseline scenario, adoption of the ACT + NOx Omnibus policy and 100 x 40 ZEV + Clean Grid scenarios will increase national net jobs at least through 2035. The loss in 2045 is largely due to the reductions in spending on diesel fuel and decreases in the costs of M/HDV ZEVs over time, resulting in decreased spending and investments in the out years. Both scenarios also increase annual GDP through 2035. For both scenarios in all years, the average wages for new jobs added to the economy are more than twice the average wages for jobs that are replaced. This is because the largest number of added jobs are in electrical component manufacturing and in construction of charging infrastructure, requiring many well-paid electricians and electrical engineers, while the largest job losses are in vehicle repair—due to lower maintenance required by ZEVs—as well as relatively low-paid retail workers at gas stations. The loss in 2045 is largely due to the reductions in spending on diesel fuel and decreases in the costs of M/HD ZEVs over time, resulting in decreased spending and investments in the later years.

Table 3 U.S. Macroeconomic Effects of Nevada Clean Truck Policy Scenarios

| Metric | | ACT + NOx Omnibus | | 100 x 40 ZEV + Clean Grid | |
|---|---|---|---|---|---|
| | | 2035 | 2045 | 2035 | 2045 |
| Net Change in Jobs | | 187 | (498) | 189 | (1,101) |
| Net Change in GDP 2020$ (million) | | $36 | ($21) | $46 | ($63) |
| Average Annual Compensation | Added Jobs | $90,998 | $86,680 | $91,695 | $87,677 |
| | Replaced Jobs | $44,355 | $36,313 | $44,575 | $36,783 |

Today many components used in electric and fuel cell vehicles—most notably batteries, but also many electric drivetrain components—are manufactured outside the United States and imported for final vehicle assembly. The percentage of imported content is higher for ZEV drivetrains today than for conventional drivetrains (gasoline and diesel engines, and transmissions). The scale of U.S. macroeconomic effects from the modeled Clean Truck policy scenarios will depend on how the nascent M/HD ZEV industry develops; for this analysis, ERM assumed that all incremental spending on ZEV batteries and electric drivetrain components would be in the United States, with no imported content. As such, the results summarized in Table 3 represent a higher-end estimate of what is possible from the ZEV transition, with the right federal and state policy supports in place to incentivize development of U.S.-based ZEV component manufacturing. If vehicle manufacturers continue to rely primarily on imported batteries and electric drivetrain components, the net job and GDP gains will be lower than those summarized here.

This macroeconomic analysis only includes direct, indirect, and induced impacts from changes in M/HD vehicle manufacturing and use, and from consumer re-spending of net utility revenue and fleet cost savings returned as lower prices for electricity and shipped goods. It does not include any effects on freight industry growth and investment due to lower operating costs, or any macroeconomic effects associated with the estimated climate and air quality (health) benefits of the modeled Clean Truck policy scenarios. These effects may increase economic and job numbers compared to those presented here.

## *Required Public and Private Investments*

Using a detailed charging model that considers typical daily usage patterns for different vehicle types, this analysis assumes that most M/HD ZEVs in Nevada will use overnight charging at their place of business, though about 10 percent will need to rely on a publicly accessible network of higher-power chargers.[31] The exception are combination trucks, 70 percent of which are assumed to require high-power public chargers since they are used primarily for long-haul freight operations.

Table 4 summarizes estimated charging infrastructure required to support M/HD electric trucks and buses under the Clean Truck policy scenarios.

Table 4 Projected Charging Infrastructure Required for Clean Truck Policy Scenarios

| Metric | | ACT Rule | | | 100 x 40 ZEV | | |
|---|---|---|---|---|---|---|---|
| | | 2035 | 2045 | 2050 | 2035 | 2045 | 2050 |
| Cumulative Charge Ports | Depot | 26,312 | 81,854 | 103,389 | 40,949 | 137,962 | 166,337 |
| | Public 150 kW | 300 | 923 | 1,171 | 458 | 1,495 | 1,824 |
| | Public 500 kW | 368 | 987 | 1,253 | 540 | 1,997 | 2,745 |
| Cumulative Investment, 2020$ (million) | Depot | $141 | $407 | $550 | $218 | $703 | $973 |
| | Public | $135 | $355 | $475 | $198 | $683 | $963 |

Depot chargers will need to be 10–50 kW per port depending on vehicle type. The smaller 150 kW public chargers are needed primarily to support single-unit freight trucks, while the higher-capacity 500 kW public chargers are needed mostly for combination trucks.

As of June 2022, there were 484 publicly accessible charging stations in Nevada with a total of 367 direct current fast-charging (DCFC) ports (>50 kW).[32] Over 60 percent of these DCFC ports are Tesla superchargers that currently can be used only by Tesla owners.[33] In Nevada, there are only 147 DCFC ports fully available to any vehicle.

Under the ACT Rule policy scenario, Nevada's fleet owners will have to invest an average of $22 million per year (2020$) between 2025 and 2050 to purchase and install depot-based charging infrastructure. The government and private investors will need to invest an average of $19 million per year over the same time period to build out a publicly accessible charging network across the region to serve the EV M/HD truck fleet.

31 See the methodology report for a detailed discussion of M/HD EV charging needs.

32 These numbers are from the U.S. Department of Energy's Alternative Fuel Data Center public charger database.

33 Hamilton Asher, Isobel. "Tesla has started selling chargers for non-Tesla cars, just as it begins to open up its Supercharger network to other vehicles." Business Insider. November 2, 2021.https://www.businessinsider.com/tesla-elon-musk-chargers-supercharger-network-2021-11.

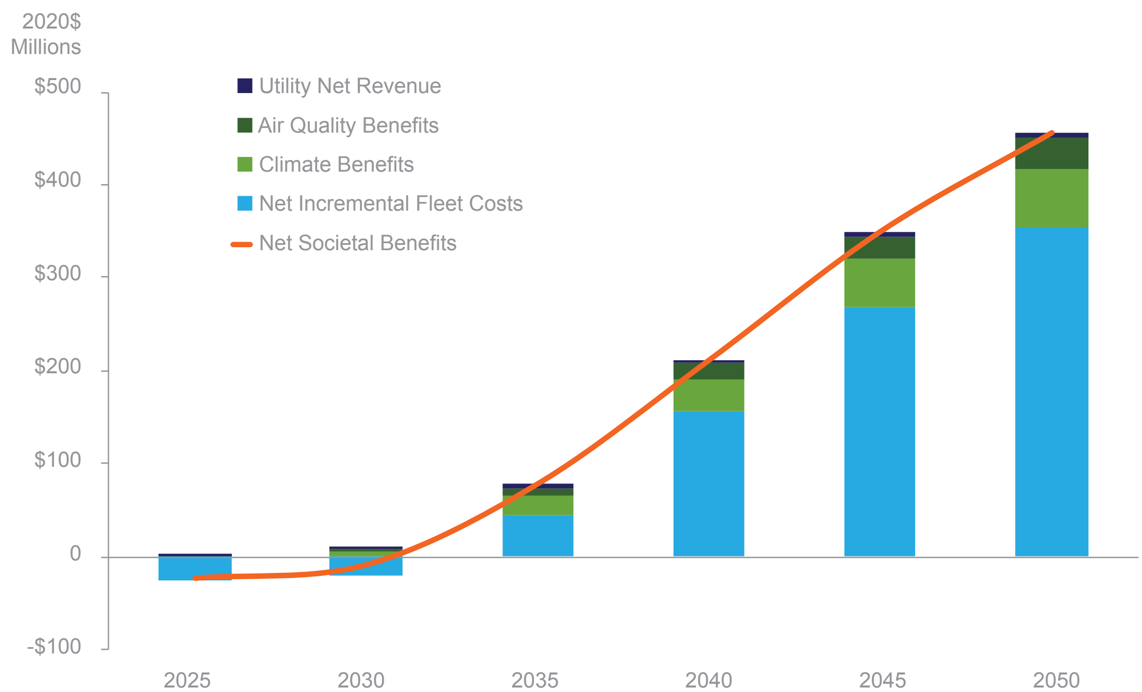
Under the 100 x 40 ZEV scenario, fleet investments in depot charging infrastructure from 2025 to 2050 will also need to increase to an average of $39 million per year, and public and private investments in the public charging network will need to rise to an average of $39 million per year.

## *Net Societal Benefits*

The net societal benefits from the modeled Nevada Clean Truck policy scenarios include the monetized value of public health and climate benefits, net cost savings for fleets, and net utility revenue from electricity sales for EV charging.

Figures 12 to 14 present projected annual net societal benefits under the ACT Rule, ACT + NOx Omnibus Rule, and 100 x 40 ZEV + Clean Grid scenarios, respectively. Under all three Clean Truck policy scenarios, near-term fleet costs are higher than fleet costs under the baseline.[34] However, after approximately 2030 all policy scenarios show annual net societal benefits, despite net fleet costs, due to growing utility net revenue in addition to public health and climate benefits. After approximately 2035 there is an annual net savings in fleet costs from operating ZEVs instead of diesel and gasoline trucks, and net societal benefits grow quickly.[35]

Figure 12 Projected Annual Net Societal Benefits from ACT Policy Scenario




34 If an individual truck owner finances a vehicle, it would better equalize payments for increased vehicle price and fuel savings, resulting in a better balancing of cash flow. On a net fleet-wide basis, however, the cost of financing reduces total net fleet savings.

35 Note that fleet-wide annual net savings under the Clean Truck policy scenarios lag average ZEV life-cycle cost parity to combustion vehicles by about 5 years. This is because even after life-cycle cost parity is achieved, most ZEVs will still have higher up-front purchase costs (vehicle plus charger) than combustion vehicles; these higher costs are then paid back over the next few years via fuel and maintenance cost savings.

Figure 13 Projected Annual Net Societal Benefits from ACT + NOx Omnibus Policy Scenario

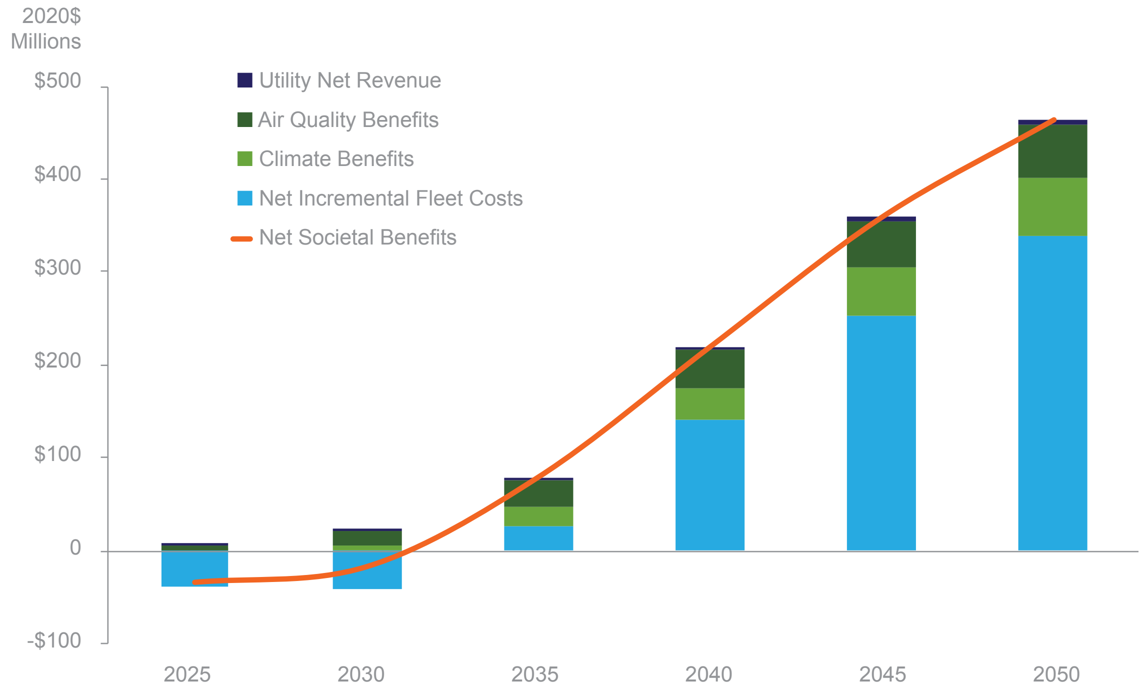
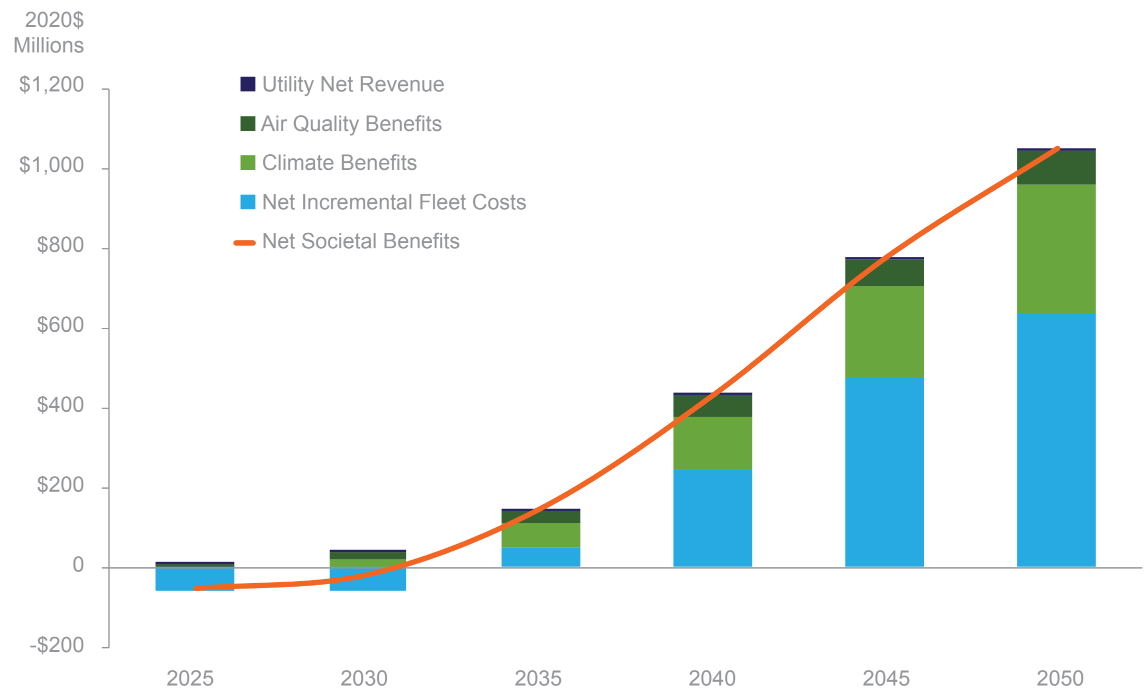



Figure 14 Projected Annual Net Societal Benefits from 100 x 40 ZEV + Clean Grid Policy Scenario



Under the ACT Rule scenario, by 2050 annual net societal benefits are estimated to be $456 million, including $354 million in net fleet savings and $5 million in utility net revenue. Cumulative estimated societal net benefits under this scenario total $4.3 billion between 2020 and 2050.

Under the ACT + NOx Omnibus scenario, by 2050 annual net societal benefits are estimated to be $464 million, including $338 million in net fleet savings and $5 million in utility net revenue. Cumulative estimated societal net benefits under this scenario total $4.3 billion between 2020 and 2050.

Under the 100 x 40 ZEV + Clean Grid scenario, by 2050 annual net societal benefits are estimated to be $1.1 billion, including $642 million in net fleet savings and $9 million in utility net revenue. Cumulative estimated societal net benefits under this scenario total $9.6 billion between 2020 and 2050.

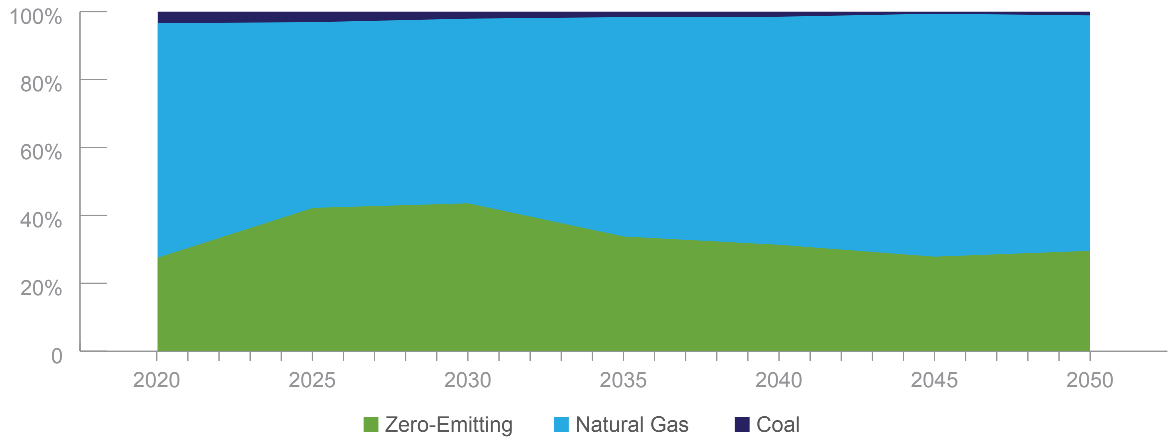
# Conclusion

This report evaluated on-road MHD ZEV costs and benefits for three distinct levels of ZEV adoption ambition—Nevada adopting California's ACT Rule, Nevada adopting California's ACT + NOx Omnibus Rule, and Nevada adopting a more aggressive 100 x 40 ZEV + Clean Grid scenario. Under all modeled Clean Truck policy scenarios, a significant portion of the Nevada M/HD fleet is assumed to turn over to EV and FCV trucks and buses. This will result in replacement of petroleum fuels—primarily gasoline and diesel fuel—with electricity and hydrogen.[36] Moving away from fossil fuels, such as diesel and gasoline, means less reliance on oil—a commodity priced on a global market that is extremely volatile in price—in favor of regionally produced and more stably priced grid electricity or hydrogen. As petroleum use decreases with rising ZEV adoption, the electricity demand within Nevada will increase. To maximize the climate and health benefits of ZEVs, it is important to meet the ZEV electricity required with zero-emitting generation, such as solar power. Nevada is well positioned to be a major solar energy producer in the U.S.—which could further advance the environmental and public health benefits as well as the economic impacts of the modeled fleet transitions.

36 A small number of M/HD trucks and buses in Nevada use natural gas currently.

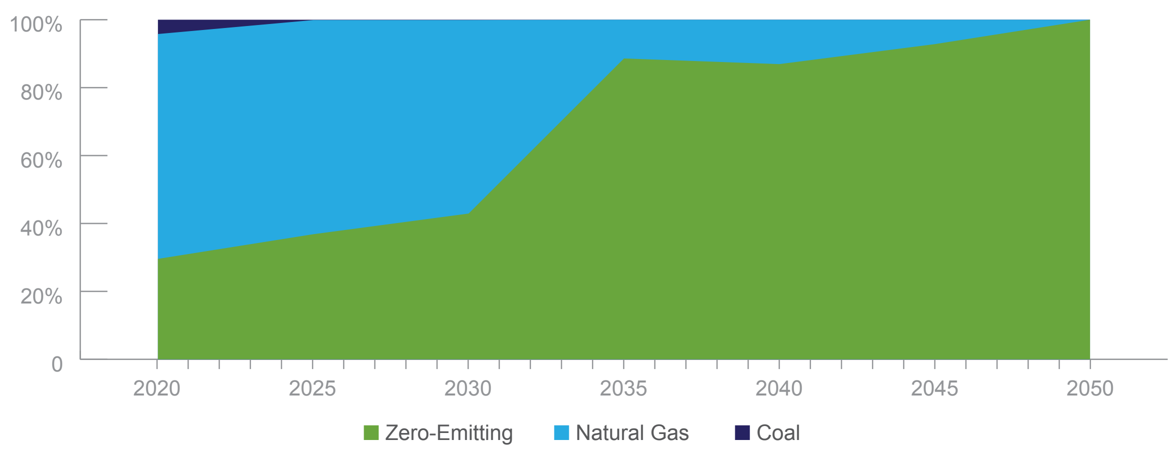
# APPENDIX: Nevada Energy Cost Assumptions and Supplemental Material

Figure A1 Nevada Business as Usual Grid Mix Assumptions




These business-as-usual grid mix assumptions were applied to the baseline, ACT Rule, and ACT + NOx Omnibus policy scenarios.

Figure A2 Nevada Decarbonized Grid Mix Assumptions




These Decarbonized grid mix assumptions were applied to the 100 x 40 ZEV + Clean Grid policy scenario.

Table A1 M/HDV In-Use ZEVs Population

| M/HDV In-Use ZEVs | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| Baseline | 167 | 298 | 437 | 628 | 813 | 993 |
| ACT | 850 | 10,298 | 36,018 | 71,672 | 108,021 | 136,647 |
| ACT + NOx OMN | 850 | 10,298 | 36,018 | 71,672 | 108,021 | 136,647 |
| 100x40 ZEV + Clean Grid | 1,168 | 15,770 | 54,611 | 115,637 | 181,817 | 222,267 |
| Total M/HDV Fleet (ZEV + ICE + Low NOx) | 173,461 | 183,731 | 194,661 | 206,299 | 218,692 | 231,892 |

Table A2 Net Incremental Fleet Benefits

| 2020$ (millions) | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| ACT | ($25) | ($20) | $45 | $156 | $269 | $354 |
| ACT + NOx OMN | ($39) | ($41) | $28 | $141 | $254 | $338 |
| 100x40 ZEV + Clean Grid | ($58) | ($57) | $51 | $245 | $478 | $642 |

Table A3 Average Nevada Household and Commercial Customer Electric Bill Savings in 2050

| 2020$ | Household | Commercial Customer |
|---|---|---|
| ACT | $3 | $14 |
| ACT + NOx OMN | $3 | $14 |
| 100x40 ZEV + Clean Grid | $6 | $27 |

Figure A3 Nevada Average Fuel Costs