PATHWAYS AND POLICIES TO ACHIEVE NEVADA'S CLIMATE GOALS

AN EMISSIONS, EQUITY, AND ECONOMIC ANALYSIS

BY EVOLVED ENERGY, GRIDLAB, NRDC, & SIERRA CLUB

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ACKNOWLEDGMENTS

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About Evolved Energy
Evolved Energy Research was founded to address key energy sector questions accelerated by policy goals and new technology development.

About GridLab
GridLab provides technical grid expertise to enhance policy decision-making and to ensure a rapid transition to a reliable, cost effective, and low-carbon future.

About NRDC
The Natural Resources Defense Council is an international nonprofit environmental organization that, since 1970, has worked to protect the world's natural resources, public health, and the environment.

About PSE Healthy Energy
Physicians, Scientists, and Engineers (PSE) for Healthy Energy is a multidisciplinary, nonprofit research institute that studies the way energy production and use impact public health and the environment.

About Sierra Club
Sierra Club is a grassroots environmental organization dedicated to defending everyone's right to a healthy world.

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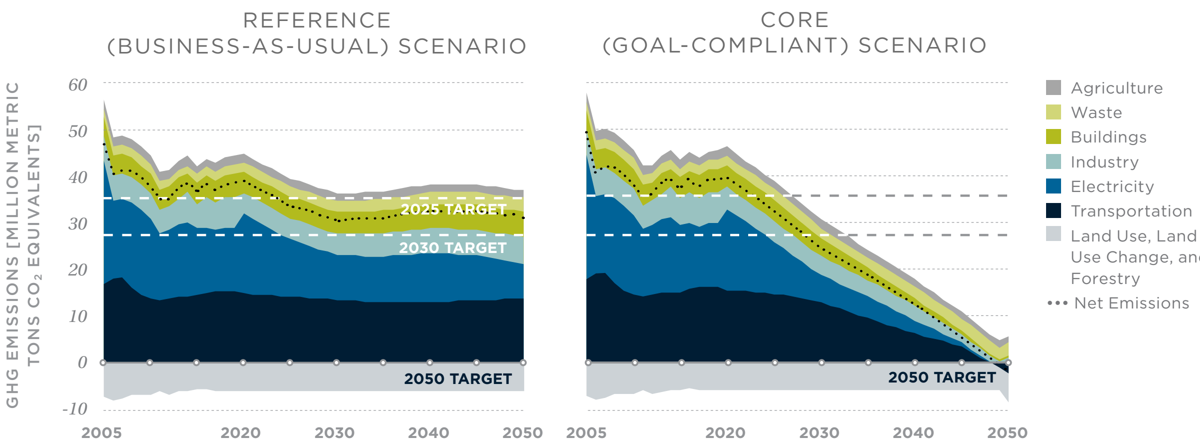
The report benefited from the review and contribution of many additional experts: Rabi Abonour, Max Baumhefner, Ariana Gonzalez, Alex Jackson, Ben Longstreth, Alejandra Mejia-Cunningham, Simon Mui, PhD, Patricio Portillo, and Lauren Urbanek from NRDC; Taylor McNair from GridLab, Evan Gillespie from the Sierra Club, Erin Overturf from Western Resource Advocates, and Rebecca Wagner. Thank you.

The climate crisis is here. Without swift action, it will further threaten the health and livelihoods of Nevadans. Fortunately, Nevada's leaders have recognized the urgency, passing a 50 percent renewable portfolio standard in 2019 and setting statewide greenhouse gas (GHG) emissions reduction goals of 28 percent below 2005 levels by 2025, 45 percent by 2030, and zero or near-zero emissions by 2050. This report describes pathways and policies to meet these goals, the equity, air pollution, and cost implications of doing so, and associated policy recommendations.

Our modeling shows Nevada can meet GHG goals with energy costs similar to or even lower than today's. Our analysis also shows that additional energy efficiency and demand flexibility can reduce the cost of the transition.

ES FIGURE 1. REFERENCE AND CORE SCENARIO GREENHOUSE GAS EMISSIONS BY SECTOR, WITH COMPARISON TO NEVADA'S 2025, 2030, AND 2050 GOALS



Evolved Energy Research (Evolved) modeled GHG reduction pathways to meet Nevada's goals, using the EnergyPATHWAYS and RIO models to study the energy system. Collectively, these tools model Nevada's energy supply and demand, including technology stock turnover, hourly electricity dynamics, and sectoral interactions. Physicians, Scientists, and Engineers for Health Energy (PSE) analyzed how current air pollutant emissions and energy costs correlate with socioeconomic vulnerability, and down-scaled Evolved's estimates of future emissions to census tracts to understand how efforts to reduce GHG emissions may affect air pollution in vulnerable communities.

THE PATH TO A FULLY CLEAN ENERGY ECONOMY

Nevada is not yet on track to meet its climate goals (see ES Figure 1). However, the goals are achievable with ambitious deployment of renewable energy, electric vehicles and appliances, and efficiency in buildings. To get on track this decade, the state must reach about 80 percent renewable electricity by 2030, stop using coal by 2025, and reduce gas plant use, while using clean imports, energy storage, and demand flexibility to maintain a reliable electricity system. Electric vehicles must grow to reach 50 percent of new light-duty sales and 20 percent of new medium and heavy-duty sales by 2030. Appliances must turn over so that about 45 percent of residential and 20 to 25 percent of commercial space and water heating is electric by 2030. New investments in the gas distribution system need to be compared to the electrification alternative and scrutinized to make sure they are necessary, cost-effective, and compatible with Nevada's climate goals. After 2030, we need to complete these transitions to rely almost exclusively on renewable electricity to power Nevada's economy.

ES FIGURE 2. KEY SECTORAL RESULTS FOR THE CORE (GOAL-COMPLIANT) SCENARIO

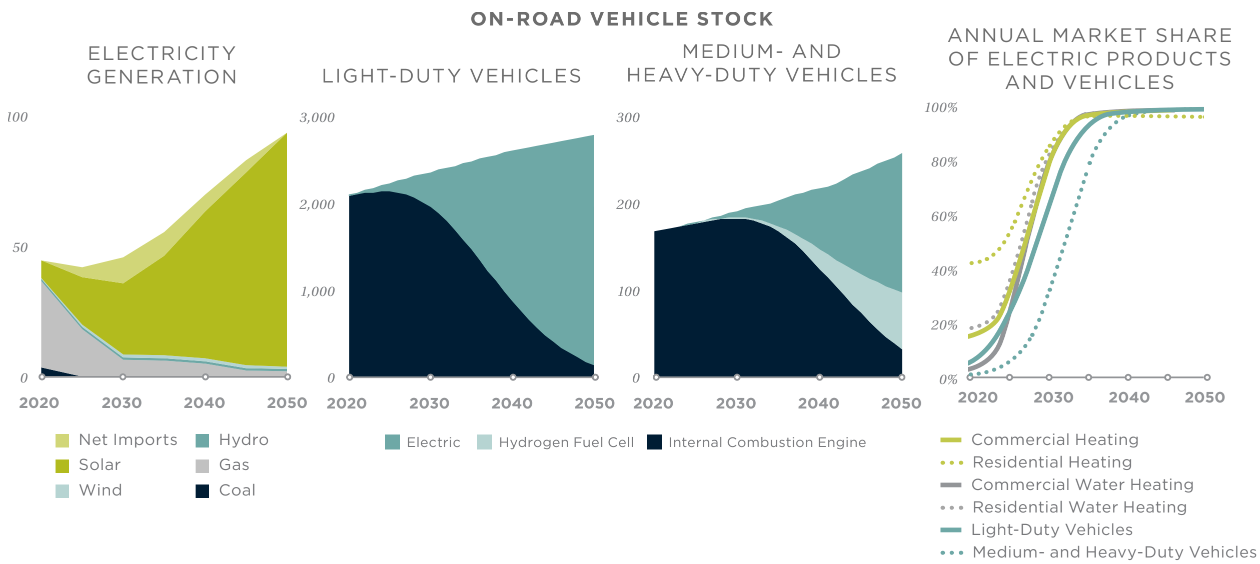


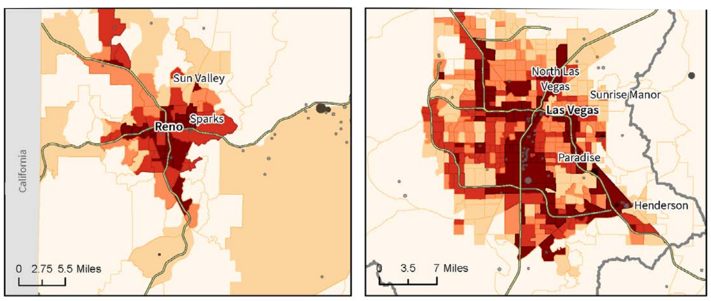
PHOTO GREAT BASIN CENTER FOR GEOTHERMAL ENERGY

PSE's results show criteria air pollution emissions are distributed inequitably in Nevada (see ES Figure 3). Emissions are concentrated in socioeconomically vulnerable census tracts and are also higher along transportation corridors, indicating the importance of addressing pollution from heavy-duty vehicles.

ES FIGURE 3. PARTICULATE MATTER EMISSIONS IN RENO AND LAS VEGAS AND PSE'S ENVIRONMENTAL AND DEMOGRAPHIC INDICES

The left two panes demonstrate particulate pollution is concentrated near transportation infrastructure. The right pane shows that communities with relatively high pollution tend to also have high socioeconomic vulnerability.

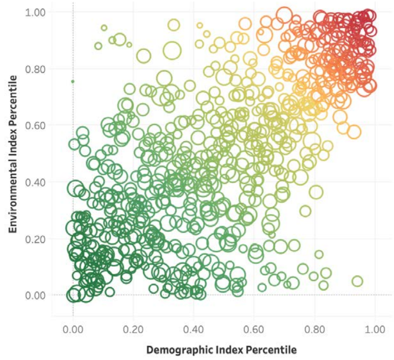
CENSUS TRACT TONNES $PM_{2.5}$ PER SQUARE MILE PER YEAR, BY PERCENTILE



TONNES $PM_{2.5}$ PER SQUARE MILE PER YEAR

1st (least $PM_{2.5}$/sqmi) 2nd 3rd 4th 5th

INDEX COMPARISON



CENSUS TRACT POPULATION

0 4,000 8,000
2,000 6,000 ≥ 10,000

Total Index Percentile

0.00 1.00

POLICY RECOMMENDATIONS

Electricity	• Increase the RPS to 80% by 2030 • Establish a power plant CO_2 emissions rule to regulate leftover emissions • Ensure CO_2 emissions rule, RPS apply to all providers and electricity users • Target early energy efficiency, electrification investments in communities with high socioeconomic and environmental vulnerability, and any consumer-focused distributed generation or storage programs • Increase coordination with other states to export solar and import wind • Increase and reform the Universal Energy Charge • Prioritize renewable energy development in lower-impact areas
Transportation	• Adopt clean medium- and heavy-duty truck rules • Facilitate investment in electric vehicle charging infrastructure • Close the classic car loophole • Adopt a Zero-Emission Vehicle program • Implement a partial sales tax incentive for electric vehicles, with a market share and vehicle cost cap • Reform the gas tax so it is indexed to fuel sales and inflation, and apply it to EVs based on their mile-per-gallon equivalent fuel economy • Change the constitution to allow gas tax revenue to be used for broader transportation system investments • Invest in public transportation, smart growth, and walking and biking infrastructure
Buildings	• Adopt high-level state energy efficiency, building shell retrofit, and electrification targets • Assign and clarify program implementation responsibilities and funding • Provide for automatic adoption of the most recent building code, with modifications that move toward all-electric new construction and EV-ready buildings • Adopt state appliance standards • Stop unnecessarily expanding the gas distribution system, create a gas Integrated Resource Planning process, and initiate a proceeding investigating the future of gas
Industry	• Ensure RPS, power plant CO_2 emissions rule, zero-emission vehicle standards apply to industry, including to self-generated electricity and vehicles that seldom travel on public roads • Include non-energy related emissions within power plant CO_2 emissions rule
Air quality data, modeling, and mapping	• Increase air quality monitoring, including expanded use of low-cost sensors to democratize air quality data • Develop inter-agency modeling efforts that assess greenhouse gas mitigation policies against health impacts, using tools like EPA's Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool • Implement a Nevada EJ Screen, formalizing the process of identifying socioeconomically and environmentally vulnerable communities

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INTRODUCTION

Climate scientists agree that the world must cut climate-warming pollution in half by 2030 and almost to zero by 2050, with any leftover climate pollution stored underground or in plants and soils, if we are to have a decent chance of limiting the most catastrophic effects of climate change. Whether and how we transform our economy and energy use over the next decade will determine the quality of the basic environment we leave for future generations.

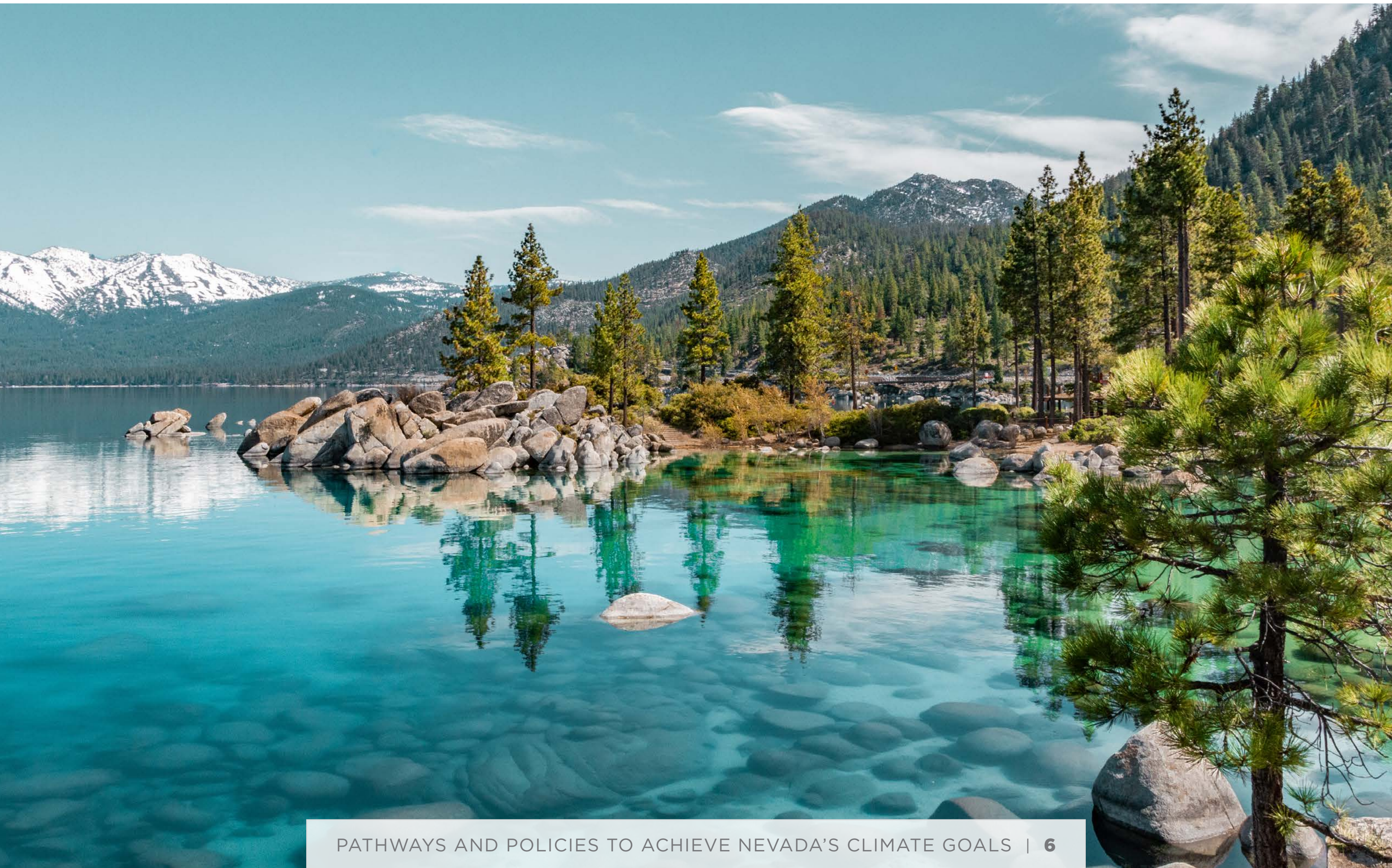
This summer, with its wildfires and extreme heat, has shown that the livability of the West is at stake in the current climate emergency. Will children be comfortable playing outside? Will older adults want to take an evening bike ride? Will construction projects have to pause for months during the summer? Will our treasured natural spaces—Red Rock Canyon, Mount Charleston, Lake Tahoe—be forever transformed? A livable climate creates more possibilities for people to live the lives they want. If we do not reduce climate-warming pollution, surviving and thriving in Nevada's already challenging climate will get much harder.

Nevada has already warmed by two degrees Fahrenheit in the last century. This warming has led to diminished snowpack, severe drought, and increased wildfires, and has combined with the urban heat island effect to cause extreme heat in Nevada's cities. According to Climate Central, Las Vegas, where most Nevadans live, is the fastest warming city in the country: the average temperature has increased by 5.8°F since 1970. In Reno in 2019, temperatures exceeded 90°F on 72 days, 18 more days than the average from 1981 to 2010. Data compiled by the Center for Disease Control shows that heat-related deaths in Nevada increased almost fivefold—from 29 to 139 summertime deaths—between 2014 and 2017. This warming is especially dangerous for older people with pre-existing heart disease. Rural Nevada is also impacted by rising temperatures and is acutely sensitive to drought. Less water means tough choices for farmers and ranchers whose livelihoods depend on the land.

Nevada is taking action to reduce emissions. During his 2018 campaign, Governor Steve Sisolak stated his hope to get Nevada on the path to 100 percent clean energy if elected. On March 12, 2019, Sisolak announced Nevada was joining the U.S. Climate Alliance, a bipartisan group of governors committed to meeting the goals of the Paris Climate Agreement. On Earth Day 2019, Governor Sisolak signed Senate Bill 358 into law, which increases Nevada renewable portfolio standard (RPS) to 50 percent by 2030, meaning half of the state's electricity will come from clean, renewable energy sources, like solar, geothermal, and wind. The bill sets a goal of 100 percent clean electricity by 2050.

In 2019, the legislature passed Senate Bill 254, which establishes statewide goals for greenhouse gas emissions reductions of 28 percent below 2005 levels by 2025, 45 percent by 2030, and zero or near-zero emissions by 2050. Lawmakers also passed bills on electric school buses and lighting efficiency standards. After the legislative session ended, the state continued to make progress. Governor Sisolak signed Executive Order 2019-22, committing the state to reducing global warming pollution. The Order requires state agencies to coordinate to develop policy recommendations to meet the state's GHG goals, incorporating stakeholder and community input and considering the impact of climate policies on low-income and disadvantaged communities. Nevada agencies are currently developing a State Climate Strategy, for delivery to Governor Sisolak on December 1, 2020, containing policy and budgetary recommendations to put the state on the path to meeting its greenhouse gas reduction goals.

GridLab, the Natural Resources Defense Council (NRDC), and the Sierra Club commissioned the modeling and analysis in this document to help the State of Nevada, stakeholders, and ourselves as advocates and policy experts understand viable pathways to a deeply decarbonized future in Nevada. Evolved Energy Research (Evolved) worked with the author organizations to develop scenarios that highlight different choices Nevada could make: the state could focus on reducing transportation and building energy demand,



for example, or could decide to delay the shutdown of coal facilities. Evolved then modeled the integrated energy system under these scenarios, using two analysis tools, EnergyPATHWAYS and RIO, which represent energy supply and demand with a high level of sectoral, temporal, and geographic detail. This detail means the models account for key dynamics in the energy system, including the inertial challenges to infrastructure stock turnover and the hour-to-hour dynamics of the electricity system. Evolved has used this modeling framework for a range of decarbonization analyses, including Committing To Climate Action: Equitable Pathways For Meeting Colorado's Climate Goals, 350 PPM Pathways for the United States, the Clean Energy Transition Institute's Meeting the Challenge of Our Time: Pathways to a Low-Carbon Future for the Northwest, and others. Evolved has used EnergyPATHWAYS for many more projects, including the National Renewable Energy Laboratory's Electrification Futures Study and a deep decarbonization analysis for Portland General Electric.

Evolved's modeling shows us that the state will fail to meet its greenhouse gas emissions reduction goals without new policies, fast power sector emissions reductions, and near-complete electrification of buildings and transportation. The modeling also reveals tradeoffs, showing, for example, that keeping coal plants open means we must electrify the vehicle fleet faster and that ramping up building retrofits and demand flexibility reduces land requirements for renewable energy. Complementing Evolved's work, Physicians, Scientists, and Engineers for Health Energy (PSE) studied the distribution of criteria air pollutant emissions across Nevada and showed that they are concentrated in already-vulnerable communities where people struggle to pay energy bills. This information is relevant in setting appropriately ambitious targets and designing policies.

CURRENT EMISSIONS

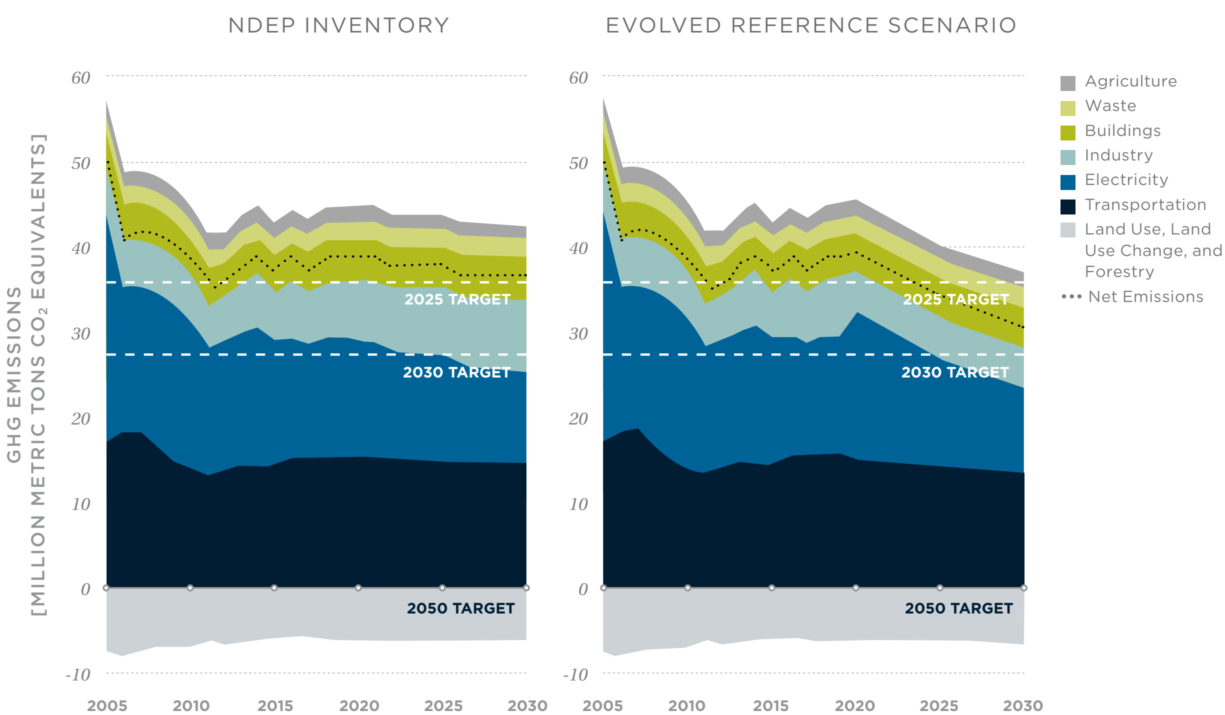
Despite taking some significant steps, Nevada is not on track to meet its 2030 and 2050 climate goals.

Nevada's gross emissions from all sectors totaled around 43 million metric tons of CO_2-equivalent ($MMTCO_2e$) in 2016, according to the state's most-recent official inventory of global warming pollution in the state, 2019 Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2039, published by the Nevada Division of Environmental Protection (NDEP). This inventory of emissions provided key baseline data for the modeling described in this report.

Figure 1 replicates the key graph in the inventory report, showing Nevada's historical greenhouse gas emissions, from 2005 to 2016, and NDEP's projections from 2017 to 2030. The graph also shows Evolved's projected Reference Scenario emissions, which include emissions from imported and exported electricity, from 2020 to 2030. The figure illustrates several important facts about Nevada's greenhouse gas emissions and trajectories. First, electricity sector emissions dropped sharply after 2005 as the Reid Gardner and Mohave coal plants retired. Second, emissions from transportation, industrial facilities, and buildings are not projected to decline much without new policy. Finally, Nevada's lands (mainly its forests) have acted as a substantial sink for CO_2 in the past, sequestering an amount of CO_2 each year approximately equivalent to industrial sector emissions. However, continued drawdown of CO_2 by forests is at risk with drought and wildfire. Although emissions from energy-using sectors are the focus of this report, taking action to protect the state's ability to continue sequestering CO_2 in its forests, habitat, and rangelands is critical to the overall climate effort.

FIGURE 1. HISTORICAL AND REFERENCE SCENARIO GREENHOUSE GAS EMISSIONS BY SECTOR, WITH COMPARISON TO NEVADA'S 2025, 2030, AND 2050 GOALS

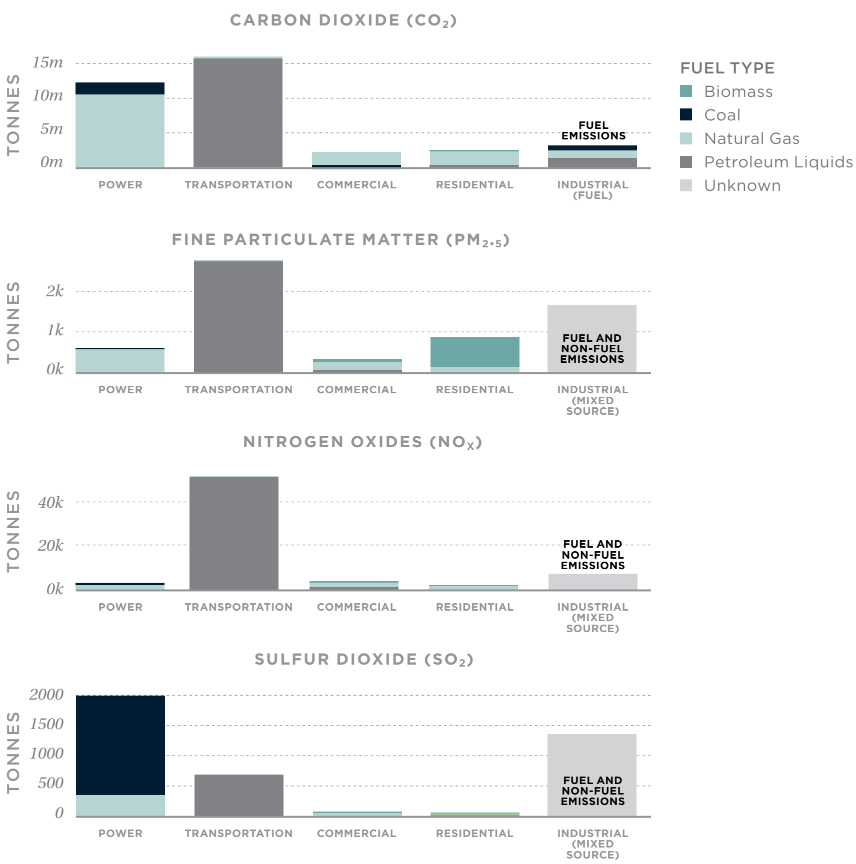
The black dotted line shows Nevada's net emissions, defined as gross emissions minus emissions sequestered in land sinks. Nevada's goals are set in terms of net emissions. Absent policy, emissions are not projected to decline enough to meet 2030 climate goals in either NDEP's projections or the Evolved Reference Scenario, as can be seen by comparing the black dotted line with the white dashed line that represents the 2030 target.



While CO_2 is a pollutant that mixes globally in Earth's atmosphere, affecting everyone, other pollutants, including "criteria" air pollutants, have more local impacts. Criteria pollutants are six of the most common air pollutants—carbon monoxide, lead, ground-level ozone, particulate matter (PM), nitrogen oxides (NO_x), and sulfur dioxide (SO_2)—which are harmful to human health and are regulated by the U.S. Environmental Protection Agency, as required by the Clean Air Act. To help understand the air quality and equity implications of Nevada's energy transition, PSE conducted an emissions burden, energy burden, and demographic analysis using 2017 to 2019 baseline emissions information, and Evolved's modeling of the future. Figure 2 shows air pollutant emissions in Nevada in 2017, broken out by sector.

FIGURE 2. CARBON DIOXIDE AND CRITERIA POLLUTANT EMISSIONS BY SECTOR IN 2017

Plotted emissions are associated with energy production and use, with the exception of criteria air pollutant emissions from the industrial sector, which include non-energy emissions as well.



Emissions of criteria air pollutants are not spread evenly across Nevada. Figure 3 shows fine particulate matter ($PM_{2.5}$) emissions by census tract, based on facility-specific emissions information for the power and industrial sectors, traffic information for the transportation sector, and PSE modeling for the residential buildings sector. Census tracts are then ranked by emissions and divided into quintiles. The figure shows that $PM_{2.5}$ emissions are higher along transportation corridors, including highways and airports. Heavy-duty vehicles are sources of $PM_{2.5}$ emissions and NO_x emissions—a precursor for ozone and PM formation—leading to higher emissions near highways. Living in a census tract with relatively low emissions does not necessarily mean that health impacts will be minimal. Particulate matter can have a direct impact where emitted and across the airshed. Nitrogen oxide emissions can likewise have local direct impacts but can also form secondary PM and ozone, which affect entire basins (e.g., the Las Vegas metropolitan area) and can travel between airsheds, affecting communities farther away from the source. Deployment of high density air monitors can help to better identify local pollution hotspots, and full air pollutant fate and transport modeling can improve understanding of the impact of different decarbonization strategies on these hotspots and their impact on public health.

FIGURE 3. LOCATION OF $PM_{2.5}$ EMISSIONS ACROSS THE POWER, TRANSPORTATION, INDUSTRIAL, AND RESIDENTIAL BUILDINGS SECTORS IN NEVADA, 2017

A similar map for NO_x emissions shows very similar results: emissions are concentrated along major highways, and at airports. The Las Vegas region is considered to be in marginal nonattainment for federal ozone standards.

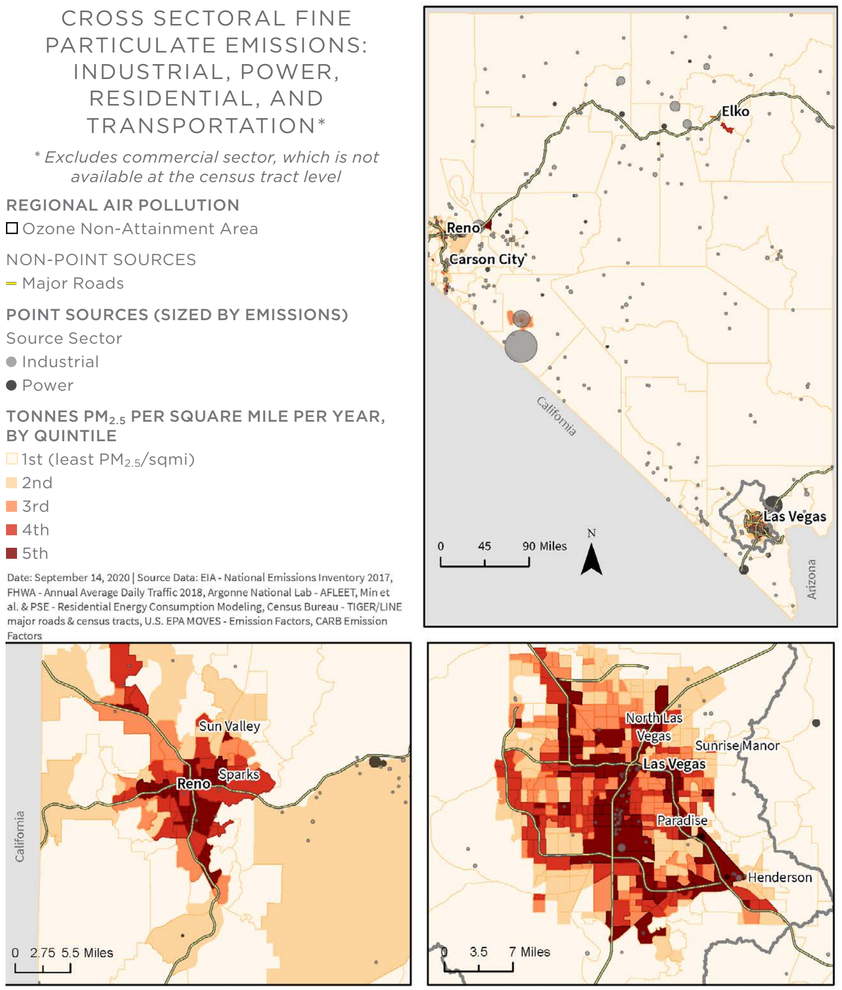
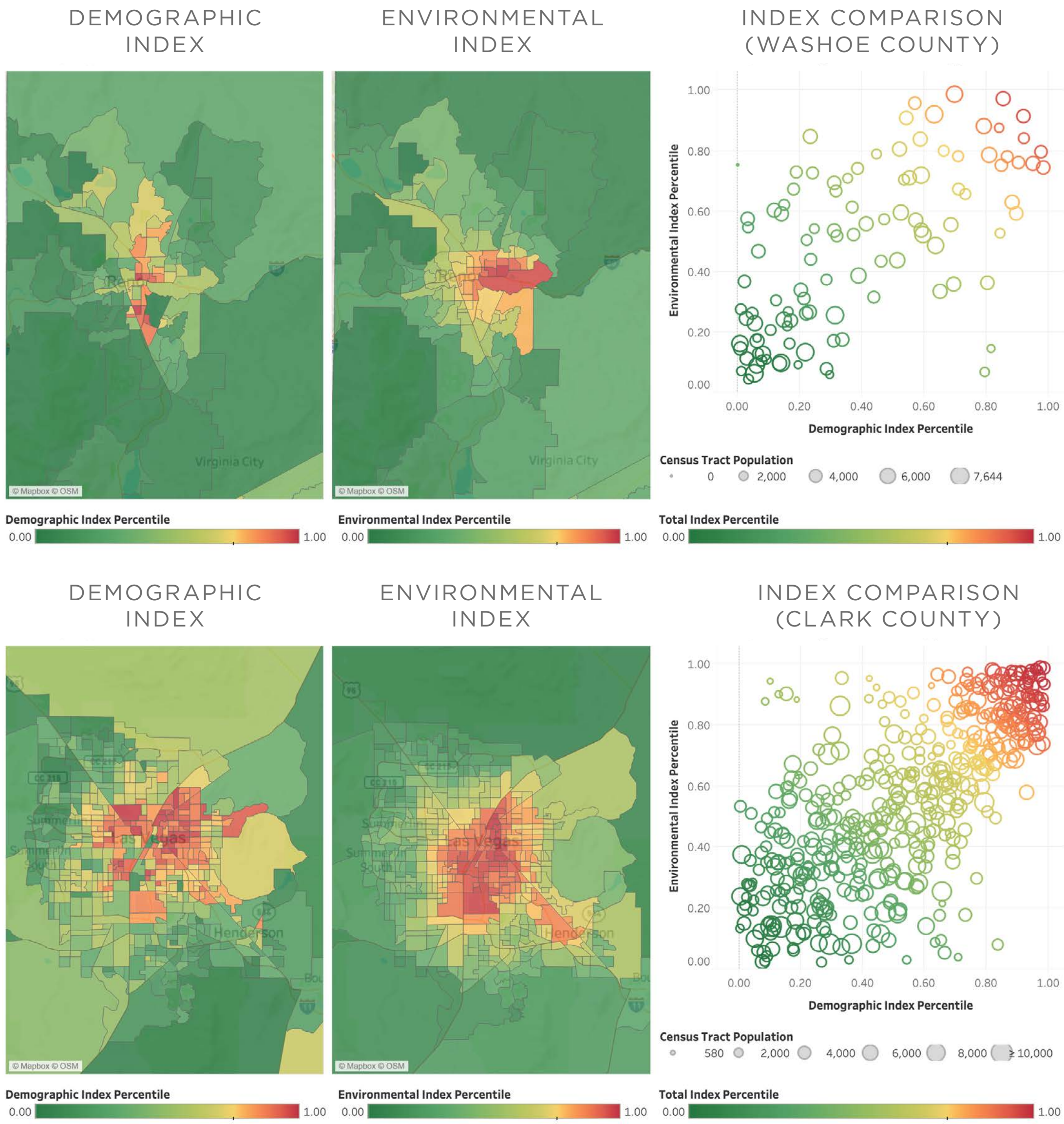


Figure 3 shows that $PM_{2.5}$ emissions are concentrated along major highways, and Figure 2 shows the large role of the transportation sector in air pollutant emissions. With the recent retirement of coal facilities and potential reduction in gas-fired electricity generation, the power sector is a rapidly shrinking source of emissions. However, a few facilities are projected to operate in the longer term for reliability purposes—including a high-emission peaker plant in a low-income and minority community in Las Vegas—without specific measures to ensure legacy fossil infrastructure does not remain in frontline communities.

FIGURE 4. CLARK (TOP ROW) AND WASHOE COUNTY (BOTTOM ROW) CENSUS TRACTS RANKED BY SOCIOECONOMIC VULNERABILITY AND ENVIRONMENTAL POLLUTION.



The maps in Figure 4 show Las Vegas and Reno census tracts with relatively high socioeconomic vulnerability[1] and census tracts with relatively high pollution, calculated from a combined set of indicators reflecting pollution metrics such as ozone and proximity to potentially polluted locations such as Superfund sites. There is a strong relationship between the two: census tracts with high direct emissions are highly likely to have high socioeconomic vulnerability. There are multiple potential explanations for this correlation, including, for example, decisions to limit truck transportation along corridors adjacent to higher income communities. These types of decisions may have contributed to the disproportionate pollution levels encountered by low-income and minority communities and should be addressed to ensure equitable outcomes.

1 Socioeconomic vulnerability was calculated using an index described in the Methodology section and calculated using indicators for minority, low-income, linguistically isolated, low educational attainment, very young, and elderly populations.

ENERGY SYSTEMS MODELING

Evolved modeled the energy system using two tools: EnergyPATHWAYS and the Regional Investment and Operations (RIO) platform.

EnergyPATHWAYS is a bottom-up energy sector scenario planning tool. It performs a full accounting of all energy, cost, and carbon flows in the economy and can be used to represent both current fossil-based energy systems as well as transformed, low-carbon energy systems. The tool represents infrastructure that produces, converts, stores, delivers, or consumes energy with a robust set of technology options. It includes detailed representations of existing infrastructure, like power plants, refineries, equipment stock in buildings, and vehicle stock, and options for new infrastructure and resources. Evolved used EnergyPATHWAYS to produce demand-side scenarios based on input assumptions for technology stock turnover under each policy scenario we considered. The model produces results for fuel and electricity demand based on these assumptions for each scenario.

Evolved paired EnergyPATHWAYS with RIO, an energy system planning tool that is specifically designed to study deeply decarbonized energy systems, which will work very differently from today's systems. RIO finds the least-cost set of investments and operational strategies for the energy supply system, considering future policy, fuel pricing, technology pricing, and demand-side flexibility. The platform represents investment and operation decisions in the electricity sector and fuel production for direct use. RIO also captures the time variability of electricity supply and demand with high resolution, which is important for characterizing systems with significant variable renewable energy generation. We used RIO to optimize energy supply decisions based on the demand-side results generated from EnergyPATHWAYS and considering emissions constraints for states in the region that have them. The following diagram describes the relationship between these two modeling tools.

EnergyPATHWAYS and RIO Overview

Description	EnergyPATHWAYS (EP)	Regional Investment and Operations (RIO)
	Scenario analysis tool used to develop **demand-side** scenarios across all end-use sectors	Tool to develop cost-optimal **energy supply** portfolios for all fuel types
Track Record	Many regional, U.S.-wide, and international decarbonization studies	Decarbonization studies of the U.S., Northwest, Mexico, and Europe
Application	Scenario design allows for alternative electrification and efficiency measures, which produces: • Annual energy demand for all fuels (electricity, pipelines gas, diesel, etc.) • Hourly electricity load shape These energy demand parameters are inputs to RIO	Demand projections from EP used to produce cost-optimal energy supply portfolios: • Electricity sector capacity expansion • Biomass allocation across fuels • Synthetic electric fuel production • Direct air capture deployment

Both models rely on input assumptions for fuel price forecasts, technology costs, and technology performance characteristics. We chose these assumptions based on reputable and commonly used sources, summarized in Table 1 below.

TABLE 1. KEY TECHNOLOGY ASSUMPTIONS

ASSUMPTION	DATA SOURCE
Renewable Energy	Costs for onshore and offshore wind, solar photovoltaics, new nuclear, new gas, and geothermal are from the mid-case scenario from the National Renewable Energy Laboratory's 2019 Annual Technology Baseline.
Power Plant Carbon Capture and Sequestration	A 90 percent capture option is available in the model, with costs from a 2018 report from Advanced System Studies for Energy Transition.
Energy Storage	Lithium-ion batteries and flow batteries are available to the model, with costs from a 2019 report from the International Council on Clean Transportation and a 2019 report from Bloomberg New Energy Finance.
Fossil Fuel Prices	Fuel price forecasts are based on the U.S. Energy Information Administration's Annual Energy Outlook 2019.
Biomass	Biomass costs are based on a 2018 report from the International Energy Agency.
Hydrogen and Synthetic Fuels	Electrolysis costs and the costs of producing electric fuels are based on a 2018 report from Advanced System Studies for Energy Transition.
Direct Air Capture	Direct Air Capture costs are based on "A Process for Capturing CO_2 from the Atmosphere," a 2018 paper by David Keith et al.

Our assumptions on biofuels availability are of particular importance to the modeling results. Biomass feedstocks carry climate and ecological risks, and only a subset of feedstocks are appropriate to use as environmentally sustainable and climate-friendly solutions. For this reason, our analysis restricts biomass availability to a subset of feedstocks with lower risks. This mix excludes high-risk feedstocks, such as forest biomass. In total, 430 million dry tons per year of sustainable biomass feedstocks are available in the model. Given this limited supply, and the potential for carbon capture on biofuels facilities, some biofuels from this biomass are considered negative emissions. Biofuels can made using the Fischer-Tropsch process (for diesel and jet fuel replacements), pyrolysis (for heavy fuel oil and solid fuel replacements), and bio-hydrogen and cellulosic ethanol (for gasoline replacement) conversion technologies. As noted elsewhere in the report, policymakers must ensure that all biofuels used to cut emissions are produced using sustainable biomass that is independently certified by the Roundtable on Sustainable Biomaterials (RSB) or meets an equivalent standard.

Evolved's modeling focused on energy and industrial emissions, but the state's climate targets cover economy-wide emissions, which extend beyond energy and industrial systems and include non-energy-related emissions from, for example, the solid waste, wastewater, and agriculture sectors, as well as land sinks. The climate targets also cover non-CO_2 greenhouse gas emissions (e.g., hydrofluorocarbons) that are related at least in part to the energy system but not covered in Evolved's modeling. The required reductions in energy and industrial CO_2 emissions are dependent on assumptions for future changes in these non-energy sectors and non-CO_2 emissions. Our analysis assumes that non-energy emissions decline substantially, in line with estimates from the U.S. Environmental Protection Agency on the mitigation potential for these emissions. Reductions in these emissions are not certain. The technical pathways and policies required to achieve these reductions are out of the scope of this report but are important for the state to achieve the state's greenhouse gas reduction goals.

To understand the tradeoffs between different emissions reduction strategies, especially the different criteria pollutant, cost, and sectoral impacts of each strategy, Evolved modeled a Reference Scenario, where the state has no binding greenhouse gas reduction targets, and the following scenarios and sensitivities, which all include binding targets:

- A **Core Scenario**, where EnergyPATHWAYS employs rapid adoption curves for key demand-side technologies like electric vehicles and appliances, informed by Evolved's expert judgement, and the RIO model optimizes energy supply decisions to meet 2030 and 2050 targets. In the modeled results, the electricity sector decarbonizes quickly to meet the 2030 goal, while the 2050 goal is met with near-complete electrification of on-road transportation, heating, and the limited use of low-carbon fuels and sequestration;
- An **Energy Efficiency Scenario**, in which energy demand for the building and transportation sectors decline even further than in the Core Scenario due to increased retrofits of existing homes, increased buildout of public transit infrastructure, and reduced aviation use. Flexibility of building and transportation electricity load is double that in the Core Scenario;
- An **Extended-Coal Sensitivity**, in which the power sector reduces CO_2 emissions more slowly than in the Core Scenario (leaving 1.7 MMT more CO_2 emissions on the system in 2030 than in the Core Scenario), forcing other sectors to move faster than their already-fast reduction trajectories. By 2050, scenario outcomes converge with the Core Scenario;
- A **Fossil-Free Sensitivity**, in which the United States stops producing and using fossil fuels by 2050, requiring the development of even more renewable fuels infrastructure.

This analysis will mostly compare the Reference, Core, and Energy Efficiency Scenarios. The Extended-Coal Sensitivity shows how failing to quickly close Nevada's remaining coal plants and replace them with clean capacity will require faster emission reductions in other sectors. The Fossil-Free Sensitivity will be used to estimate the maximum amount of renewable energy infrastructure Nevada will need to develop and to demonstrate the need for well-coordinated land-use planning in a very-high renewables future.

These scenarios are intended to show tradeoffs among different strategies, rather than to emphasize absolute outcomes. The kind of modelling in this report is inherently uncertain and imperfect, and using highly specific results can seem to provide false precision. The policy recommendations therefore do not perfectly track any of the scenarios but instead represent the scale of ambition needed to meet the 2025, 2030, and 2050 emissions targets.

Assumptions for each scenario and sensitivity are in Table 2 below. New power plants and battery energy storage projects that are planned but not yet operational at the beginning of 2020 are not automatically included in the scenarios and sensitivities.

TABLE 2. SCENARIO AND SENSITIVITY ASSUMPTIONS

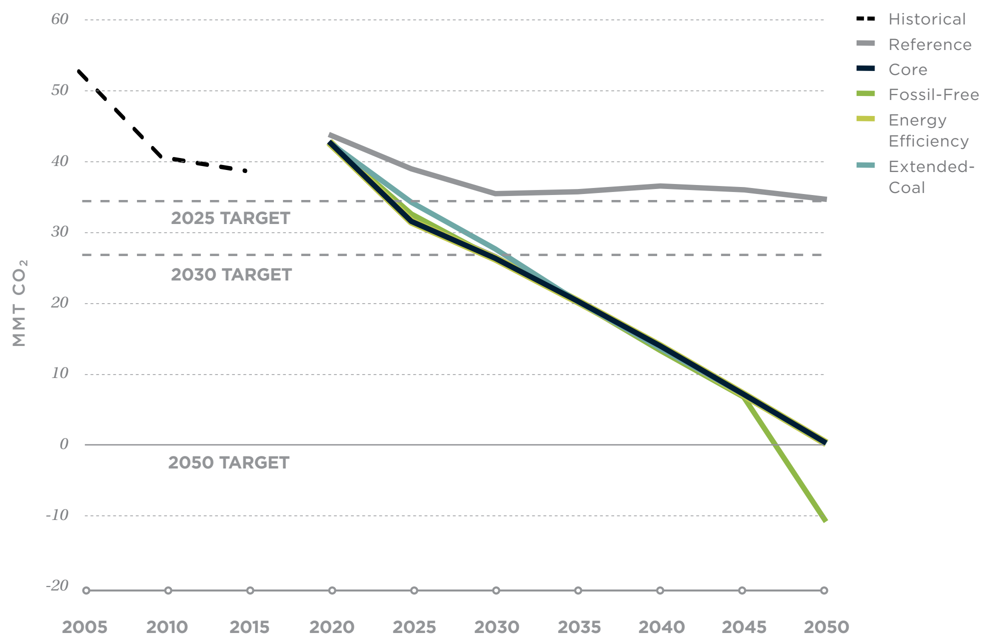
	REFERENCE SCENARIO	CORE SCENARIO	ENERGY EFFICIENCY SCENARIO	EXTENDED-COAL SENSITIVITY	FOSSIL-FREE SENSITIVITY
ECONOMY-WIDE					
Are 2025, 2030, 2050 targets binding?	No	Yes	Yes	Yes	Yes
ELECTRICITY					
North Valmy 1 and 2 coal-fired power plants:	retire according to their firm retirement dates, in 2021 and 2026, respectively.	are allowed to economically retire before firm retirement dates; in results, they economically retire between 2021 and 2025	same as Core	Valmy 2 is made to stay open longer than economically justified given GHG limits; in results, it retires between 2026 and 2030.	same as Core
TS Power:	operates beyond 2040 as a dual-fuel, coal-gas steam plant, with fuel choice dependent on prices.	is allowed to economically retire; in results, it economically retires between 2021 and 2025.	same as Core	is made to stay open longer than economically justified given GHG limits; in results, it retires between 2031 and 2035.	same as Core
Renewables development:	is optimized, considering economics and the 50% RPS.	is optimized, considering economics and the GHG targets.	same as Core	same as Core	is optimized, considering economics, GHG targets, and the need to replace fossil fuels by 2050.
TRANSPORTATION					
Pace of vehicle electrification	is slow.	is rapid, based on Evolved's expert judgement of the pace needed to meet GHG reduction goals.	same as Core	is faster than in the Core Scenario, to make up for extra emissions from coal plants.	same as Core
Vehicle miles traveled (VMT) and aviation demand:	increase as projected by the U.S. Energy Information Administration in the Annual Energy Outlook.	same as Reference	are less than in the Reference and Core Scenario: light-duty VMT is 35% lower than in the Core Scenario; heavy-duty VMT and aviation demand are 20% lower.	same as Reference and Core	same as Reference and Core
Electric vehicle load flexibility:	N/A	Half of light- and medium-duty vehicle load and 25% of heavy-duty vehicle load is flexible.	All light- and medium-duty vehicle load and 50% of heavy-duty vehicle load is flexible.	same as Core	same as Core

	REFERENCE SCENARIO	CORE SCENARIO	ENERGY EFFICIENCY SCENARIO	EXTENDED-COAL SENSITIVITY	FOSSIL-FREE SENSITIVITY
BUILDINGS					
Pace of adoption of building electrification and efficient appliances:	Minimal electrification and efficiency improvements	is rapid, based on Evolved's expert judgement of the pace needed to meet GHG reduction goals.	same as Core	is faster than in the Core Scenario, to make up for extra emissions from coal plants.	same as Core
Pace of building shell retrofits:	No shell improvements	is rapid, based on Evolved's expert judgement of the pace needed to meet GHG reduction goals.	is more rapid than in the Core Scenario. All residential buildings are retrofitted by 2050.	same as Core	same as Core
Share of building electricity load that is flexible:	None	50%	100%	same as Core	same as Core
FOSSIL FUELS					
	N/A	N/A	N/A	N/A	Fossil fuel production and use stops in 2050. In the scenario results, all fossil-fuel energy use not eliminated by efficiency, electrification, and hydrogen must be replaced with biofuels or synthetic fuels.

Except in the Reference Scenario, all scenarios meet the 2025, 2030, and 2050 greenhouse gas reduction goals in SB 254, as shown in Figure 5 below. All scenarios include emissions from imported and exported electricity. In the Fossil-Free Sensitivity, emissions are negative in 2050 because gross emissions drop to near zero with the elimination of fossil fuels from the economy and a small amount of biofuels with carbon capture provides a net emissions sink.

FIGURE 5. NEVADA ENERGY AND INDUSTRIAL CO_2 EMISSIONS ACROSS SCENARIOS, WITH SB 254'S 2025, 2030, AND 2050 EMISSIONS TARGETS

The emissions targets are the equivalent targets for energy and industrial CO_2 emissions, calculated based on the economy-wide GHG targets and trajectories for reductions in non-energy and non-CO_2 emissions. Scenarios have similar trajectories until 2050, where the Fossil-Free sensitivity shows negative emissions.



HEALTH AND EQUITY ANALYSIS

Using Evolved's results, PSE performed secondary modeling to estimate local air emissions in the different decarbonization scenarios and to study how emissions reductions map with low-income communities and communities of color. PSE also examined the existing distribution of criteria air pollutant emissions and energy burdens in Nevada.

PSE's analysis covered:

- The relationship between socioeconomic and demographic indicators across the state and energy system impacts and trends;
- The recent (2017, 2019) distribution of criteria air pollutant emissions from fossil fuel use;
- Modeled changes in these air pollutant emissions under the scenarios and sensitivities and the geographic distribution of those changes;
- Historical trends in energy costs, energy burdens, and access to clean energy technologies;
- Modeled adoption of clean energy technologies, changes to energy costs, and the energy burden and equity implications of these changes.

PSE analyzed the characteristics of populations across Nevada using data aggregated from the U.S. Census Bureau and the U.S. Environmental Protection Agency's EJSCREEN environmental justice screening tool.[2] EJSCREEN includes a nationally consistent dataset and approach for combining environmental and demographic indicators, a way to display this information visually, and a method for combining environmental and demographic indicators into environmental justice indices. The tool includes census block group information on a set of demographic and environmental indicators, including:

Demographic indicators:

- **Minority:** Fraction of people who are not non-Hispanic, white-alone individuals;
- **Low-income:** Population in households whose income is less than double the federal poverty level;
- **Linguistic isolation:** Population living in households where no one over 14 speaks English as a primary language and all adults speak English less than "very well;"
- **Educational attainment:** Fraction of adults with less than high school education;
- **Children:** Population fraction under age five;
- **Elderly:** Population fraction over 64.

2 https://www.epa.gov/ejscreen

Environmental indicators:

- **National-Scale Air Toxics Screening Assessment data:** Indicators for 1) cancer risk from air toxics, 2) respiratory hazards from air toxics; and 3) diesel particulate matter;
- **Particulate matter:** Average annual fine particulate matter ($PM_{2.5}$) concentrations;
- **Ozone:** Average of summer daily eight-hour maximum ozone concentrations;
- **Traffic proximity:** Vehicle count at major roads;
- **Lead paint:** Percent of buildings built before 1960;
- **Hazardous facilities and sites:** Indicators for proximity to 1) Risk Management Plan sites with chemical accident plans; 2) hazardous waste facilities; 3) Superfund sites, and 4) wastewater discharge sites.

PSE created two indices to reflect combinations of demographic indicators and combinations of environmental indicators to identify populations vulnerable to pollution, in part due to socioeconomic burdens, or who might particularly benefit from the economic savings and resilience benefits of clean energy technologies. The Demographic Index was calculated by first averaging the percentiles for each of the six listed demographic indicators for each census tract. This raw census tract average was then assigned a statewide percentile by comparing census tracts across the state. This percentile value is the Demographic Index. A similar Environmental Index was created by applying the same methods to the environmental indicators from EJSCREEN. A census tract with a high score on the Demographic Index has a relatively high percentage of minority, low-income, linguistically isolated, low-education, young, and/or elderly people. A census tract with a high score on the Environmental Index has higher prevalence of the environmental pollution indicators, relative to other Nevada census tracts.

In addition to the indicators included in EJSCREEN, air pollutant emission and energy consumption data were aggregated from numerous sources, primarily federal datasets from the U.S. Environmental Protection Agency (EPA), U.S. Energy Information Administration (EIA), U.S. Bureau of Transportation Statistics (BTS), U.S. Federal Highway Administration (FHWA), and the U.S. Census. Census tract energy use for the residential sector was estimated using a regression model based on EIA Residential Energy Consumption Survey data and U.S. Census American Community Survey household data. Residential emissions were calculated by applying EPA AP-42 and California Air Resources Board (CARB) emissions factors. Transportation emissions were calculated by applying EPA Motor Vehicle Emissions Simulator emissions factors to vehicle travel and vehicle class data from the FHWA Highway Performance Monitoring System. Household transportation energy burdens were calculated using BTS, National Household Travel Survey, and FHWA data. Full data sources and methods will be detailed in a forthcoming report from PSE.

This section describes the results of the modeling and analysis from Evolved and PSE, broken down by sector. For each sector, we describe the technology adoption and energy supply changes that occur in the modeled scenarios, CO_2 emissions projections, and criteria emissions projections. Before this sector-specific information, we discuss costs broadly, using total per-capita energy and infrastructure costs from the modeling.

The core finding of this cost analysis is that Nevada can meet its climate goals while maintaining total energy costs similar to today's levels. The modeled pathways to achieving the climate goals also lead to significant reductions in criteria air pollutant emissions, but additional policies are necessary to ensure that socioeconomically and environmentally vulnerable communities are not stuck with remaining emissions. Achieving the state's emissions reduction goals requires a rapid acceleration in adoption of clean technologies across all sectors, starting today. The major changes the energy system must make by decade are described below. These major findings focus on the modeling results and do not include the other related steps (like a community engagement processes) that policymakers must take to ensure equitable outcomes. The table that follows, Table 2, shows key sectoral results in 2030.

2020s

- Build solar energy and battery storage at record pace, stop using coal by 2025, and curb use of gas power plants
- Accelerate EV sales so they comprise more than half of new sales by 2030 and begin electrification of medium- and heavy-duty transport
- Invest in electric transit, rail, and other measures that increase mobility while reducing transportation service demand
- Accelerate adoption of highly efficient, electric appliances so that they make up the bulk of sales by 2030
- Implement strategies to ensure electrified building appliances and vehicles operate flexibility to enable smoother operation of a highly renewable grid
- Ensure that all new residential buildings built in the 2020s have highly efficient shells, and by 2030, begin retrofitting the existing building stock to make it healthier and more efficient
- Heavily scrutinize new investments in the gas distribution system
- Ensure low-income households are included in building upgrades and adoption of efficient, electric appliances and electric vehicles

2030s

- Accelerate buildout of solar energy and storage even further to meet growing electricity demand from electrification and keep gas generation low
- Implement strategies to ensure imported electricity is clean
- Transform the light-duty vehicle stock with electric vehicles making up almost all new sales
- Accelerate sales of electric and hydrogen fuel cell vehicles for medium- and heavy-duty applications
- While ensuring that all or nearly all new buildings are fully electric and have highly efficient shells, upgrade a significant number of existing homes each year
- Begin building infrastructure to produce clean hydrogen and synthetic fuels
- Ensure low-income households are included in building upgrades and adoption of efficient, electric appliances and electric vehicles and implement strategies to reroute polluting heavy-duty trucks away from socioeconomically and environmentally vulnerable areas

2040s

- Accelerate buildout of solar energy and storage even further to meet growing electricity demand, reduce gas generation to near-zero, and ensure that remaining gas capacity operates only with carbon-neutral fuels
- Complete the electrification of vehicles and buildings
- Complete the turnover of building appliance stock to efficient options
- Expand production of clean hydrogen and synthetic fuels

TABLE 3. SUMMARY OF KEY SECTOR-BY-SECTOR RESULTS IN 2030

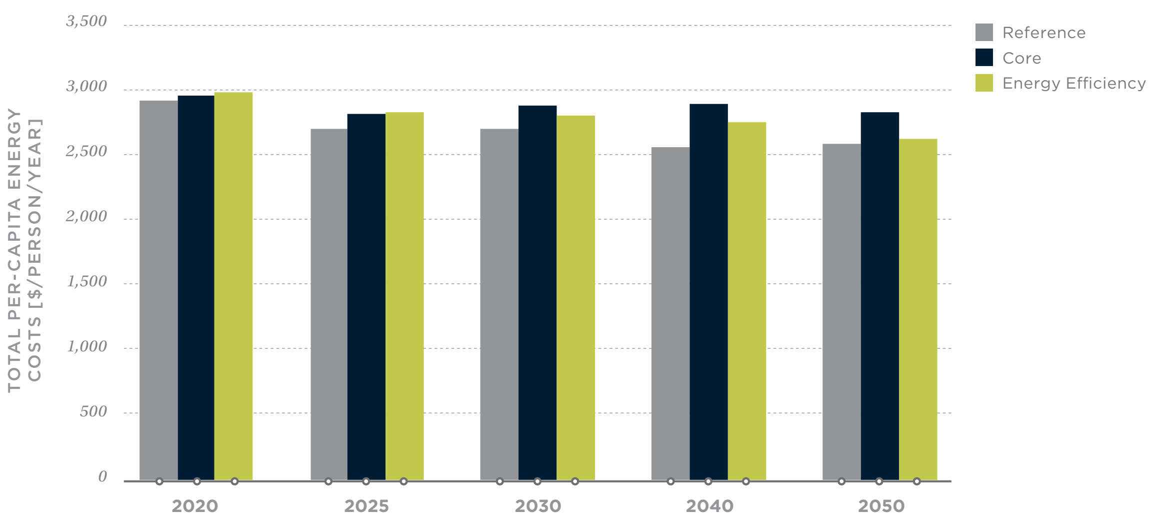
Sector	Measures/Metrics by 2030	Core Scenario	Energy Efficiency Scenario	Fossil-Free Sensitivity	Extended-Coal Sensitivity
Economy-wide	GHG reductions (relative to 2005)	46%	46%	46%	43%
Electricity	CO_2 reductions (in-state generation only, relative to 2005)	90%	87%	89%	86%
	% of in-state generation that is renewable	82%	78%	82%	80%
	Renewable energy capacity (GW)	12.8	12.6	13.4	14.7
Transportation	% of new vehicle sales that are zero-emission (electric or hydrogen):				
	Light duty	54%	54%	54%	78%
	Medium & heavy duty	21%	21%	21%	47%
	% of on-road vehicle stock that is zero-emission:				
	Light duty	17%	17%	17%	25%
	Medium & heavy duty	4%	4%	4%	9%
	Reduction in light-duty vehicle miles traveled (compared to Reference case)	0%	7%	0%	0%
	% of load that is flexible				
	Light duty	50%, 8 hrs	100%, 8 hrs	50%, 8 hrs	50%, 8 hrs
	Medium duty	50%, 3 hrs	100%, 3 hrs	50%, 3 hrs	50%, 3 hrs
	Heavy duty	25%, 3 hrs	50%, 3 hrs	25%, 3 hrs	25%, 3 hrs
Buildings	% of residential units with high-efficiency shells	11%	25%	11%	11%
	% of appliance stock that is high efficiency	20-40%	20-40%	20-40%	20-40%
	% of appliance stock that is electric				
	Commercial space heaters	25%	25%	25%	25%
	Commercial water heaters	21%	21%	21%	21%
	Residential space heaters	47%	47%	47%	61%
	Residential water heaters	44%	44%	44%	74%
	% of load that is flexible				
	Residential space heating / conditioning	50%, 1 hr	100%, 1 hr	50%, 1 hr	50%, 1 hr
	Residential water heating	50%, 2 hrs	100%, 2 hrs	50%, 2 hrs	50%, 2 hrs
	Commercial space heating	50%, 1 hr	100%, 1 hr	50%, 1 hr	50%, 1 hr

COSTS AND ENERGY BURDENS

Our modeling indicates that Nevada can achieve its greenhouse gas reduction goals with energy costs that are lower than today's. Figures 6 and 7 show the state's fuel and electricity expenses and any capital expenditures for energy-using infrastructure (e.g., vehicles, building appliances, equipment at industrial facilities). The per-capita energy costs are marginally higher in the Core Scenario than in the Reference case, though costs remain similar to today's through 2050. In the Energy Efficiency Scenario, which includes significant demand flexibility, costs are slightly higher than in the Core Scenario in the near-term, but lower in 2030 and beyond. Included within these per-capita cost figures is a transformation in how Nevadans pay for energy services. The state must make large new investments in clean energy infrastructure like renewable power plants, transmission lines, and electric vehicles and appliances, which then reduce the need for fossil fuels. That means Nevadans spend more on the electricity system but a lot less on fossil fuels, resulting in similar costs overall.

FIGURE 6. ANNUAL PER-CAPITA ENERGY COSTS FOR REFERENCE, CORE, AND ENERGY EFFICIENCY SCENARIOS

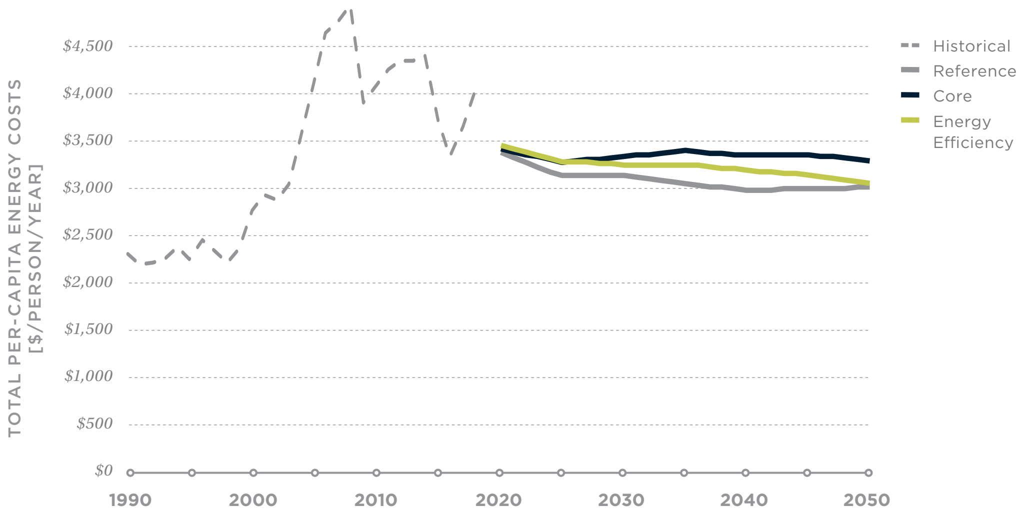
Costs for a given year include total capital investments that year (including, for example, the cost of upgrading buildings and purchasing new vehicles), combined with the operating, maintenance, and fuel costs of the energy and industrial system incurred that year, divided by the state population. Our analysis shows that increased levels of energy efficiency and demand flexibility may lower the cost of decarbonization over time.



Costs under the Core and Energy Efficiency Scenarios also are well within the range customers have experienced in the past, as the price of oil has increased and decreased. Figure 7 shows modeled energy costs in the context of historical energy expenditures.

FIGURE 7. PER-CAPITA MODELED ENERGY COSTS AND HISTORICAL ENERGY EXPENDITURES, 1990-2050

The Reference, Core, and Energy Efficiency lines represent modeled energy system costs, including total capital investments for a given year, combined with the operating, maintenance, and fuel costs of the energy and industrial system incurred that year, divided by the state population. The Historical line represents historical energy expenditures, which may not capture additional costs from demand-side capital investments that are not captured in fuel costs. For this reason, real historical energy costs may be higher than shown here. Data sources: U.S. Energy Information Administration State Energy Data System (SEDS): 1960-2018 (complete)



The impact of energy costs, even if they remain stable, is magnified for those with constrained budgets. People with low incomes spend a larger portion of that income on the basic necessities of life: housing, food, and cell phone bills, for example, as well as transportation and electric and gas utility service. Figure 8 below shows that residents in census tracts with a low average household income tend to spend a greater portion of their income on their energy bills. Energy burdens are somewhat higher in rural areas. Then, Figure 9 shows that the places where a large fraction of household income is spent on energy are also the places where low-income communities and communities of color live, based on the Demographic Index.

FIGURE 8. AVERAGE ENERGY BURDEN FOR RESIDENTIAL & TRANSPORTATION ENERGY COSTS BY CENSUS TRACT

Residents of lower-income census tracts spend a larger portion of their income on energy to power their homes and fuel their vehicles and appliances. "Micro" refers to census tracts located in a statistical area that has at least one urban cluster of between 10,000 and 50,000 people. Rural census tracts are defined as those that are neither in a metropolitan area or a micropolitan area.

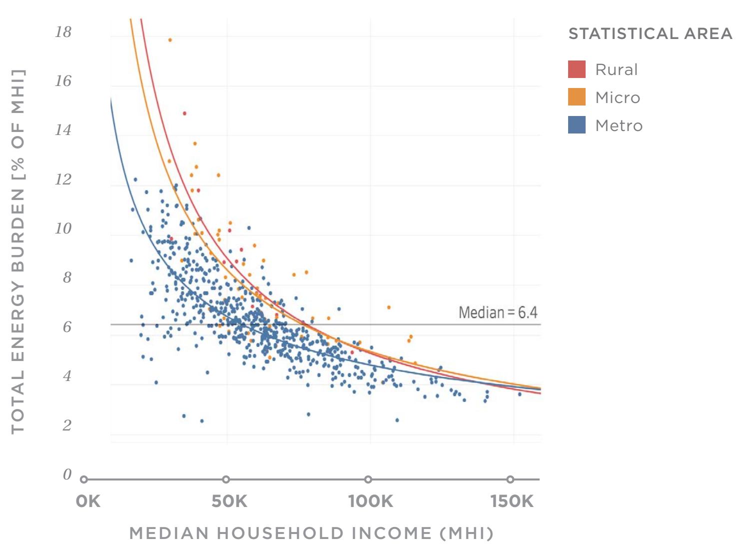
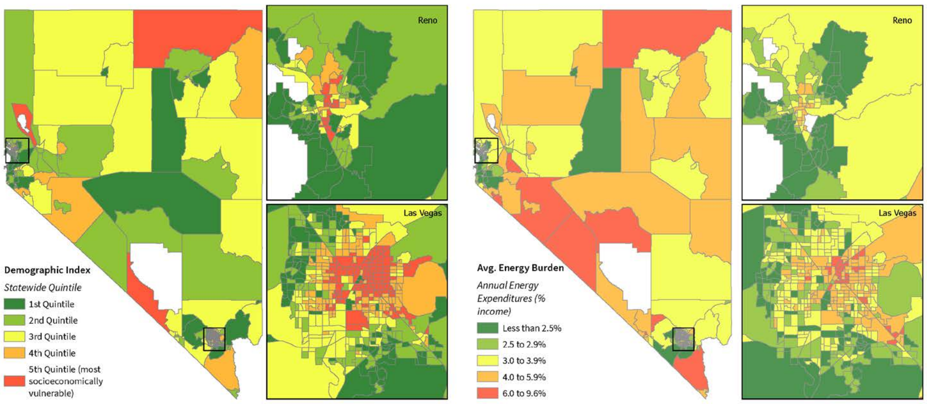


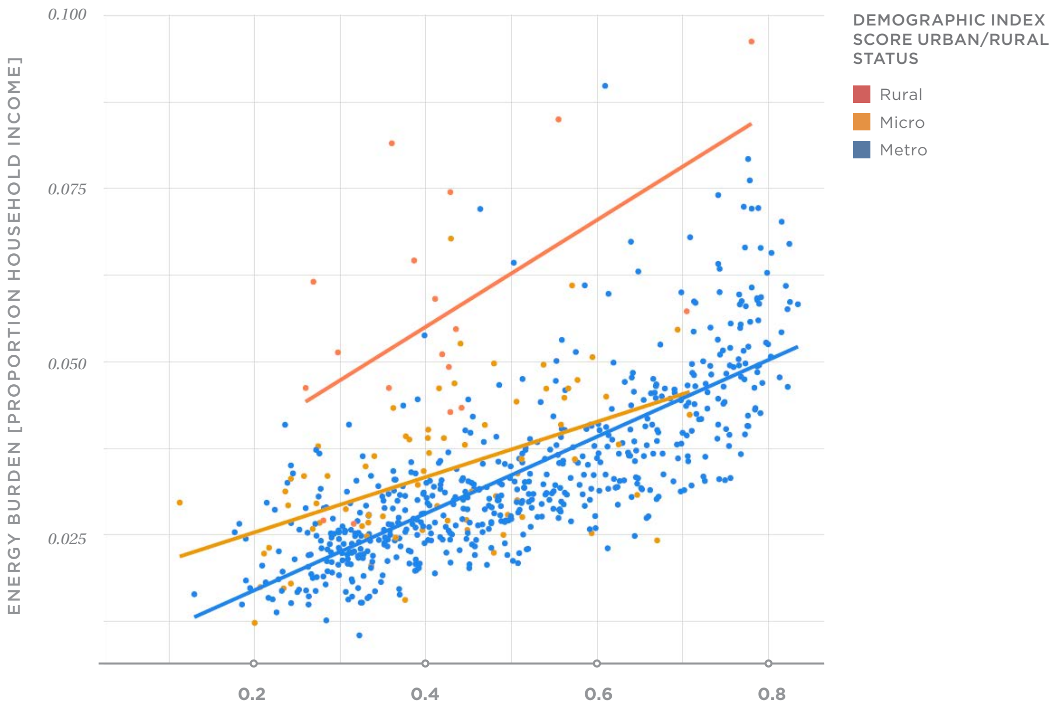
FIGURE 9. SOCIOECONOMIC VULNERABILITY AND ENERGY BURDEN IN NEVADA BY CENSUS TRACT

CENSUS TRACT DEMOGRAPHIC INDEX

CENSUS TRACT ENERGY BURDEN



CENSUS TRACT AVERAGE HOUSEHOLD ENERGY BURDEN AND DEMOGRAPHIC INDEX SCORE



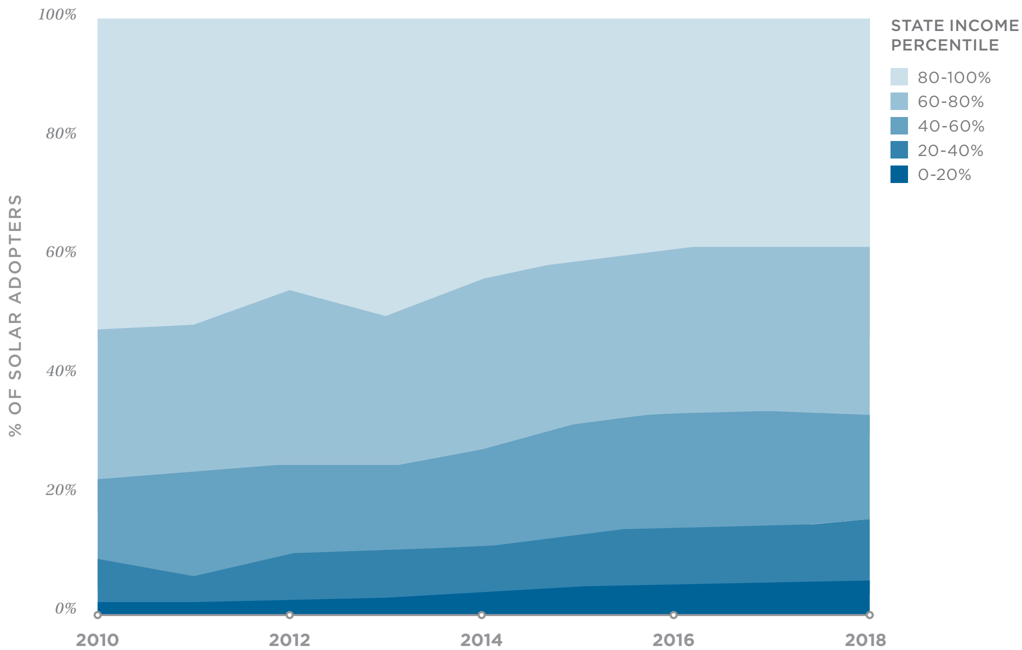
ADDRESSING ENERGY BURDENS AND COST

Targeted assistance is important to ensure that low-income people can afford investments that reduce the cost of decarbonization, such as efficiency measures and electrification. This targeted assistance is not limited to the energy sector. Programs like the Section 8 Housing Choice Voucher Program and the Supplemental Nutrition Assistance Program exist to help reduce the burdens of poverty on adults and children. To limit the cost impact of decarbonization for low-income customers, Nevada should update energy assistance programs, increase the ability of low-income customers to receive retrofits and efficiency improvements, address the split-incentive problem for renters and owners, and improve public transport and its accessibility. We should develop programs that help low-income customers move off of gas service and protect remaining customers from increasing gas rates as wealthier customers electrify their homes.

Clean, cheap, and reliable energy is critical but not the only goal. Nevada should design and implement an energy transition that engages low-income communities and communities of color in decision-making processes, addresses historical harm and inequities, prevents further inequities in a decarbonized energy system, and ensures benefits reach these communities. As an example of this dynamic, while well-sited large-scale renewable installations under contract to the utility benefit all customers, the high upfront cost of and other barriers to small-scale systems have resulted in disproportionate solar adoption by wealthier people, as shown in Figure 10, which shows the installation of small-scale solar systems by income bracket.

FIGURE 10. SOLAR ADOPTER INCOME DISTRIBUTION OVER TIME IN NEVADA, 2010 TO 2018

An equal distribution would have equal-sized "layers" for each income percentile.



Berkeley Lab, Electricity Markets and Policy Group, Solar Demographics Tool

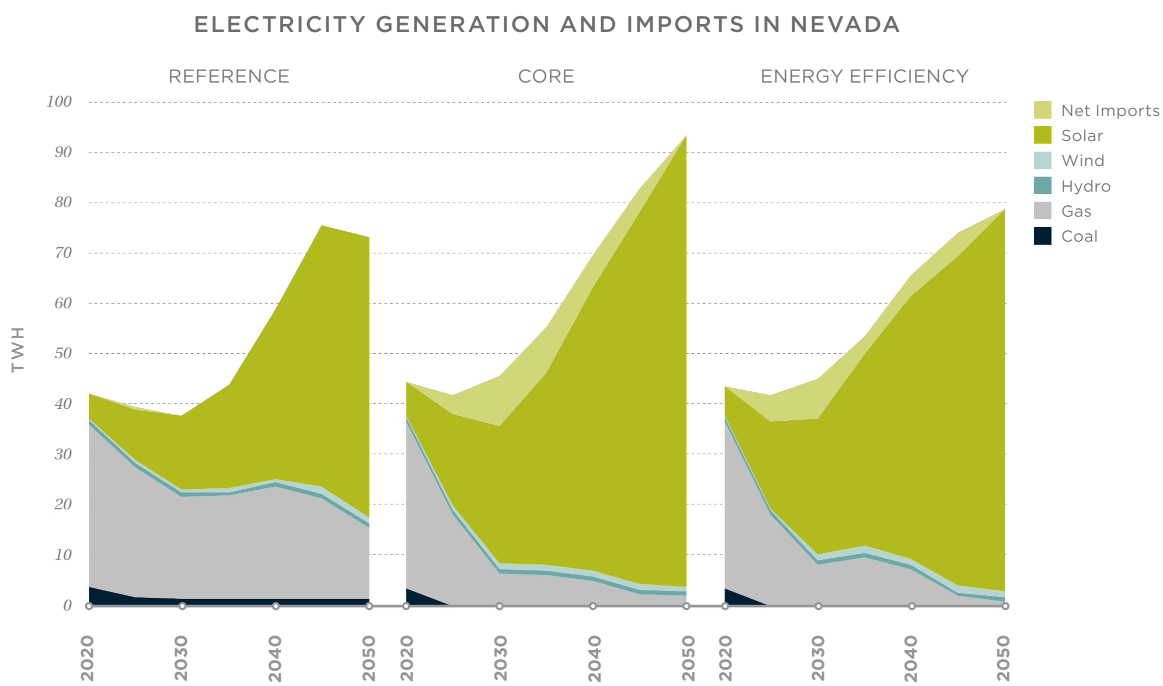
Limiting the costs of decarbonization for all customers will require policymakers to craft policies that cost-effectively realize decarbonization objectives. Policymakers should carefully design large new incentive programs to ensure that communities that have previously been left behind are engaged and prioritized in program and incentive design. This focus is particularly important for incentives that otherwise are likely to be disproportionately used by wealthier households.

ELECTRICITY

The biggest single takeaway from our modeling effort is the need for the electricity sector to decarbonize as quickly as possible. Nevada's 50 percent RPS is a start but is not sufficient to ensure the necessary growth in renewables, storage, or flexible grid management needed to meet the state's decarbonization goals. In the Core Scenario, carbon dioxide emissions from in-state electricity generation and electricity imports drop to 77 percent below 2005 levels by 2030. Renewables increase to provide 82 percent of in-state generation in 2030. Quickly decarbonizing the power sector with renewables is important because renewables are a comparatively cheap source of emissions reductions. A low-emissions power sector allows other sectors, especially transportation and buildings, to rely on electrification as a key decarbonization strategy.

FIGURE 11. YEARLY ELECTRICITY GENERATION ACROSS SCENARIOS

Nevada generates a growing amount of electricity from solar, with much greater growth in the Core and Energy Efficiency Scenarios. Coal generation drops to zero and gas generation drops considerably in the Core and Energy Efficiency Scenarios.



Solar energy—the vast majority generated at utility-scale plants—powers Nevada's future, as seen in Figure 11. Solar provides 76 percent of in-state generation, up from 16 percent in 2020. Meanwhile, gas generation declines, dropping from 74 percent of total generation in 2020 to 18 percent in 2030. While many gas-fired power plants stay online, they run much less frequently than today, as can be seen in Figure 11 and is shown specifically in Figure 14. This transformation must occur while the electricity generation and transmission system grows; compared to the Reference Scenario, electricity generation and imports are 19 percent higher in 2030 and 26 percent higher in 2050 in the Core Scenario, due to the significant electrification of buildings and vehicles required to decarbonize the other sectors.

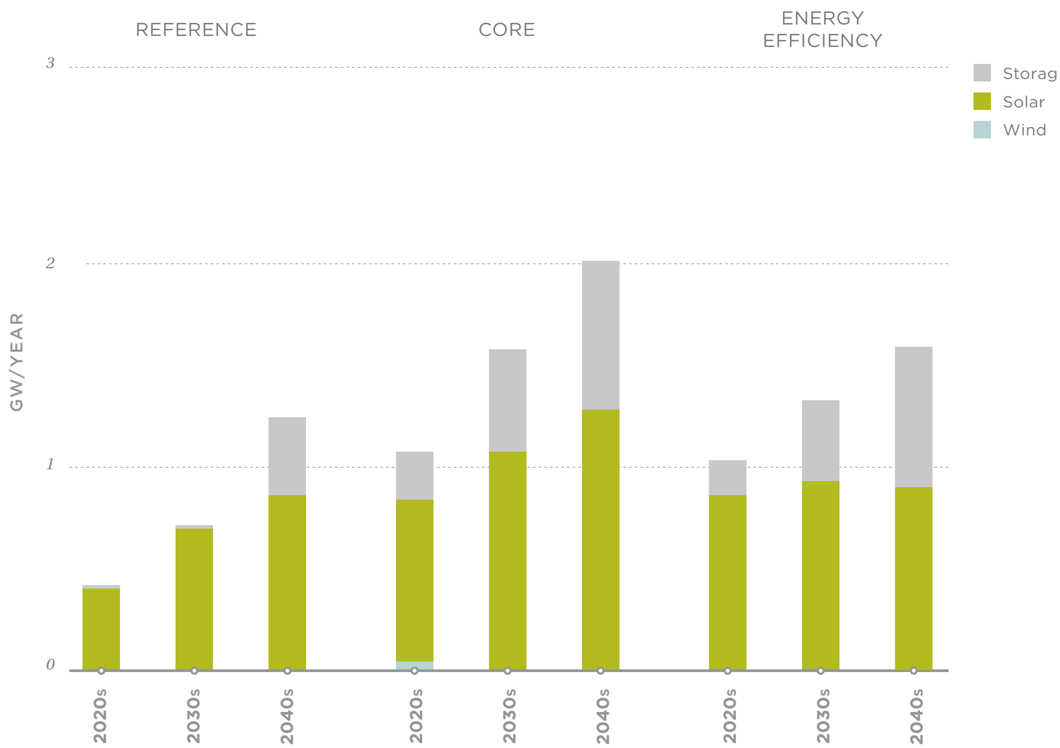
To achieve these levels of renewable generation, Nevada must build large amounts of solar power plants and energy storage facilities, as seen below in Figure 12. In the Core Scenario, Nevada is projected to add a total of 8.1 GW of solar, 2.3 GW of storage, and 300 MW of wind between 2020 and 2030, and an additional 24 GW of solar and 12 GW of storage in the two decades from 2030 to 2050. Additions are smaller in the Energy Efficiency Scenario, which requires 500 MW less storage capacity in 2030, and 5.2 GW less solar capacity and 1.2 GW less storage capacity between 2030 and 2050. The Energy Efficiency Scenario requires less renewable energy and energy storage capacity both because of increased energy efficiency *and* increased load flexibility. This scenario includes double the amount of flexible electric vehicle and building load than in the other scenarios and sensitivities. Energy efficiency and load flexibility reduce the need for new renewable power plants and therefore reduce these plants' associated land footprint.

Our modeling, with cost assumptions from the National Renewable Energy Laboratory's 2019 Annual Technology Baseline, does not show new geothermal being built in the Core or Energy Efficiency Scenarios. Geothermal is more likely to come online if costs are lower than assumed, or if the industry achieves technological and contractual changes that make geothermal plants able to operate more flexibly, as have been demonstrated at The Geysers power plant in California.

Storage development is likely underestimated in our results because the energy supply model does not take into account the need for ancillary grid services or sub-hourly ramping needs. Storage builds that were planned or underway but not yet operational at the beginning of 2020 are not automatically included in the Reference or other scenarios and sensitivities.

FIGURE 12. NEW POWER PLANT AND BATTERY ENERGY STORAGE CAPACITY, IN GW PER YEAR BY DECADE, ACROSS SCENARIOS

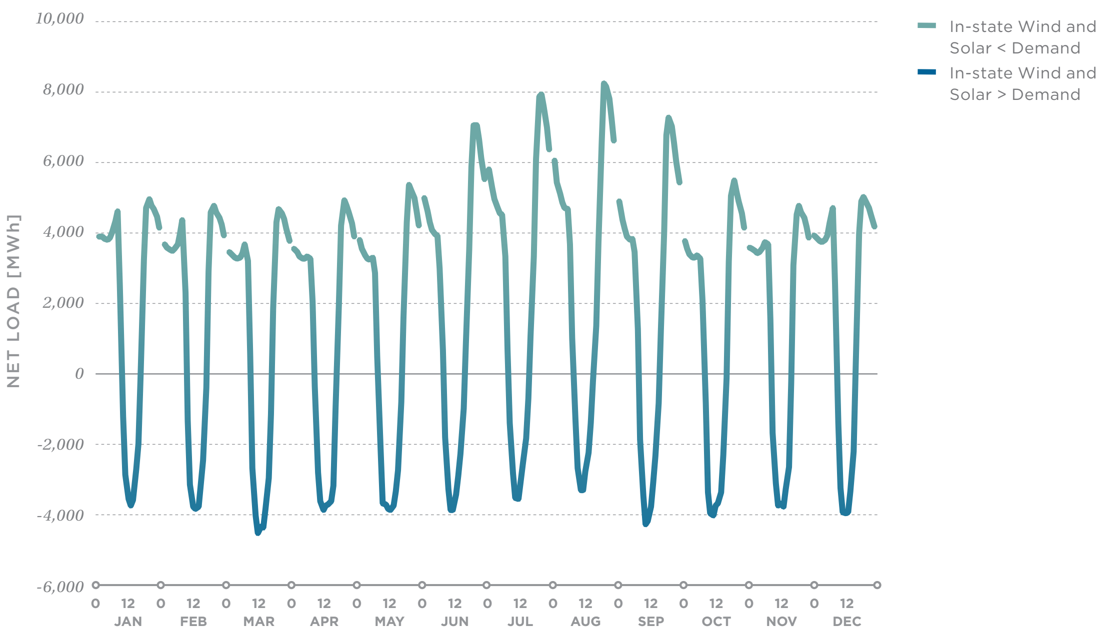
Nevada builds about 400 MW more solar capacity per year for the next three decades in the Core Scenario than in the Reference Scenario. While the state builds almost no energy storage until the 2040s in the Reference case, about 200 MW come online per year in the 2020s and 500 MW come online per year in the 2030s in the Core Scenario.



The main technical and economic challenge to operating a decarbonized electricity system—albeit a well understood challenge with many potential solutions—is balancing supply and demand at all times, with the variability in renewable energy output and the potential for lengthy periods of low or zero renewable energy output. Grid flexibility (e.g., through regional coordination, flexible demand, and long- and short-term storage) becomes more important with increasing levels of renewable energy. As shown in Figure 13, the 2030 electricity system in the Core Scenario experiences a noticeable year-round diurnal pattern, with a surplus of solar energy during the day and a deficit at night. This regular pattern of renewable energy deficits and surpluses is natural to highly renewable grids, and the model employs several grid flexibility strategies to provide reliable and affordable renewable electricity, shown in Figure 15.

FIGURE 13. AVERAGE MONTH-HOUR LOAD, NET OF WIND AND SOLAR GENERATION, IN THE CORE SCENARIO IN 2030

Net load is the difference between demand in a given hour and the output of variable renewable energy resources—like wind and solar—in that hour. The line in the graph is lighter blue in hours when demand exceeds the output of solar and wind (i.e., when net load is high), and darker blue in hours when the output of solar and wind exceeds demand (i.e., when net load is low). The graph shows us that in 2030, a highly decarbonized electricity system in Nevada would have large daily variations in in-state renewable energy output throughout the year because the vast majority of in-state renewable energy generation comes from solar. Average in-state solar output far exceeds in-state load in the middle of the day throughout the year—the trough in the middle of day around 12—while in the evenings solar output drops and net load peaks.



The modeled electricity system complements in-state solar generation with electricity imports, energy storage, some gas capacity, and flexible demand in order to reliably meet electricity needs and cut emissions.

Nevada is endowed with abundant solar and geothermal but less wind than many neighboring western states. As such, to meet its climate goals, Nevada would benefit from access to wind energy production from across the region, particularly to help meet demand during times of the day and seasons when solar is unavailable or less available. Meeting this demand through in-state resources alone during all hours of the year would be significantly more expensive and would likely use fossil capacity more frequently. A platform for sharing of short- and long-term energy products and joint transmission planning and development would allow Nevada to more easily access wind, and allow Nevada to more easily sell its solar surpluses. There are 38 separate balancing authorities across the fully interconnected western region. While power transfers among these units are increasing through the Energy Imbalance Market, there is still significant duplication of resources and disjointed regional planning and cost recovery for new transmission.

Nevada must cooperate with neighboring states to import wind and ensure that the imported electricity is entirely zero-emission in the long run. However, the near-term imports include some fossil generation in the Core Scenario. These near-term imports are still useful to enable greater solar adoption in the state, but the state must stop importing fossil electricity in the long run to meet its climate goals. By 2030, imported electricity is the largest source of electricity-sector emissions in the Core Scenario because most imports still come from fossil fuel power plants. Emissions from in-state generation drop 87 percent below 2005 levels by 2030, declining faster than emissions from imported generation. But by 2045, emissions from imported generation drop to zero, as the state only imports electricity from renewable resources.

In addition to trading power with neighbors, Nevada should strategically use in-state resources to ensure reliability. The Core Scenario includes 2.3 GW of energy storage in 2030, which charge during the solar peak and discharge to serve load when solar production wanes. Flexible building and transportation load is also important to reduce peaks and better match supply and demand. Most gas plants (6 GW of the existing 7 GW) stay online in 2030 for those times when renewable resources are not available on the western grid. However, these gas plants run very infrequently. On average, the remaining gas plants operate just 12 percent of the time in 2030, compared to 53 percent of the time in 2020. Gas plant utilization declines even further in the 2030s and 2040s, when the grid only uses these plants for system reliability. In this decarbonized grid, it will be important that Nevada plan for and secure sufficient reliability resources, taking into account the range of potential weather conditions, loads, imports, unit performance, and contingencies.

FIGURE 14. GAS CAPACITY AND UTILIZATION ACROSS SCENARIOS

Most existing gas plants stay online but run very infrequently in 2030 and beyond. By 2050, the remaining gas plants only run using carbon-neutral fuels (e.g., synthetic fuels produced with clean electricity). Fossil gas use declines to zero for the power sector by 2050.

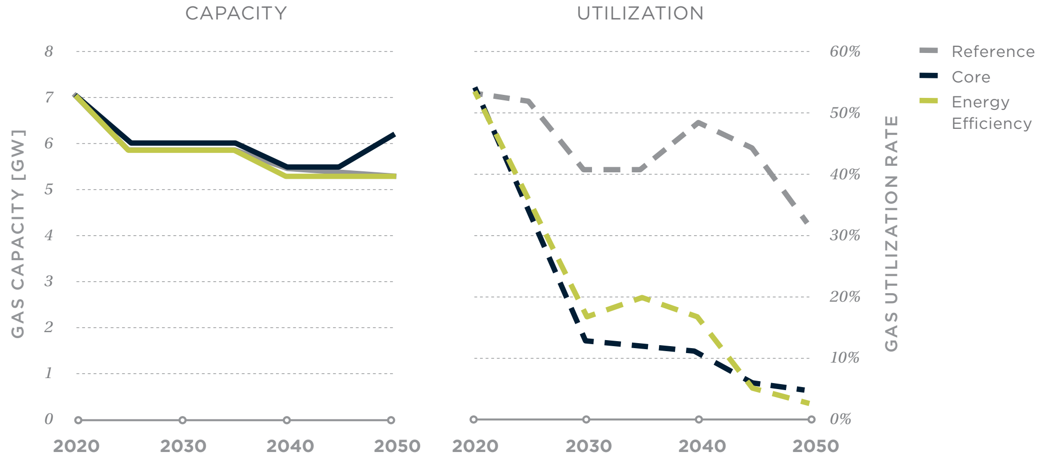
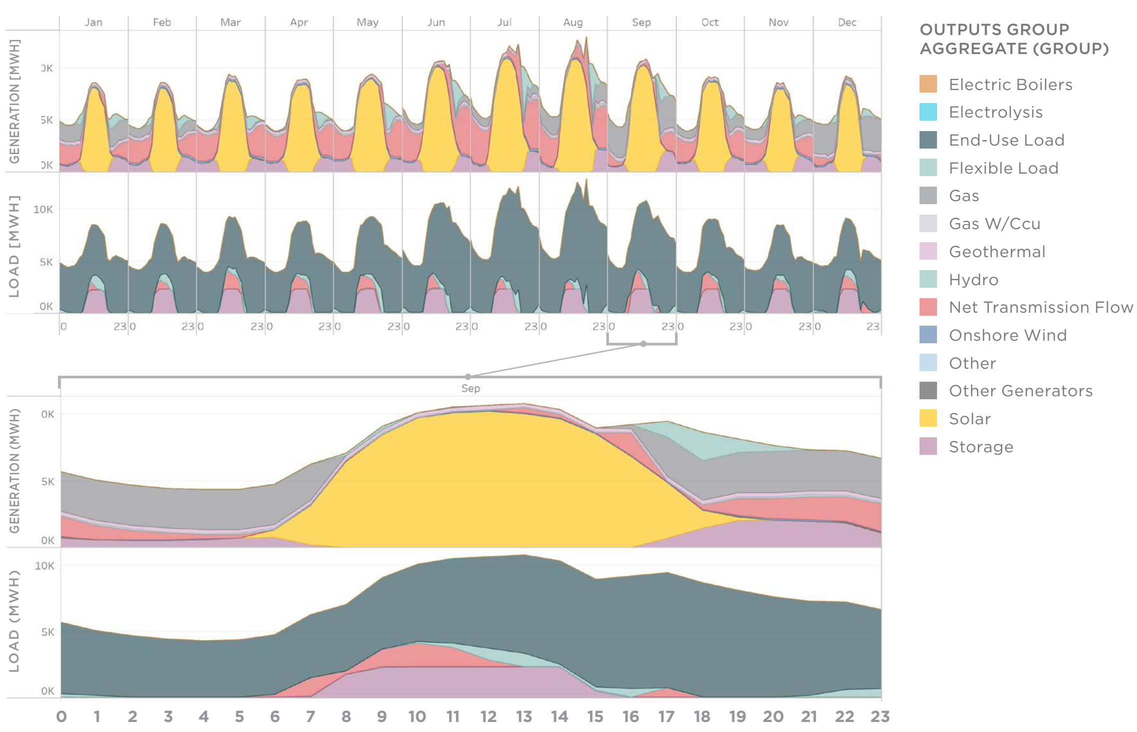


FIGURE 15. AVERAGE HOURLY DISPATCH FOR GENERATION AND LOAD, BY MONTH, CORE SCENARIO, 2030, WITH DETAIL FOR SEPTEMBER

The top two graphs depict generation and load over the course of the entire year, while the bottom two graphs show generation and load for September alone, meant to show detail. The generation graphs in each set (the first and third from top) show the operation of generation resources that meet loads, including solar, gas, storage, demand flexibility, and imports, called "net transmission flow." The load graphs in each set (the second and fourth from top) show demand: what is consuming electricity produced in the state: end-use load, exports (in coral), and the charging of battery storage (in purple). Looking at the detailed graphs of September, the most obvious feature is the solar production in the middle of the day. Solar meets daytime load and is used to charge storage resources between around 8:00 AM and 3:00 PM (the purple at the base of the load graph). Nevada exports some of this solar from 7:00 AM to noon (the coral "net transmission flow" on the load graph). As solar production begins to decline, around 4 PM, flexible loads, like heat pump water heaters that had charged earlier in the day, begin to be used, along with gas. Storage use ramps up around 7:00 PM (the purple on the generation graph), as people return home and turn on appliances. The state receives imports (the coral color on the generation graph) overnight.



The plots of sum of Gen-MWh and sum of Load-MWh for Adjusted Timestep broken down by Month. Color shows details about Outputs Group Aggregate (group). The data is filtered on Zone, Year, Run Name and Output. The Zone filter keeps nevada. The Year filter keeps 2030. The Run Name filter keeps central. The Output filter excludes renewable curtailment and storage soc. The view is filtered on Outputs Group Aggregate (group) and Month. The Outputs Group Aggregate (group) filter excludes demand response, over generation and unserved energy. The Month filter keeps Sep.

COMPLETELY EXITING COAL MAKES NEVADA'S TASK EASIER

Nevada has already reduced its reliance on dirty coal plants, but meeting the state climate goals requires completing the exit from coal, and inefficient steam plants like TS Power, by 2030. Current plans are for the 254 megawatt (MW) Valmy 1 to shut down at the end of 2021 and for the 254 MW Valmy 2 to shut down by the end of 2025. Nevada's third remaining coal power plant, the 242 MW TS Power, is currently being converted to dual-fuel coal-gas operation and is expected to operate indefinitely as a gas steam unit.

In the Core Scenario, all three units retire by 2025. TS Power economically retires by 2025 because, as a steam unit, it uses gas less efficiently than combined cycle plants, resulting in high fuel costs; it has the high operations and maintenance expenses of a steam plant; and, in the context of GHG goals, the model finds the plant is not cost-effective to operate. Evolved did not conduct a full reliability analysis of closing these plants, so it is possible that other resources, like solar and storage, would need to be added to the grid at these plant locations to maintain reliability (and solar and storage are being built in this area now). In the Extended Coal Sensitivity, Valmy 2 closes in 2030 and TS Power operates as a gas steam unit until it retires in 2035.

With extended operation of these steam units, Nevada's electricity sector only sees an 86 percent reduction in emissions by 2030 relative to 2005 levels, compared to 90 percent in the Core Scenario. This gap makes it harder for Nevada to meet the goal of reducing economy-wide emissions 45 percent by 2030. To make up for the extra emissions, buildings and vehicles need to electrify more quickly. Space and water heating reach majority electric market share five years earlier in the Extended Coal Sensitivity than the Core Scenario. Light-duty EVs reach majority market share two years earlier in the Extended Coal Sensitivity than in the Core Scenario.

RENEWABLE ENERGY REQUIREMENTS FROM THE FOSSIL-FREE SENSITIVITY TO THE ENERGY EFFICIENCY SCENARIO

The amount of new renewable energy necessary to meet the state goals varies based on the scenario. The Fossil-Free Sensitivity shows the greatest growth in renewable energy, while the Energy Efficiency Scenario shows a pathway to meet the state goals while limiting the amount of new renewables needed.

The Fossil-Free Sensitivity represents an upper bound on the amount of renewable energy in a zero-emission economy. Fully eliminating fossil fuels from the economy requires the greatest buildout of renewable energy because it is needed to make synthetic fuels and synthetic alternatives to petrochemicals and oil-based products. Achieving a fossil-free system requires greater production of alternatives for hard-to-decarbonize uses like jet fuel or diesel at industrial facilities, which could otherwise theoretically use some fossil fuels even in a net-zero emissions economy. Elimination of fossil fuels also has implications beyond the energy system, where hydrocarbons are used as inputs for chemicals, plastics, and other products. A fossil-free system must replace these inputs with synthetic alternatives or reduce demand for these products through reuse, recycling, and substitution of other materials. As a result, in the Fossil-Free Sensitivity, Nevada has 111 GW of renewable energy capacity online in 2050, three times as much as in the Core Scenario. With this much renewable energy on the system, wind and solar facilities take up about 580,000 acres of land, about five times the area of Lake Tahoe or 0.8 percent of the total land area in Nevada. This sensitivity represents the upper range of the amount of renewable capacity that would be necessary, even in a fossil-free world, because we do not assume significant reduction in demand for plastics and other products currently produced using fossil-based inputs.

The Energy Efficiency Scenario, by contrast, shows a pathway to meeting the climate goals with a lower need for renewable energy growth. With greater energy efficiency and aggressive load flexibility assumptions, this scenario shows us how the state can achieve lower total system cost—including storage and other grid flexibility investments—by maximizing efficiency measures and flexible demand through electric vehicles and newly electrified loads. In the Energy Efficiency Scenario, Nevada has 31 GW of renewable energy capacity in 2050, 5 GW (15 percent) lower than in the Core Scenario. This renewable capacity takes up about 260,000 acres, about twice the area of Lake Tahoe, or 0.37 percent of the land area in Nevada. Prioritizing energy efficiency and other demand-reduction measures can reduce the size of the electricity system and thus its impact.

TRANSPORTATION

To meet GHG reduction goals, Nevada's transportation sector needs to completely transition to electric vehicles (for the light-duty sector) and a combination of EVs and hydrogen fuel cell vehicles (for the medium- and heavy-duty sectors) by 2050, and this transition needs to accelerate now. Electrifying the vehicle fleet, the primary transportation decarbonization strategy, can save people money on fuel costs, put downward pressure on electricity rates, and reduce air pollution. Investments in public transit, rail, and smart urban design reduce energy demand, increase mobility, and create safer, healthier, and more accessible transportation systems.

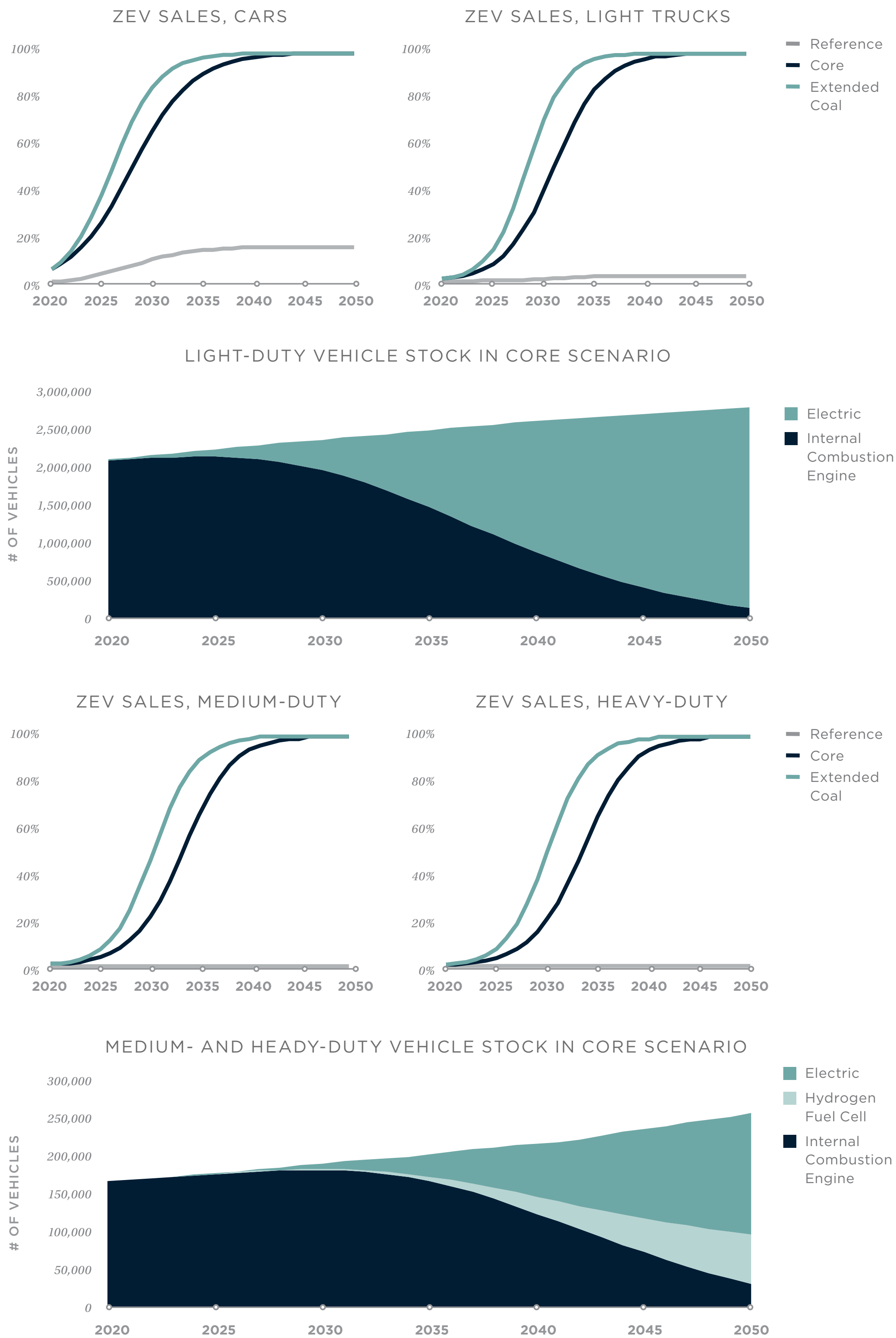
Our analysis suggests that electric vehicles should make up at least a quarter of new light-duty vehicle sales by 2026, half of new light-duty vehicle sales by 2030, and nearly all light-duty vehicle sales by 2035 or soon thereafter to meet the 2030 and 2050 climate goals, as shown in the Core Scenario. Electric vehicles make up the majority of the light-duty vehicles on the road by 2037.

Medium- and heavy-duty vehicles are remarkably emissions-intense: these vehicles make up 4 percent of the Nevada vehicle stock and are responsible for more than half of the vehicle-related $PM_{2.5}$ emissions in the state. Even so, because of the higher costs of larger batteries and fuel cells, this sector transforms five years after the light-duty sector in the model. Electric vehicles and hydrogen fuel cell vehicles make up more than half of the medium- and heavy-duty fleet by 2042.

PHOTO NEVADA GOVERNOR'S OFFICE OF ENERGY

FIGURE 16. ANNUAL SALES AND STOCK OF ELECTRIC AND HYDROGEN FUEL CELL VEHICLES IN THE LIGHT-DUTY AND MEDIUM-DUTY/HEAVY-VEHICLE CLASSES

Electric vehicle sales need to dramatically increase in the mid-2020s if Nevada is to meet its greenhouse gas reduction targets. Hydrogen fuel cell vehicles make up just a few thousand sales per year in the light-duty segment, not enough to be visible on the light-duty stock graph.



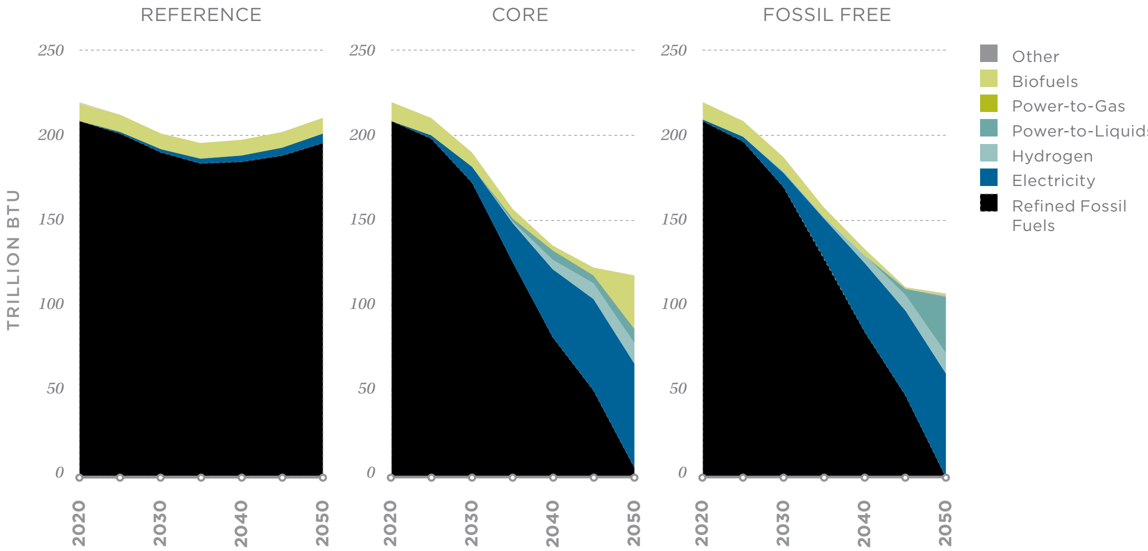
Policymakers should think of these ambitious growth trajectories—and the role of policy—as pulling forward and completing a transition that is already happening. For example, Bloomberg New Energy Finance (BNEF), forecasts that, given expected changes in future manufacturing costs and charging infrastructure even without new policy, EVs will make up 60 percent of new light-duty vehicle sales in the United States in 2040, 8.5 years after Nevada reaches that milestone in our Core Scenario. Even without new policy, the transformation from gasoline to electricity takes place because the cost of manufacturing an EV is expected to be no higher than that of a similarly configured gasoline-powered car by 2022 for large cars and SUVs and 2024 for small and medium vehicles. At this point, EVs will begin to be priced similarly to conventional vehicles—as has already happened in the compact luxury segment with the Tesla Model 3—removing a big barrier to adoption. Another reason for the transition is that there will be more EVs to choose from: Rivian, Ford, and Tesla are set to bring electric pickup trucks to the U.S. market in the early 2020s, Ford has sold out of its pre-orders of the Mustang Mach-E, and Toyota is releasing a plug-in hybrid version of its popular RAV4 this fall. Finally, EVs are improving in ways that are important to the customer experience, like charge time and range. Most new EV models have maximum charging capabilities (either as standard or with an option) of at least 100 kW,[3] which means mass-market cars, like the upcoming 2021 Volkswagen ID4 crossover, have charging times that were previously only available for Tesla vehicles.

The transition from gasoline is shown in Figure 17. For the state to decarbonize, the transportation fuel mix must transition to primarily electricity, with some biofuels and synthetic fuels providing energy for heavy-duty applications and aviation. The Fossil-Free Sensitivity relies even more on synthetic fuels because the limited quantity of biofuels is used to replace fossil fuels in other hard-to-decarbonize sectors, such as petrochemicals.

3 Fischer, Ryan. Bloomberg New Energy Finance. Will Ultra-Fast Charging Take-Off (Part one). Page 3. May 20, 2019.

FIGURE 17. TYPES OF FUEL USED FOR TRANSPORTATION IN THE REFERENCE AND CORE SCENARIOS, AND FOSSIL-FREE SENSITIVITY

The transportation sector currently relies almost entirely on gasoline and other refined fossil fuels.

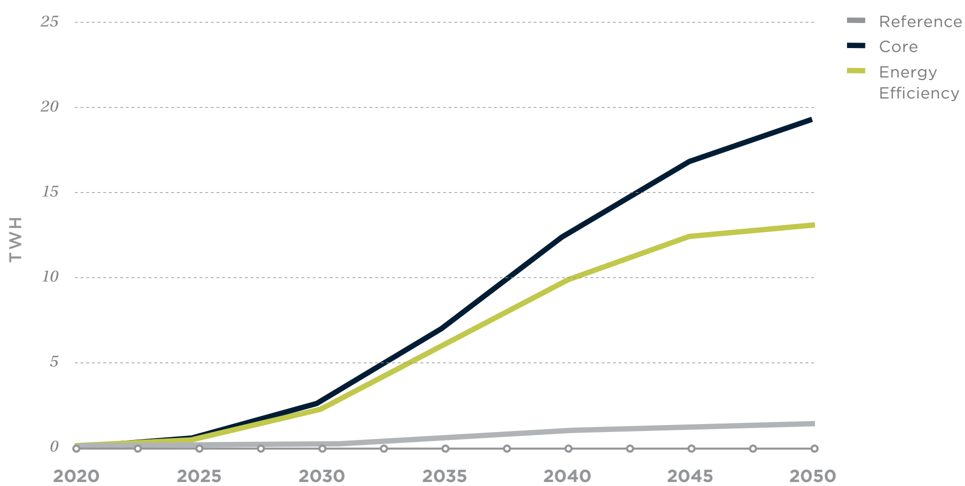


Transportation electrification contributes to growth in electricity demand in all modeled scenarios. In the Core Scenario, new electric vehicles add 3 TWh of annual electricity demand by 2030, or about 6 percent of total electricity use. By 2050, the transportation sector uses 19 TWh of electricity, roughly 20 percent of total electricity load.

Electric vehicle load, including from electrified public transportation, is more flexible than most existing loads, and could make a high-renewables electricity system easier to manage, if manufacturers, utilities and their regulators design smart charging systems and rates. Personal vehicles are parked about 95 percent of the time, school busses are parked during the summer, during the middle of the day, and at night, and mainly park at school or at a depot. Over the long term, vehicle-to-grid processes, where the EV battery provides services to the grid based on grid operator signals, algorithms, or prices, can add additional value. Our analysis assumes a significant portion of EV load is flexible. In the Core Scenario we assume that 50 percent of light-duty vehicle load can shift up to eight hours, 50 percent of medium-duty vehicle load can shift up to three hours, and 25 percent of heavy-duty vehicle load can shift up to three hours. That means, for example, that 50 percent of the electricity required to charge electric cars can shift a few hours later in the evening to avoid the late afternoon peak in demand.

As a bookend on the potential for flexibility, in the Energy Efficiency Scenario, 100 percent of LDVs and MDVs and 50 percent of HDVs can shift load. Enabling this load flexibility requires policy solutions, including rate structures that encourage charging when electricity is plentiful and discourage charging when it is scarce. In the Energy Efficiency Scenario, we also model transportation demand reductions that reduce total vehicle miles traveled. These reductions stem from changes such as increased public transit or strategies to increase bike use and walking as alternatives to passenger vehicle use. The demand reduction measures and additional load flexibility help reduce the additional electricity load from EVs.

FIGURE 18. ELECTRICITY LOAD FROM TRANSPORTATION ELECTRIFICATION IN REFERENCE, CORE AND ENERGY EFFICIENCY SCENARIOS



Electrification of vehicles accounts for a significant portion of the transportation sector transformation, but the sector also requires carbon-neutral fuels for vehicle types that will be difficult or impossible to electrify. Some medium- and heavy-duty trucking applications will likely remain difficult to serve with electric or hydrogen fuel cell vehicles, and some air travel is likely to remain impossible to directly electrify. Decarbonizing these transportation applications requires the buildout of infrastructure to produce and use carbon-neutral or low-carbon fuels. These strategies are especially important for Las Vegas, which relies heavily on air travel to support its tourism and business-travel economy.

SYNTHETIC FUELS AND BIOFUELS

Our analysis found that Nevada can replace its remaining fossil fuel use with biofuels and synthetic fuels produced with green hydrogen, captured CO_2, and clean electricity. These synthetic fuels are called "power-to-gas" and "power-to-liquids." In the Core Scenario, the transportation sector decarbonizes mainly with electricity, hydrogen, and biofuels, only relying on a small amount of synthetic fuels. Notably, combustion of biofuels still produce harmful air pollution—especially particulate matter and nitrogen oxides—and should therefore be used sparingly, and emissions from biofuels should be minimized and mitigated near vulnerable populations. In the Fossil-Free Sensitivity, the available biomass sources are needed for other hard-to-decarbonize sectors (e.g., replacement feedstocks for petrochemical products) so the transportation sector requires a greater quantity of synthetic fuels. Figure 17 above shows the types of fuels used for transportation and the increasing portion of non-fossil fuels.

As a result of increased demand for synthetic fuels in transportation and other sectors in Nevada and across the country in the Fossil-Free Sensitivity, the state develops a large clean hydrogen and synthetic fuel production industry. By 2050, Nevada has the capacity to produce 11 times more clean hydrogen and almost 15 times the amount of synthetic fuels in the Fossil-Free Sensitivity than in the Core Scenario. A robust synthetic fuels industry would provide an opportunity for Nevada to use its low-cost solar resources to produce clean fuels for other states.

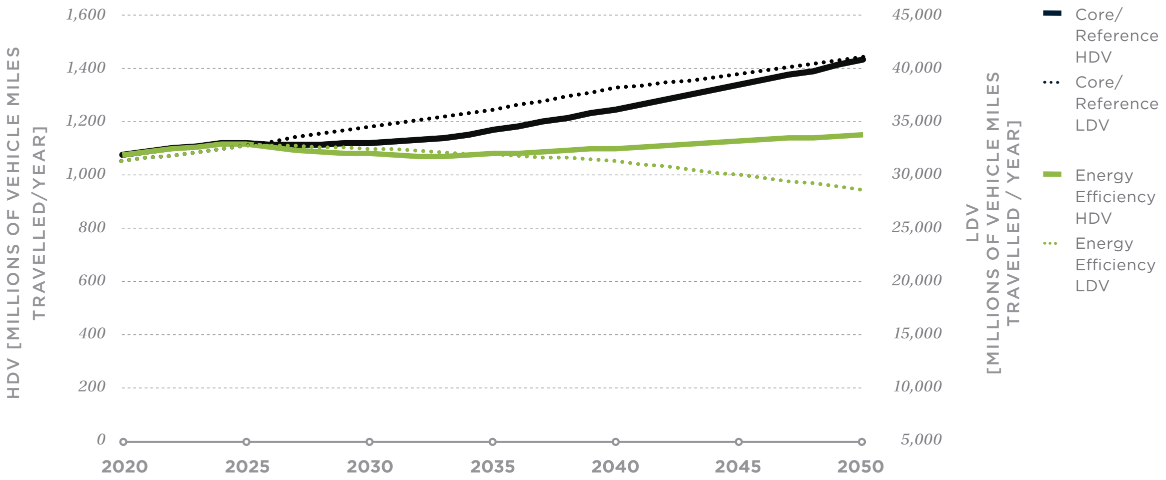
In our modeling, all biofuels are produced with sustainable biomass feedstocks. For the state to credibly reduce emissions using biofuels and avoid harm to ecosystems, policymakers must ensure that all biofuels are produced with biomass that is independently certified by the Roundtable on Sustainable Biomaterials (RSB) or to an equivalent standard. Without these standards, biofuels can generate more emissions than they save: some biofuels are from unsustainable forest harvesting, or energy-intensive agricultural practices.

EFFICIENT TRANSPORTATION: SMART GROWTH, MORE TRANSIT OPTIONS

An electrified transportation sector would use significantly less energy than the present system, even if service demand (e.g., vehicle miles traveled) increases. Transportation energy use in the Core Scenario in 2050 is 46 percent less than the sector's energy use today. Investments that reduce transportation service demand would reduce energy use further, and substantially reduce the amount of clean energy production required to meet the climate goals.

The Energy Efficiency Scenario assumes that Nevadans rely more on public transit, walking, and biking and less on personal vehicles. As a result, the transportation sector requires 59 percent less energy in 2050 than today's system, and light-duty vehicle miles traveled are 7 percent lower than the Core Scenario in 2030 and 35 percent lower in 2050. Heavy-duty vehicle miles traveled are 4 percent lower in 2030 and 20 percent lower in 2050. As a result, the Energy Efficiency Scenario transportation system uses 32 percent less electricity and 18 percent less synthetic fuels and biofuels than in the Core Scenario in 2050. Achieving these energy savings would require investments in electric transit, bike and pedestrian friendly road development, and improvements to city design, starting immediately.

FIGURE 19. LIGHT- AND HEAVY-DUTY VEHICLE MILES TRAVELLED IN THE REFERENCE, CORE, AND ENERGY EFFICIENCY SCENARIOS



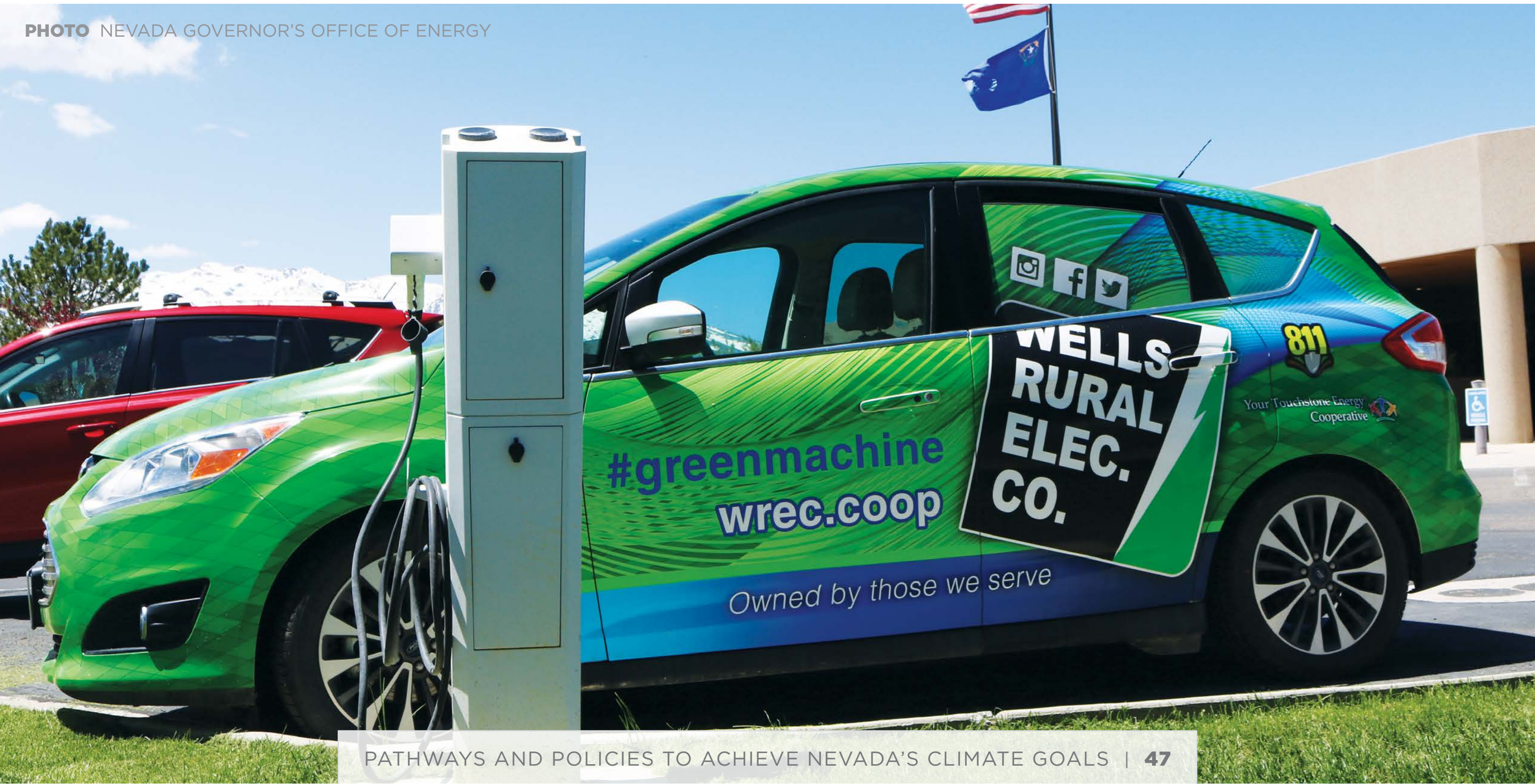


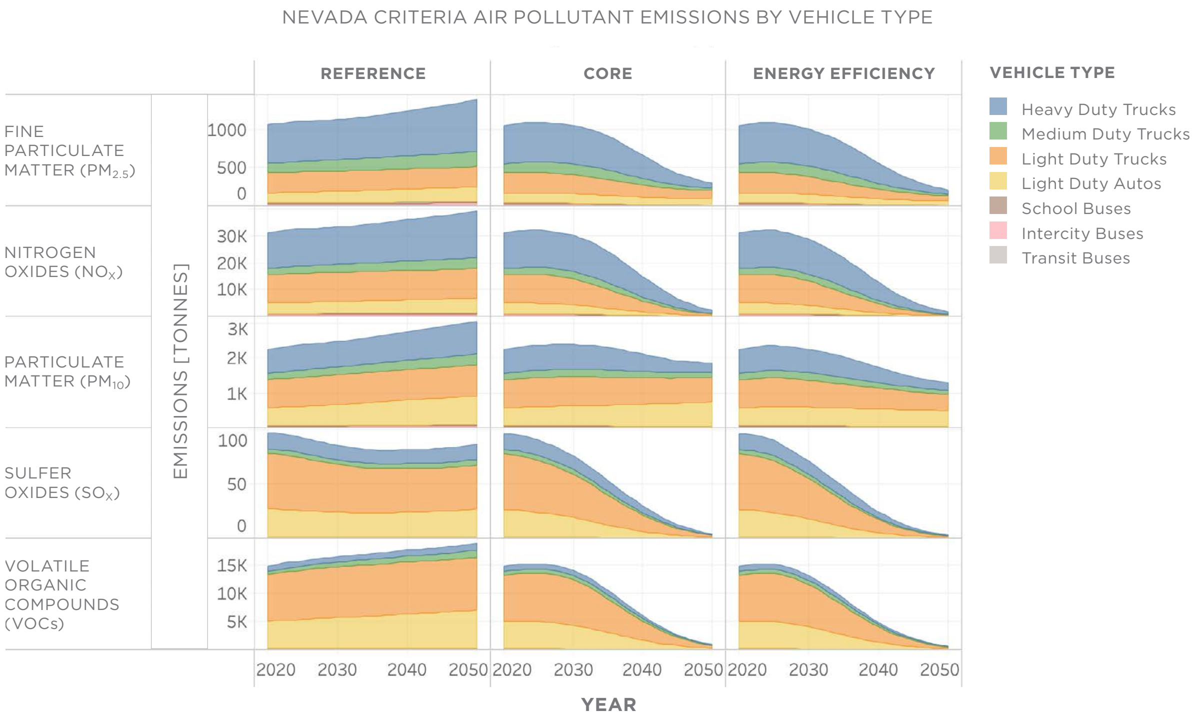
PHOTO NEVADA GOVERNOR'S OFFICE OF ENERGY

TRANSPORTATION AIR POLLUTANT EMISSIONS

The transportation sector is an important contributor towards criteria air pollutant emissions in Nevada, as shown in Figure 2 on page 10. Electrification and demand reduction measures can reduce these emissions, as shown in Figure 20, which compares reductions in transportation sector emissions across pollutants and scenarios. Emissions are lowest in the Energy Efficiency Scenario, where transportation demand is the lowest.

FIGURE 20. CRITERIA AIR POLLUTANT EMISSIONS FROM ON-ROAD VEHICLES ACROSS SCENARIOS

Emissions decline almost to zero by 2050, except for $PM_{2.5}$ and PM_{10} emissions. Heavy-duty vehicles, which predominantly burn diesel fuel, dominate $PM_{2.5}$ emissions, despite the small size of the heavy-duty vehicle fleet.



Compared to the Reference Scenario, emissions decrease in the Core and Energy Efficiency Scenarios. Transportation emissions will be lower than they otherwise would have been absent electrification, as shown in the top panel of Figure 21. Electrification alone will not entirely solve Nevada's transportation emissions problem, as can be seen in the bottom two panels of Figure 21. Highway-adjacent census tracts see an absolute increase in emissions between 2020 and 2030 in the Core Scenario, an increase which the Energy Efficiency Scenario avoids.

FIGURE 21. MODELED TRANSPORTATION SECTOR $PM_{2.5}$ EMISSIONS CHANGES IN RENO AND LAS VEGAS AREAS, WITH THREE DIFFERENT SCENARIO COMPARISONS

The color indicates percentage changes, with darker blues showing larger percentage decreases, and darker reds showing larger percentage increases. The top row of graphs compare Reference and Core Scenario census tract $PM_{2.5}$ emissions in the year 2030. The blue colors on the Reno and Las Vegas graphs show how, under the Core Scenario, emissions in 2030 are everywhere less than they otherwise would have been absent electrification. The second row compares $PM_{2.5}$ emissions today *with 2030 emissions in the Core Scenario: this shows that, along transportation corridors in Las Vegas, and broadly in Reno, absolute emissions would not decrease between 2020 and 2030 in the Core Scenario: emissions would* increase *from today. Because the MDV/HDV sector electrifies more slowly, VMT increases in 2030 lead to increased emissions. The final row, which compares $PM_{2.5}$ emissions today with 2030 emissions in the Energy Efficiency Scenario, shows that VMT reduction addresses the MDV/HDV-related emissions increase.*

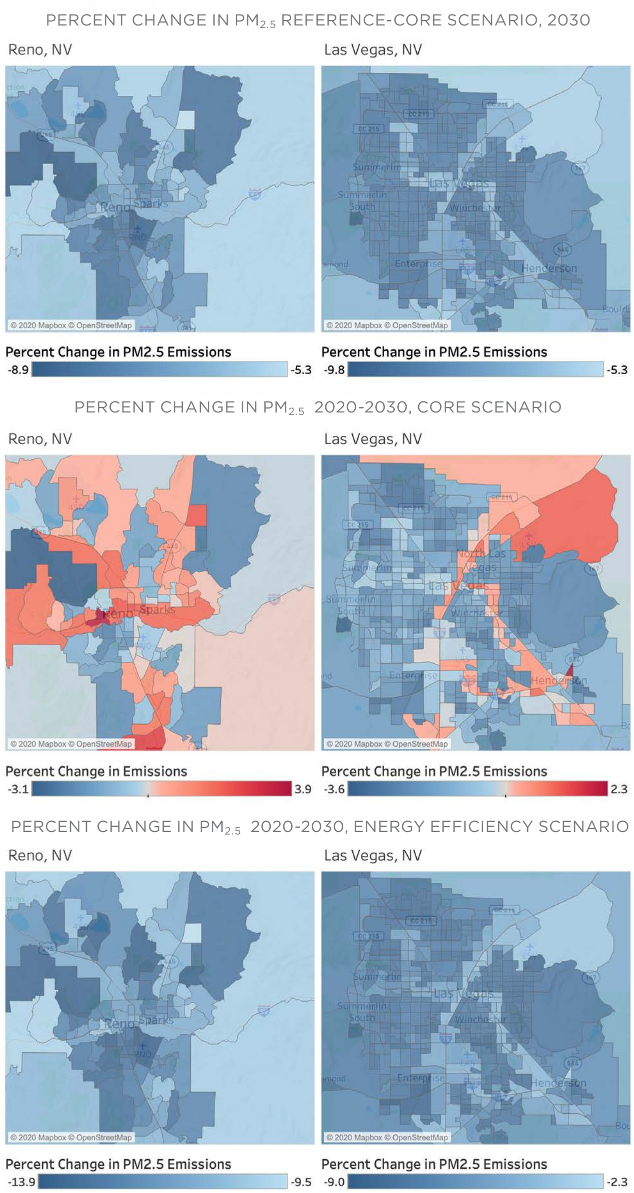


Figure 21 demonstrates the importance of controlling heavy-duty truck pollution, which continues to increase in the Core Scenario as heavy-duty VMT rises for the next decade without yet being offset by electrification, delayed in the heavy-duty vehicle segment because of higher costs. After 2030, these emissions begin to fall in the Core and Energy Efficiency Scenarios. Controlling this pollution requires both in-state and multi-state efforts. Nevada's support for the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding will be important, given the role of Interstates 15 and 80 as California-East corridors. Nevada can and should encourage neighbors, like Arizona and Utah, to join too. Nevada can also curb emissions from in-state vehicle use by addressing medium-duty vehicles that distribute goods from a Nevada warehouse or distribution center, as well as heavy-duty vehicles associated with in-state trucking, construction, and intermodal transfer operations. Nevada can also address in-state truck routing to reduce pollution in overburdened communities.

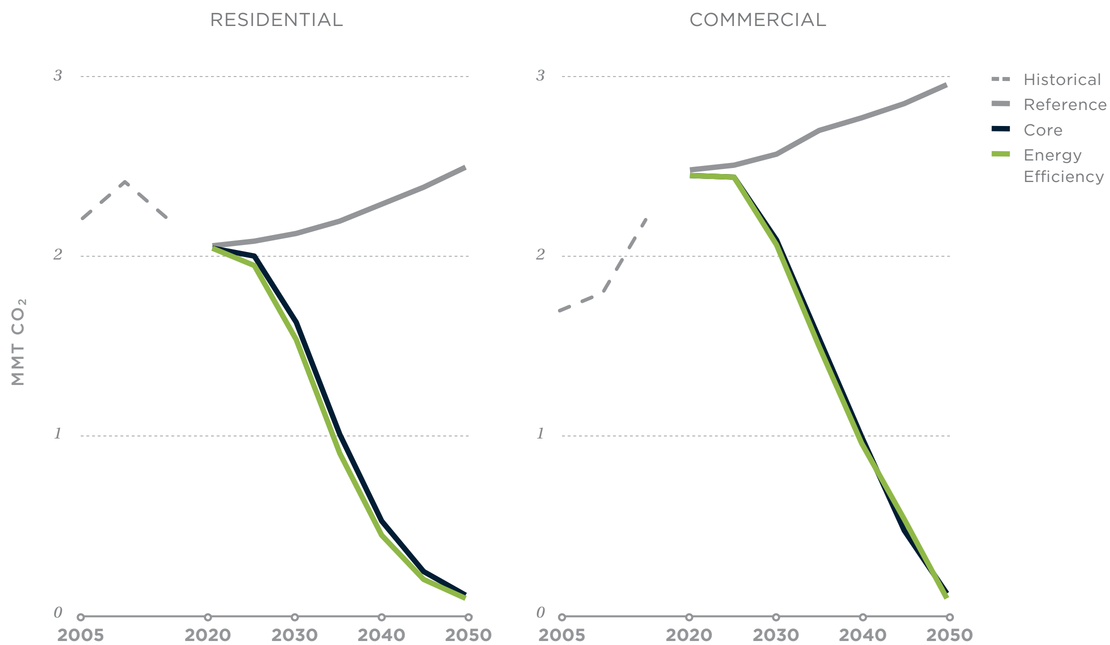
BUILDINGS

Nevada must move to a highly electric and efficient building sector to meet its climate goals. Doing so requires shifting from fossil fuels to clean electricity to heat homes and offices, ensuring that new buildings are built with highly efficient shells, adopting efficient appliances, and upgrading the existing building stock. These changes will also cut health-damaging pollutants in buildings. Additional planning and policies are needed to ensure that all Nevadans can afford and access these upgrades, including renter and mobile-home populations. These changes to the building sector can be accomplished without significantly increasing energy bills, even while taking into account the cost of upgrades, and Nevada can reduce inequality by targeting upgrades to people and communities with high energy burdens.

In our modeling, Nevada's building sector—whose emissions are made up of fossil fuels burned for space and water heating in buildings—makes modest reductions to help meet Nevada's 2025 and 2030 goals but achieves much bigger reductions between 2030 and 2050. Building sector emissions are expected to increase absent new policy, as shown by the Reference Scenario in Figure 22 below, so the state must take action.

FIGURE 22. CARBON DIOXIDE EMISSIONS FROM RESIDENTIAL AND COMMERCIAL BUILDINGS

Residential emissions decline 27 percent from 2005 levels by 2030 in the Core Scenario. Though commercial emissions are 18 percent lower in the Core Scenario than the Reference case by 2030, they are still higher than 2005 levels because of substantial growth in emissions over the last 15 years.



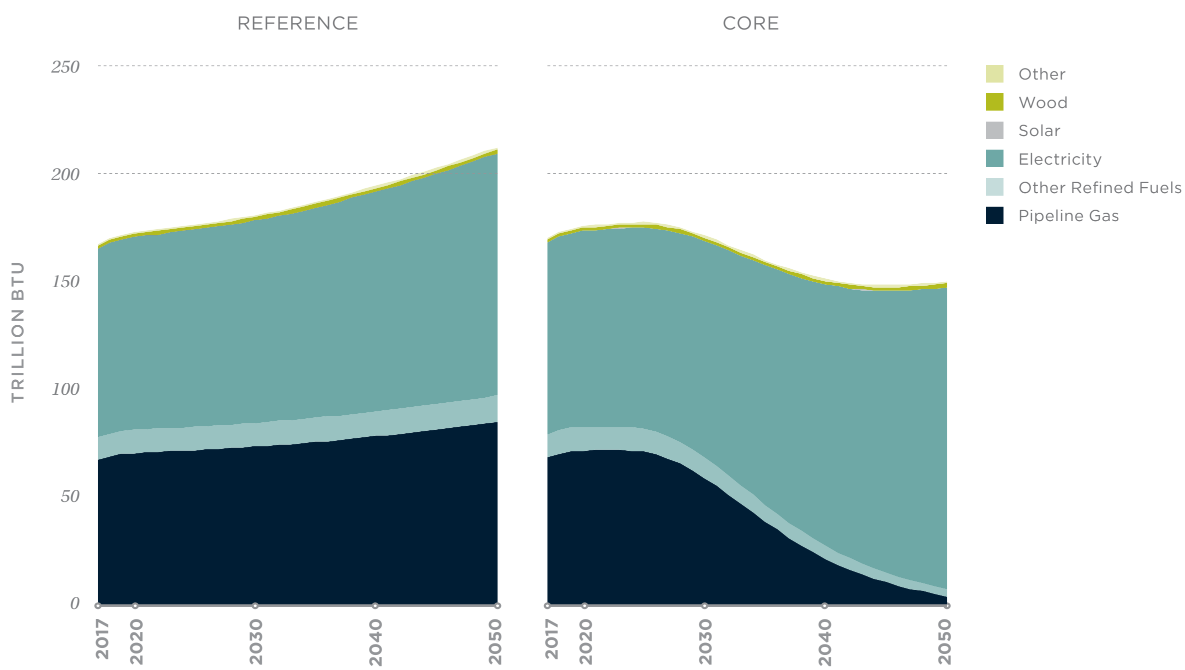
Nevada's buildings sector today relies on electricity, the direct combustion of gas, and a small amount of wood and heating oil for space and water heating and cooking. By 2050, the fuel mix must shift almost entirely to electricity, as shown below in Figure 23. Getting there requires rapid adoption of electric heat pumps for space and water heating and electric cooktops and stoves for cooking. This new electric load can actually be helpful to the grid because, like EV load, water and space heating loads can be made more flexible than today's typical electricity uses. A heat pump water heater, for example, has inherent storage ability. Appliance owners or aggregators can shift the time when water is heated to times when renewables are plentiful on the grid, storing heat for use later in the day when solar power wanes. Advances in sensors, controls, and data science can enable "smart" operation in which the systems use data to "learn" how to best provide grid services while still meeting building needs. Such resources can be aggregated, as demonstrated in various pilots in the Pacific Northwest.[4]

4 For example, see https://www.peakload.org/dialogue--bpa--portland-general-electric---nweea and https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-17167.pdf

Energy saving programs and building shell improvements, as modeled in our Energy Efficiency Scenario, also help manage the system and save customers money. Building electricity use is 8 percent lower in 2050 in the Energy Efficiency Scenario than in the Core Scenario, as seen in Figure 23 below. In the Energy Efficiency Scenario—which also includes transportation demand reduction measures—the resulting electricity savings reduce the amount of renewable infrastructure that needs to be built: 500 MW less storage capacity is built in the Energy Efficiency Scenario than in the Core by 2030, and an additional 5.2 GW less solar capacity and 1.2 GW less storage is built between 2030 and 2050. By reducing the need for renewable capacity growth, these demand reduction measures have the added benefit of reducing the amount of land that needs to be disturbed in Nevada to meet climate goals.

FIGURE 23. FUEL USE IN BUILDINGS

Gas use nearly disappears in Scenarios that meet climate goals.



BUILDING ELECTRIFICATION

As with electric vehicles, adoption of electric appliances for buildings needs to accelerate to meet the state's climate goals. In the Core Scenario, electric options make up nearly 100 percent of new sales by 2040 for space heating, 2039 for water heating, and 2034 for cooking in residential buildings. Commercial building equipment needs to follow a similar trajectory, as shown in Figure 24A below. Adoption needs to be quicker in the Extended Coal Sensitivity, where Valmy 2 and TS Power stay open longer, because the other sectors need to make up for the extra power sector emissions if the state is to meet its greenhouse gas reduction goals.

FIGURE 24A. PERCENTAGE OF NEW RESIDENTIAL AND COMMERCIAL APPLIANCES THAT ARE ELECTRIC MODELS IN THE REFERENCE AND CORE SCENARIOS, AND THE EXTENDED COAL SENSITIVITY

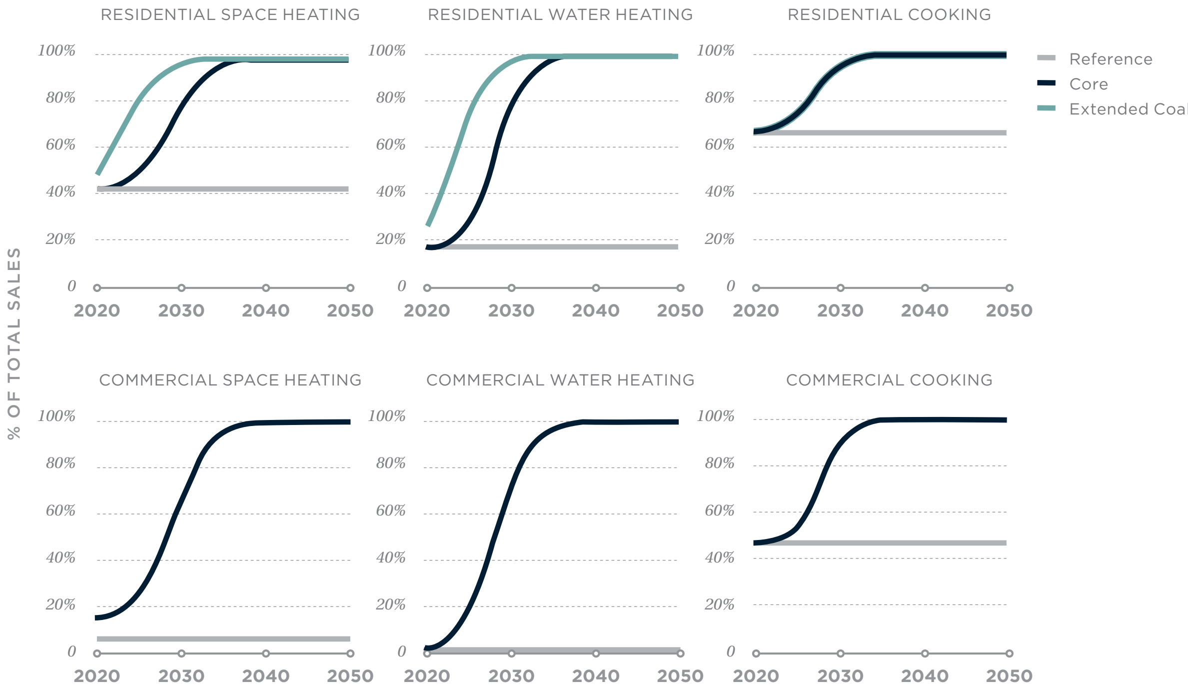
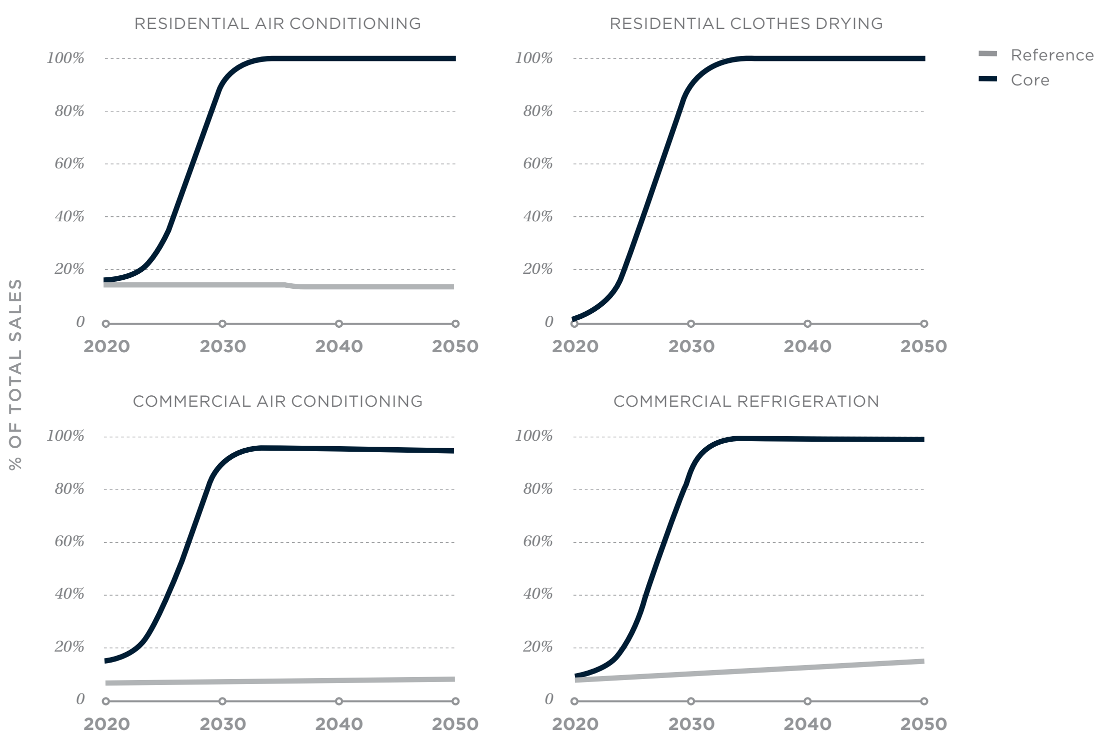


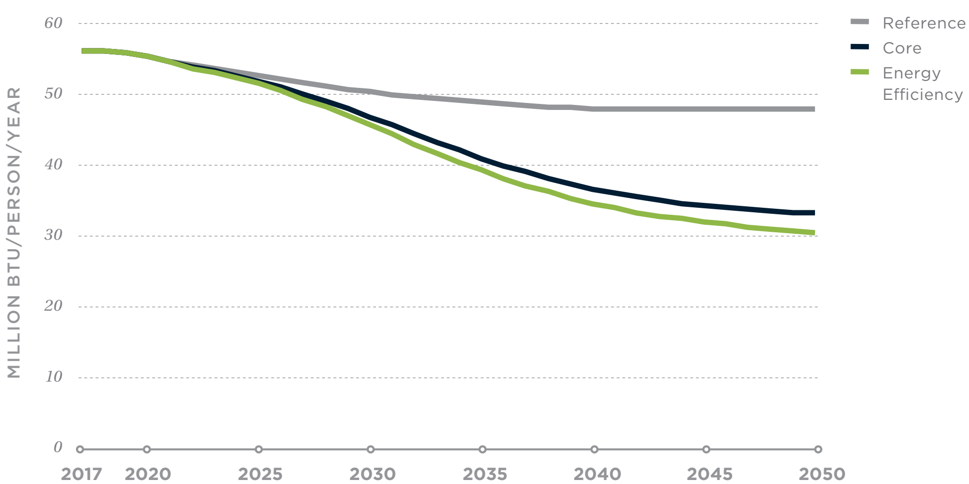
FIGURE 24B. MARKET SHARE OF NEW RESIDENTIAL AND COMMERCIAL EQUIPMENT THAT IS HIGH-EFFICIENCY IN REFERENCE AND CORE SCENARIOS



These levels of adoption are the equivalent of ensuring that more than 80 percent of new homes are all electric starting today, requiring all new homes to be all electric by 2027, and thereafter replacing 1.5 to 2 percent of non-electric space heaters in existing homes with electric heat pumps each year through 2050. The state must electrify residential water heating even more quickly, ensuring that all new homes have electric water heaters starting today while simultaneously ramping up replacements of water heaters in existing buildings so that 3 to 4 percent of existing water heaters are replaced with electric heat pumps every year in the late 2020s and 2030s. This is just one pathway to achieving the required level of adoption; other pathways might accelerate replacement of gas appliances in existing buildings. Doing so has the added benefit of helping prevent existing households with gas heating from being stuck with the fixed costs of the gas distribution infrastructure as building electrification accelerates.

BUILDING ENERGY EFFICIENCY

FIGURE 25. BUILDING ENERGY USE PER CAPITA IN THE REFERENCE, CORE, AND ENERGY EFFICIENCY SCENARIOS



Ensuring that new electric appliances, and new and existing building shells, become highly efficient, is critical to reducing building sector emissions. Building shell retrofits and efficient HVAC systems also reduce air conditioning demand that can make it difficult to meet net load peaks in shoulder months, thus reducing the need to build energy storage and allowing the state to reduce imports and reliance on gas plants.

The market for space heating, water heating, and cooking appliances, where gas currently dominates, needs to move rapidly toward highly efficient, electric options. For other appliances, such as air conditioning, refrigeration, and clothes washers and dryers, the existing stock has a greater share of electric options. For these appliances where there is equal opportunity to purchase gas or electric, the core strategy is to transform the market such that highly efficient (and electric) options are the norm—and eventually take up the whole market.

In addition to replacing the appliance stock with efficient, electric equipment, Nevada must also ensure that new buildings have highly efficient envelopes. Nevada's residential building stock is expected to grow 15 percent by 2030 and 42 percent by 2050. Ensuring that new homes are highly efficient will curb the added energy demand from building growth. Retrofitting existing buildings to improve building envelope efficiency is also an important part of the solution. These retrofits should consider a package of potential upgrades to make the whole building more efficient, such as improved insulation, cool roofs, air sealing, windows and doors, and air ducts. Some measures may be more important than others for different vintages and types of buildings, and a strategic retrofit program would tailor measures to each building. In the Core Scenario, Nevada retrofits 14,000 homes and apartments per year in the mid 2020s, 26,000 per year in 2030, and about 36,000 every year through 2050. In the Energy Efficiency Scenario, the state retrofits even more homes and apartments: 35,000 per year in the mid 2020s, 62,000 per year in the 2030s, and more than 70,000 per year in the 2040s, upgrading every home and apartment in the state by 2050. The adoption trajectory of retrofits is shown below in Figure 26.

FIGURE 26. TOTAL NUMBER OF RESIDENTIAL BUILDINGS (IN THOUSANDS) WITH ENERGY EFFICIENT BUILDING SHELLS ACROSS SCENARIOS

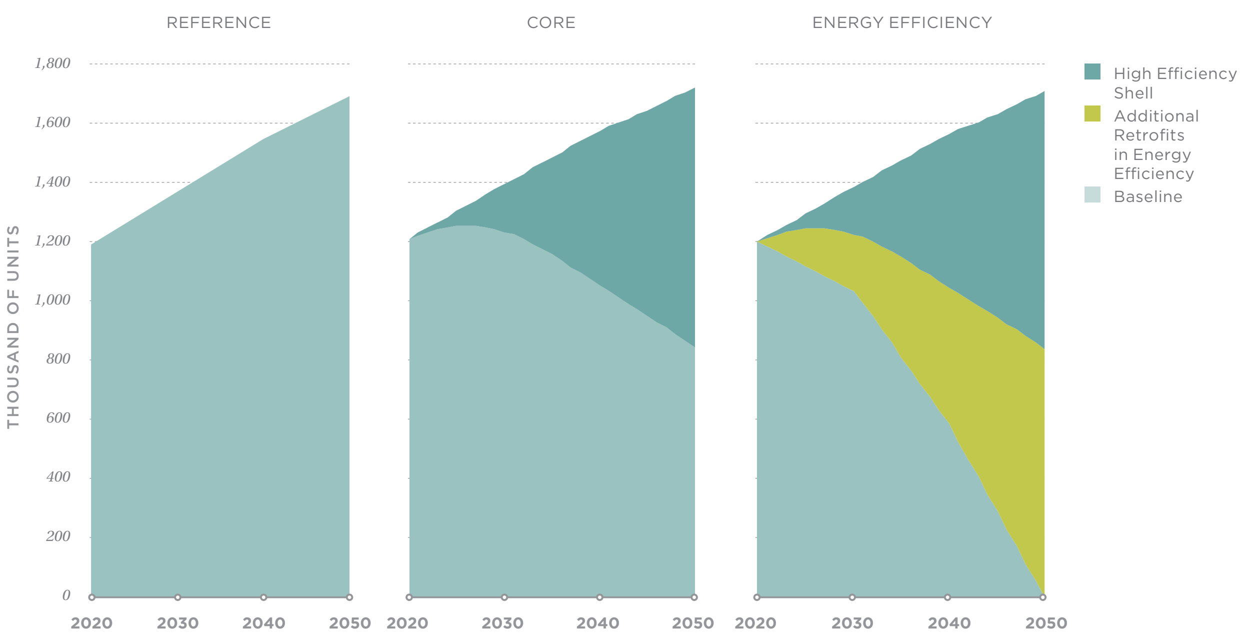
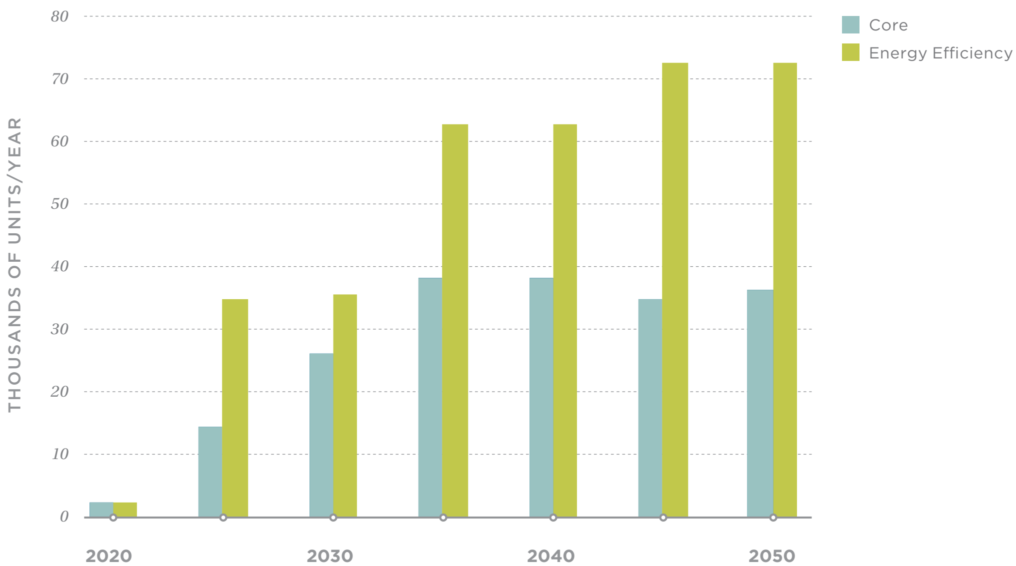


FIGURE 27. ANNUAL NUMBER OF RESIDENTIAL BUILDINGS THAT ARE RETROFITTED TO HAVE ENERGY EFFICIENT BUILDING SHELLS, IN THOUSANDS OF BUILDINGS



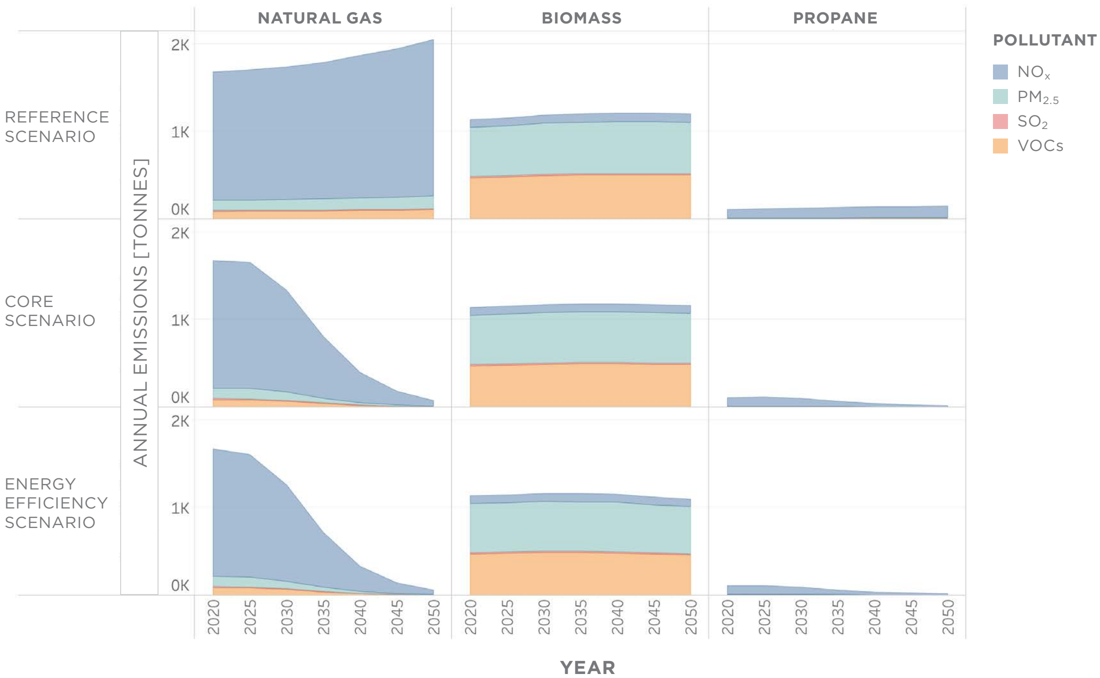
BUILDING SECTOR AIR POLLUTANT EMISSIONS AND HEAT STRESS

Burning fossil fuels and biomass in homes produces criteria air pollutants. Decarbonizing buildings through efficiency and electrification will significantly cut pollution.

The major pollutants from home energy use are $PM_{2.5}$ and NO_x. Buildings are a major source of $PM_{2.5}$ emissions, exceeding $PM_{2.5}$ emissions from power plants and producing similar amounts as the transportation sector in Nevada. Residential $PM_{2.5}$ emissions are most substantial in rural areas (largely due to biomass burning), especially where wood is burned for home heating. A fraction of $PM_{2.5}$ emitted from wood burning may remain indoors, posing a significant health hazard to residents that use wood for heating. Buildings are a smaller but still significant source of NO_x emissions, and though NO_x emissions from transportation, power plants, and industrial facilities are much greater than those from buildings, some residential NO_x emissions are indoors and have a greater direct impact on human health.

FIGURE 28. RESIDENTIAL BUILDING-RELATED CRITERIA AIR POLLUTANT EMISSIONS OVER TIME, BY FUEL TYPE, FOR ALL SCENARIOS

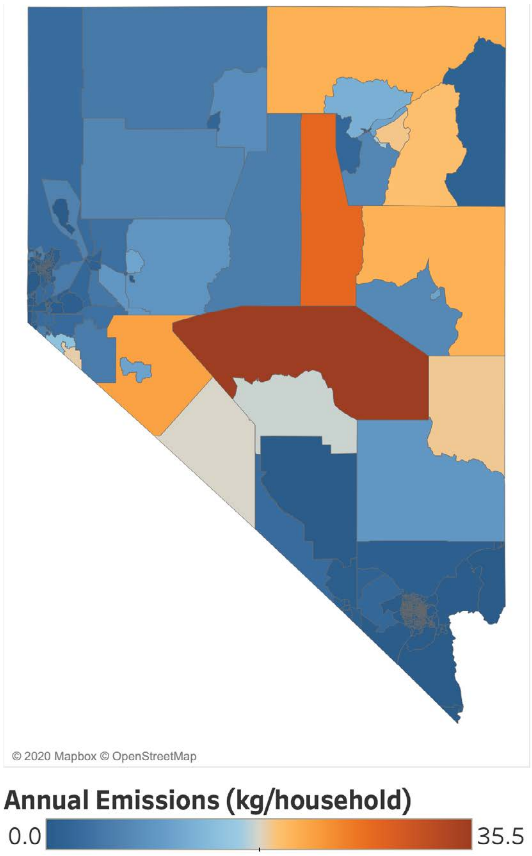
With electrification, emissions from fossil fuels decline almost to zero, while emissions from biomass remain.



As shown in Figure 28, emissions from fossil fuel use in buildings declines substantially between 2020 and 2050 in the Core and Energy Efficiency Scenarios but not in the Reference Case. Biomass use, responsible for locally-significant air emissions (statewide, the $PM_{2.5}$ and VOC emissions from burning wood in homes dwarfs the emissions from fossil fuels used in the buildings) does not decline in the model. While biomass makes up a tiny fraction of total building energy use, it makes up a disproportionate share of criteria air pollutant emissions from buildings, especially in Central and Eastern Nevada, as shown in Figure 29. Building sector policies should include a focus on electrifying building heating in rural areas that heat with wood. The concentration of emissions suggest retrofit policy should take into account the health benefits of wood-to-electric space heating conversions.

FIGURE 29. RESIDENTIAL BUILDING-RELATED $PM_{2.5}$ EMISSIONS IN 2017

Emissions are concentrated in Central and Eastern Nevada.

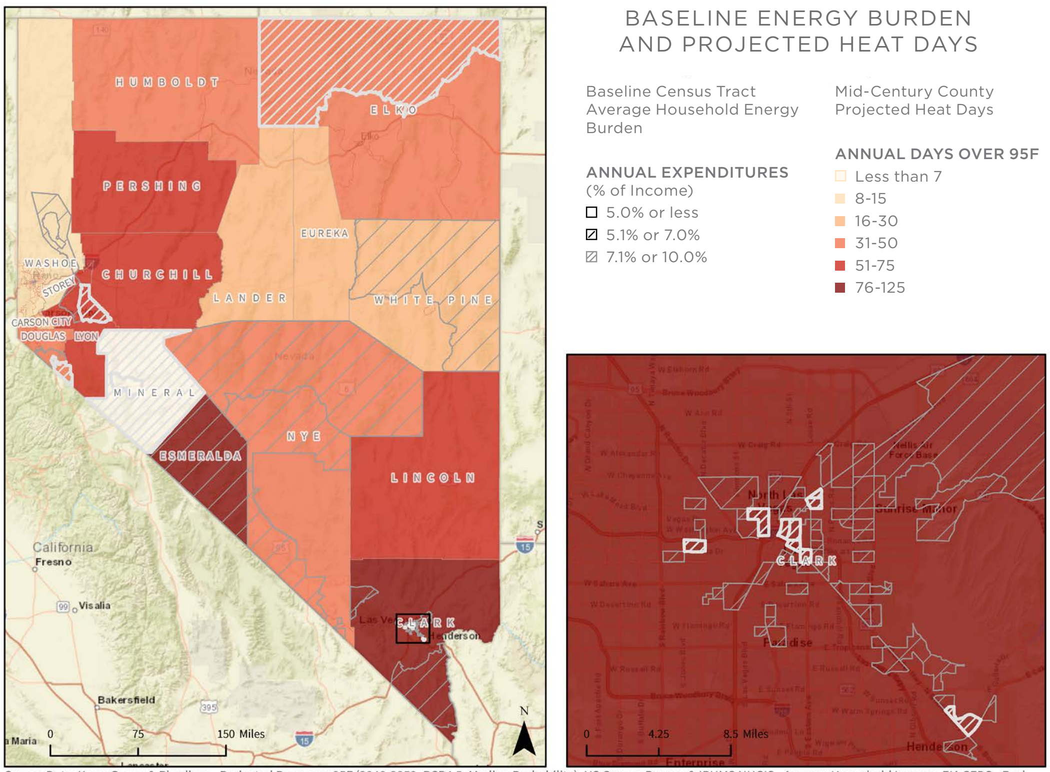


Efficiency will help reduce the emissions shown in Figures 28 and 29, but efficiency upgrades that seal buildings without proper ventilation can exacerbate health impacts, so it is important to couple efficiency measures with proper ventilation. Electrification reduces these dangerous emissions and thereby improves indoor and outdoor air quality and health outcomes.

Access to cooling for vulnerable communities is emerging as an important theme in the face of climate change around the globe. Efficiency can help maintain not just comfortable, but livable, indoor temperatures during cold snaps and heat waves. Heat waves could be especially challenging for households with high energy burdens, who are most likely to have difficulty affording the electric bills to run their air conditioning but face health risks—such as heat stroke—if they do not run the AC. The intersection of energy burden and projected extreme heat days is shown in Figure 30. Many Las Vegas residents could be in danger of losing air conditioning when it is most needed later this century. Policymakers should focus investments to reduce energy costs for these high-risk households and to provide community-based solutions such as community cooling centers. As populations across the West face increased threats from wildfires, such community centers can serve multiple purposes.

FIGURE 30. ENERGY BURDEN AND PROJECTED EXTREME HEAT DAYS

Certain areas of Las Vegas should be the target of clean energy investments to support energy savings and resilience; building shell efficiency measures and HVAC system investments, for example, can help reduce bills for low-income households and ensure affordable electricity to support cooling in the face of increased heat waves in a warming climate.



Source Data: Kopp Group & Rhodium - Projected Days over 95F (2040-2059, RCP4.5, Median Probability), US Census Bureau & IPUMS NHGIS - Average Household Income, EIA SEDS - Fuel Prices, Min et al. & PSE - Residential Energy Modeling | Date: September 14, 2020

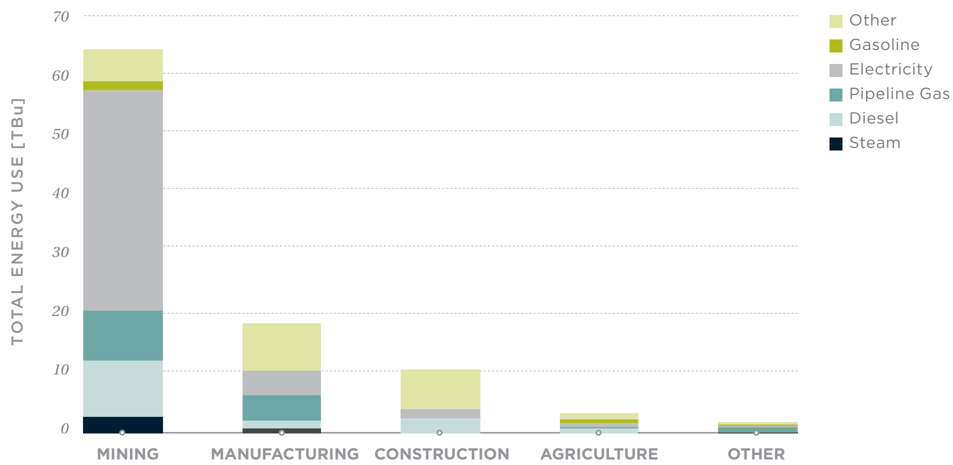
INDUSTRY

Nevada must transition from an industrial sector powered by fossil fuels to one that relies heavily on clean electricity, energy efficiency, and some low-carbon or carbon-neutral fuels. Industrial energy use makes up 10 percent of total energy-related CO_2 emissions in the state today. These emissions are expected to grow if the state continues current practices; Nevada must reverse this trend to achieve its climate goals.

Figure 31 shows that mining makes up the largest share of industrial energy use today, followed by manufacturing and construction. While electricity provides the majority of energy for the mining industry, direct use of fossil fuels still makes up a substantial portion, releasing CO_2 and criteria air pollutants.

FIGURE 31. FUEL USE BY INDUSTRIAL SUBSECTOR IN 2018

Mining uses the most energy by far of any industrial sub-sector in Nevada. Manufacturing and construction also are meaningful energy users in the state.



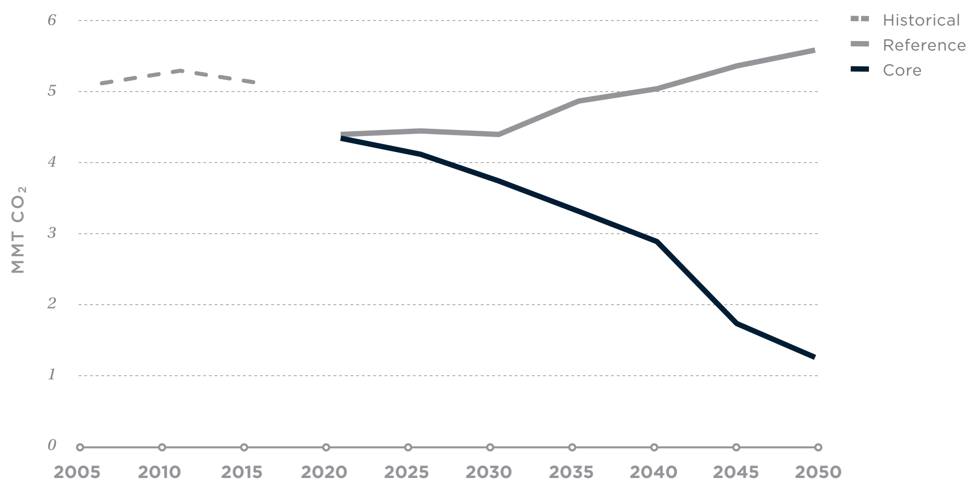
Considering only energy-related emissions, industrial CO_2 emissions drop to 27 percent below 2005 levels by 2030 and 75 percent by 2050 in the Core Scenario, as shown below in Figure 32. By 2050, the industrial sector uses 78 percent less fossil fuel in the Core Scenario than in the Reference Scenario. Achieving these emissions reductions requires electrification of industrial processes, greater energy efficiency at industrial facilities, and adoption of some low-carbon and carbon-neutral fuels. These strategies replace the use of fossil fuels at industrial facilities and hence cut emissions. Decarbonization of the power sector is also critical, since much of mining already relies on electricity and some of it is produced with coal or gas (e.g., the TS Power Plant).

Energy efficiency is a critical strategy to reduce emissions from industry. In the Core Scenario, industrial energy use drops 5 percent by 2030 and 7 percent by 2050, compared to 2020 levels. More importantly, efficiency measures reduce projected growth in industrial energy demand. Energy use is 9 percent lower in the Core Scenario than in the Reference case by 2030 and 21 percent lower in 2050, reducing the need for electricity and synthetic fuels to decarbonize industry.

The industrial sector also relies in part on biofuels and synthetic fuels to replace fossil fuels and achieve the remaining required emissions reductions. Whereas no biofuels and synthetic fuels are used under business as usual, they make up 16 percent of total industrial energy use by 2050 in the Core Scenario. These fuels are important for industrial applications that are difficult to electrify, such as high-temperature process heat and vehicles and equipment that have limited electric alternatives. In our modeling, all biofuels are produced with sustainable biomass feedstocks. For the state to credibly reduce emissions using biofuels and avoid harm to ecosystems, policymakers must ensure that all biofuels are produced with biomass that is independently certified by the Roundtable on Sustainable Biomaterials (RSB) or to an equivalent standard.

FIGURE 32. CARBON DIOXIDE EMISSIONS FROM INDUSTRIAL ENERGY USE IN THE REFERENCE AND CORE SCENARIOS

Industrial CO_2 emissions increase in the Reference case from today's levels, but the Core Scenario reverses this trend and achieves substantial reductions by 2030 and deep reductions by 2050.



Electricity makes up a large share of today's industrial energy use in Nevada, but the sector must further electrify and supplement with low-carbon and carbon-neutral fuels to meet the state's climate goals. In the Core Scenario, total energy use declines from energy efficiency measures, and biofuels and synthetic fuels supply a growing share of energy. The Fossil-Free Sensitivity requires greater adoption of synthetic fuels to replace the remaining fossil fuels.

FIGURE 33. FUEL USE IN THE INDUSTRIAL SECTOR ACROSS THE REFERENCE AND CORE SCENARIOS AND THE FOSSIL-FREE SENSITIVITY

In the Core Scenario, power-to-liquid fuels and biomass are used, but the bulk of industrial sector energy demand is met with electricity, supplemented with a small amount of fossil fuels. In the Fossil-Free Sensitivity, where fossil fuels cannot play a role in 2050, biomass is diverted to higher-value applications, and power-to-gas plays a larger role.

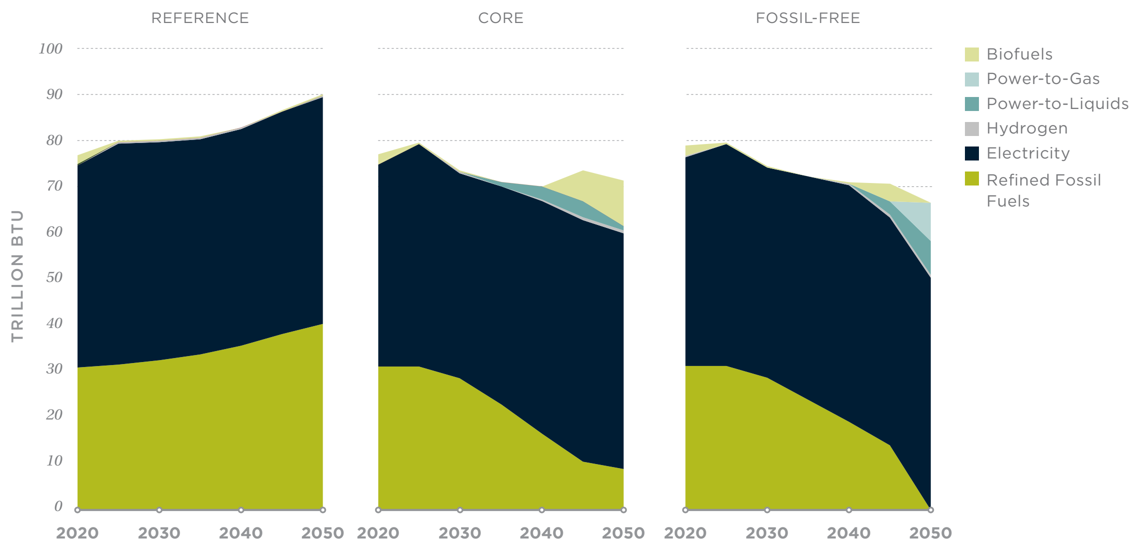
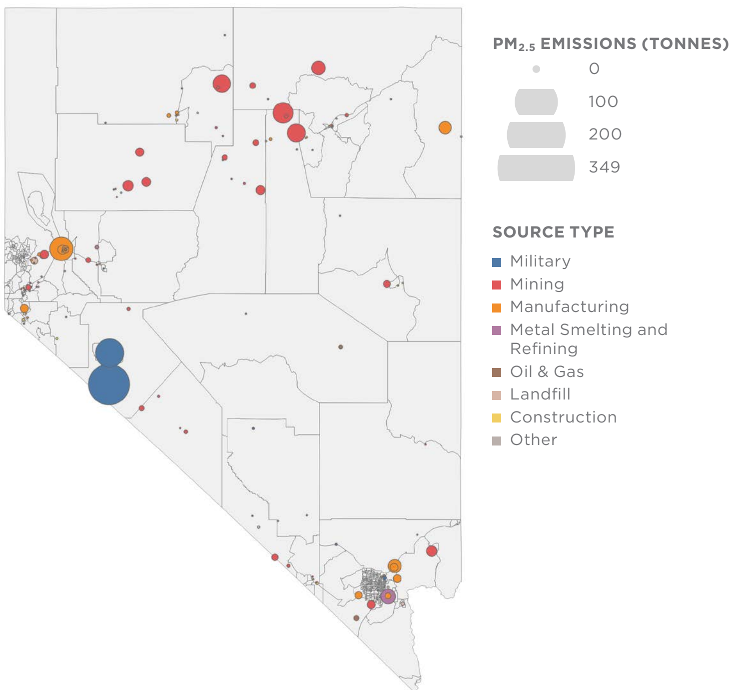


FIGURE 34. NEVADA INDUSTRIAL POINT-SOURCE $PM_{2.5}$ EMISSIONS

Emissions are concentrated at mining facilities along I-80 and the military installations in Hawthorne.



The data in Figure 34 need to be used with caution, as EPA's National Emissions Inventory does not include detailed information about the source of criteria air pollutant emissions within these industrial facilities, including to what degree emissions are related to the direct use of fossil fuels. To the extent emissions are from energy-related fuel combustion, power and transportation sector policies can target them. The state could, for example, prioritize electrification of heavy mining equipment and electrification of the buses that transport miners between I-80 cities and mines. The non-energy pollution is outside the scope of this report, but we encourage the state to collect more in-depth data on the energy- and non-energy pollution effects of industry and implement strategies to mitigate these effects.

Our modeling shows the physical changes in Nevada's energy-using systems—and the forecasted cost of those changes—necessary to meet the state's 2030 and 2050 greenhouse gas reduction goals. Smart policies, reinforced by the fast-lowering costs of the technologies needed for the energy transition, will give Nevada a good chance of reaching its targets at little additional cost. Three main principles underlie our policy recommendations.

First: we need to consider inequality and inequity in program design. The people and communities with the highest energy burdens are also the people and communities that breathe a disproportionate amount of Nevada's criteria air pollutant emissions. The transition is an opportunity to invest in these communities while lowering energy bills and reducing pollution.

Second: adopting economically efficient policies that limit the total cost of the energy transition will keep energy bills manageable for all families and businesses. Those planning major investments in the energy system need to make decisions that are informed by the cost of greenhouse gas and air pollution. We need to make smart technological investments, taking into account energy system needs as a whole, rather than investing in technologies in isolation based on their individual attributes. This might mean selecting more costly technologies than others if their system benefits exceed the benefits of slightly less expensive alternative technologies

Third: we need to start now. Nevada should already be accelerating the transition to electric vehicles and appliances. New investments in the gas distribution system should be scrutinized to make sure they make sense given the need to electrify buildings. Every new home built now without a super-efficient building shell and efficient electric appliances will require a more expensive retrofit down the road.

ELECTRICITY

Increase the RPS and establish a power plant carbon dioxide emissions rule to drive the elimination of emissions from the power sector

Our modeling shows that the level of renewables and power sector emissions reductions necessary to meet Nevada's 2030 and 2050 climate goals is well beyond the amount that can be delivered by the current 50 percent by 2030 RPS. Faster and deeper reductions will allow transportation and buildings to cleanly electrify and will cut emissions from sectors that already use electricity. Nevada therefore needs new or upgraded policies that finish the task of decarbonizing the power sector.

We present two options that are not mutually exclusive: increasing Nevada's existing RPS and/or establishing a CO_2 emissions rule that applies to CO_2-emitting power plants located in or that deliver electricity into Nevada. A CO_2 emissions rule would require that each ton of CO_2 emitted by a facility that produces electric power be paired with an emissions allowance, distributed by NDEP. The number of emissions allowances available each year would decline over time to match the CO_2 budget necessary to meet the state's climate goals. A benefit of a power sector CO_2 limit is that it would provide good incentives to decarbonize the remaining fossil fuel-fired generation in Nevada: higher-emitting units would operate at a competitive disadvantage. Policymakers would also have visibility into and more ability to control emissions from the non-renewable fraction of Nevada generation than if Nevada just increased the RPS without enacting a emissions limit.

Both policies would require new legislation that addresses the following points.

Which entities have compliance obligations

To continue effectively reducing emissions without creating loopholes, an increased RPS would need to apply to utilities (including municipal utilities, governmental agencies, and rural cooperatives) and "providers of new electric resources," which are defined by Nevada law as power companies that serve large customers that procure their own generation. A CO_2 emissions rule could be designed either to apply to owners/operators of CO_2-emitting generation in Nevada or to utilities and providers of new electric resources.

In designing policies that aim for complete decarbonization, policymakers should ensure that on-site CO_2-emitting generation is covered by an emissions limit or the increased RPS, to the extent these generators are used more than a trivial number of hours per-year. This will ensure Nevada does not create an incentive for large customers to self-generate to avoid paying for clean power.

Coverage

The increased RPS should apply to all electricity used in Nevada, whether it comes from on-site CO_2-emitting generation or is delivered by a utility distribution company, a load-serving entity, or a provider of new electric resources. While it may make sense for smaller utilities, such as municipal utilities or rural cooperatives, to have a separate timeline for decarbonization, they should still be covered by the policy.

To avoid creating an incentive for utilities to buy power from CO_2-emitting generators from outside the state, a CO_2 emissions rule needs to cover imports of electricity for use in Nevada. In order to avoid creating an incentive for owners of CO_2-emitting generation in Nevada to simply shift contracts to customers in states that do not have emissions regulation, the rule needs to apply to exports as well, unless those exports are into a state that has power plant CO_2 regulations as stringent as Nevada's and those exports are matched with an allowance from that other state's program.

Interaction between a carbon dioxide emissions rule and Nevada's Renewable Portfolio Standard

In 2019, Nevada lawmakers unanimously approved a renewable portfolio standard that will require utilities and providers of new electric resources in Nevada to get 50 percent of their electricity from renewable sources by 2030. This achievement was the result of years of effort, and the standard may be enshrined in the Nevada Constitution after the 2020 general election.

A CO_2 emissions rule would lay atop the existing RPS, rather than supplant it, and policymakers should take care to avoid double counting of clean electricity. The Public Utilities Commission of Nevada (PUCN) must require that utilities and other providers continue to retire renewable energy credits associated with the non-emitting share of their power mix. A utility, for example, that uses wind delivered from Wyoming to meet its CO_2 budget needs to retire the RECs associated with that generation, even if not used or needed for RPS compliance.

Carbon dioxide emissions rule budgets and Renewable Portfolio Standard

Early and fast power sector emissions reductions are needed if Nevada is to meet its emissions goals. The power sector emissions budgets and RPS percentages shown below should be considered high-level goals, indicating the level of ambition needed. More analysis, overseen by the PUCN and other state agencies, including analysis of local reliability, will be needed to set precise targets. At high levels (e.g., beyond 85 percent renewable energy), and informed by more analysis, Nevada should consider broadening RPS eligibility to include non-renewable zero- emission technologies.

TABLE 4. INDICATIVE RPS TARGETS

YEAR	2025	2030	2035	2040	2045	2050
New RPS	60%	85%	90%	95%	95%	100%
Existing RPS schedule	34%	50%	50%	50%	50%	50%

TABLE 5. INDICATIVE ELECTRICITY SECTOR CARBON DIOXIDE TARGETS (IN-STATE AND IMPORTS)

YEAR	2025	2030	2035	2040	2045	2050
Power Sector Budget (MMT CO_2e)	11	6	5	3	1	0

Ensure 2025 closure of Valmy 2 and consider other options at TS Power

The PUCN and NDEP should prioritize the closure and, if necessary, replacement with emission-free alternatives of the Valmy 2 coal plant and the dual-fuel TS Power Plant. Extending the life of these inefficient steam power plants means other sectors will have to decarbonize and electrify even faster than in our Core Scenario. This extra effort means that the total cost of decarbonization increases if these plants stay online. The RIO model used here does not have a detailed representation of unit operations and transmission constraints, so additional resources or upgrades may be necessary for reliability at these two locations if these plants close. A CO_2 emissions limit on generators would provide improved closure signals for these plants.

Energy efficiency, storage, and distributed generation for energy- and emissions-burdened people and communities

Nevada policy has long supported customer adoption of distributed generation and rooftop solar, though adoption of rooftop solar may slow as new net metering customers now receive a credit equal to 75 percent of their retail rate when they export electricity to the grid. The legislature in 2019 also passed AB 465, which creates a utility-operated shared solar program, where customers can subscribe to receive their electricity from community-located smaller-scale projects and a large-scale utility solar project, mirroring a program where large business customers are able to save money by being assigned electricity from large, inexpensive utility-scale solar projects. Under the AB 465 program, low-income customers pay a discounted rate for this electricity, and 25 percent of program capacity is reserved for these customers.

The AB 465 program will allow certain low-income customers to receive some of the benefits that wealthier net-metered customers receive, especially those who signed up when grid exports were credited at the retail rate. Going forward, AB 465 and other distributed generation policies, such as incentives for small-scale storage systems, should be targeted at low-income communities and communities of color. People in these communities and with specific medical needs are more likely to be at risk during an extreme heat wave and are at higher risk of falling behind on their bills and suffering a shut-off of utility service. These customers should also be prioritized for electrification investments and building shell improvements. Ratepayer funds could be leveraged to upgrade existing community centers for resilience purposes, providing relief against heat waves as well as climate-related natural disasters like wildfires.

Increase coordination with other states to advance renewable energy

Nevada will increasingly need to both export and import renewable electricity to keep the costs of meeting the greenhouse gas reduction targets low, given the state's renewable resource strengths and weaknesses—great sun and geothermal but less wind than other western states. To facilitate these long-term economic relationships and short-term energy balancing, and improve the hour-to-hour and minute-to-minute operation of the grid, Nevada should build on NV Energy's existing participation in the Western Energy Imbalance Market and current consideration of the Enhanced Day-Ahead Market. Further, the state should work with labor unions, environmental justice organizations, clean energy companies and other stakeholders in Nevada that benefit from the clean economy to explore additional steps to facilitate the movement of clean energy in Western states. Nevada should work with other states committed to robust climate policy to expand collaboration, jointly plan and allocate costs for transmission, and share renewable resources while ensuring any market rules do not disadvantage clean energy, demand response, and energy efficiency as compared to incumbent fossil and nuclear generation.

Increase and reform the Universal Energy Charge

Our modeling shows that meeting climate goals with near-complete, early decarbonization of the electric sector can be achieved at electricity rates quite similar to today's. But customers with already-high energy burdens need to be protected from potential increases. Nevada already has a charge on utility bills that helps pay for energy assistance programs for low-income customers, but it is small: just 0.039 cents/kWh of electricity and 0.33 cents/therm of gas. The charge is regressive because an individual large customer's contribution is limited to $25,000 per quarter, no matter how much energy they use. It is also not indexed to inflation, nor has it been increased since established by the Legislature in 2001. The funds raised by the charge are split between direct bill assistance (75 percent) and weatherization programs (25 percent), and households generally must have an income less than 1.5 times the federal poverty level to be eligible for assistance.

The charge should be increased and reformed, so that the programs it funds can better offset energy burdens. We recommend the following changes:

- Broadening the eligibility threshold
- Increasing the charge to a level that allows money collected to better fund programs that protect customers from high bills and heat stress, adding to existing federal Low Income Heating Assistance Program and Weatherization Assistance Program funds
- Removing per-customer caps on contributions, eliminating the regressive nature of the charge
- Allow multifamily dwellings and other rental dwellings with a substantial share of eligible customers to receive weatherization services

Smart from the start planning framework for new renewables

Substantially increasing Nevada's solar capacity increases land requirements, which could be harmful to wildlife, ecosystems, and scenic values unless infrastructure is placed carefully. Development should take place preferentially on lower-impact land types such as disused agricultural land (developers should own and retire the water rights), former mine lands, brownfields, and checkerboard and lower-impact public lands, prioritizing designated solar energy zones. The state should take the following steps to plan the wise development of renewable energy infrastructure:

- Identify and prioritize high-potential, lower-impact renewable generation zones. A geospatial analysis created with public input and expert opinion can reveal the best locations for renewable development based on resource potential, proximity to existing or planned transmission, and avoidance of high value conservation lands, cultural resources, and other conflicts. Indigenous communities should be engaged in this early stage of the planning framework.
- Ensure that planned and upgraded transmission connects the renewable generation zones in the most efficient network and that transmission upgrades or new lines also avoid high-value conservation lands, cultural resources, and other conflicts.
- Identify where transmission modernization is needed to support development of renewable energy on ideal lands types. For example, the Amargosa Valley has numerous suitable locations for solar development on several ideal land types, like disused agricultural land. NV Energy's proposed Greenlink Nevada project will go through this area, opening these lands to development.
- Enact policies that will incentivize and facilitate development of renewable energy on ideal land types and transmission network upgrades, such as financial and increased permitting efficiency benefits. Identify policy solutions that ensure that economic and environmental benefits and burdens from renewable energy buildout are shared equitably among communities.

- Establish a mitigation framework to address unavoidable impacts of energy development.

TRANSPORTATION

Adopt clean medium- and heavy-duty truck rules

Cleaning up Nevada's medium- and heavy-duty vehicle fleet is critical to reducing climate pollution, but also locally harmful air pollution. Figure 21 shows how, with VMT increases and the later electrification of medium- and heavy-duty vehicles, Las Vegas and Reno will still see an absolute increase in transportation-related $PM_{2.5}$ emissions from today's levels even as the light-duty vehicle sector electrifies.

Under the Clean Air Act, Nevada is able to adopt California's Advanced Clean Truck (ACT) and Omnibus rules by reference, which would require truck makers to sell an increasing number of clean, zero-emission trucks in place of dirty diesel and gasoline ones. Nevada should sign the Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding, where it would join other states working collaboratively to advance the market for electric trucks and buses and establish a public process to work with industry and community stakeholders to develop a broad set of strategies to reduce emissions from heavy-duty vehicles. It will be important to develop a broad-based coalition—including labor, environmental justice, utility, EV industry, and consumer advocates—to support strong standards for commercial trucks including the ACT rule coupled with a Heavy-Duty Omnibus rule. Complementary measures must simultaneously be adopted on clean trucks and buses including charging infrastructure policies and incentives. NDEP should develop the rulemaking with input and coordination with the Governor's office, Nevada Governor's Office of Energy (NGOE), Nevada Department of Transportation, and the PUCN.

Advanced Clean Truck Rule

A Nevada Advanced Clean Truck rule would require manufacturers who sell trucks in the state to ensure that, on average, 30 to 50 percent of new commercial truck sales are zero emissions by model year 2030 (depending on the weight class and credit modifiers) and reaching 40 to 80 percent by model year 2035. Compliance is determined based on manufacturers generating credits for selling electric trucks and using those credits to meet their overall credit requirement. Quick adoption of California's rule would allow Nevada to begin benefitting from reduced emissions as soon as possible.

Heavy-Duty Omnibus Rule

California adopted new criteria pollutant standards from heavy-duty conventional, internal combustion engine trucks in its Omnibus Rule. Reducing truck emissions by a similar order of magnitude in Nevada will result in significant public health benefits. This rulemaking is a complementary standard to an ACT rule in Nevada and should ideally be pursued simultaneously by the NDEP.

Complementary Policies

Paired with the ACT and an Omnibus rule, the state should support the development of a robust market for zero-emission medium- and heavy-duty vehicles through complementary strategies such as a fleet purchase requirements, infrastructure investments, and incentives for technology adoption.

Equity Considerations

These combined rulemakings will reduce harmful fossil fuel emissions in communities throughout the state. However, communities near highways or industrial hubs—which are predominantly communities with high socioeconomic vulnerability—have for years disproportionately suffered from air pollution from diesel trucks. Negative impacts in these areas could be addressed by prioritizing electrification infrastructure to replace trucks along polluted urban highways, supporting the electrification of heavy-duty trucks and equipment at warehouses and industrial facilities in overburdened communities, relocating bus terminals and yards away from already overburdened communities or switching current yards to service electric buses only, and limiting the amount of time buses and trucks can idle.

Facilitate investment in electric vehicle charging infrastructure

Meeting EV deployment targets requires policies and programs that support the development of EV charging infrastructure. A larger charging network increases the value of an EV to a customer, and a larger fleet of EVs makes the charging network more viable. Policymakers should work backwards from EV deployment goals and ZEV targets when determining the number of EV chargers that will be necessary to support Nevada's future fleet of electric cars, trucks, and busses. While battery prices are coming down rapidly, there's no technology cost-reduction curve for trenching, pouring concrete, and running electrical wires, which means that even when the EVs have achieved cost-parity with fossil equivalents, the costs of installing charging infrastructure will remain a persistent barrier to widespread adoption.

The electric utility will have a large role here. They can directly invest in the charging network, particularly in hard-to-reach segments. They can also make investments on the utility side of the meter that make it cheaper for public charging providers, including private companies or transportation agencies, to install charging infrastructure: investments like transformers and conductors, and trenching, repaving, and conduit that carry electricity to the electric vehicle supply equipment itself.

Our analysis shows the critical role of flexible demand from electric vehicles. Approvals of charging infrastructure should ensure the technology and rates adopted by the utilities facilitate smart charging. The PUCN must make sure that Nevada EV owners can use rate structures that do not penalize EV load but encourage vehicle charging that supports the grid. Rates for EVs owners, provided they charge at times when renewable energy is plentiful and refrain from charging when renewables are scarce, should be designed to recover the marginal cost of EV load, rather than make a full contribution to fixed costs, given the social benefits of EV adoption.

Legislators should, in 2021, pass legislation that requires NV Energy to make short-term, economically stimulative investments that accelerate EV adoption and to propose long-term strategic charging infrastructure plans, including investments in charging infrastructure and utility-side "make ready" infrastructure when requested by owners or operators of public or fleet electric vehicle supply equipment. Those investment plans should include targeted program funding and effort on providing infrastructure in and benefits to communities with high socioeconomic and environmental vulnerability, through support for public transit and school bus electrification, and placement of charging infrastructure in high-impact locations. These communities need to be consulted early on infrastructure and placement decisions, and have valuable insights on barriers to adoption in their communities. Communities deserve electrified transit investments, dedicated neighborhood charging, and programs to make EVs, including used EVs, available and affordable.

Close the classic car loophole

Nevada law allows vehicles aged 20 years or older to avoid the Nevada Emissions Control Program (i.e., the "smog check") if the owner self-certifies that they drive the vehicle less than 5000 miles per-year. The provision, intended for seldom-driven classic cars, is frequently abused: a 20-year-old car can easily be a daily driver, and older cars produce much more smog-forming pollution than current models. Since the law was changed to open the loophole in 2011, the number of cars claiming the classic car exemption has gone from 5,000 per-year to more than 30,000 in 2016.

Lawmakers should close this loophole and use the resulting smog check fees to fund pollution-reducing repairs and electric and hybrid vehicle subsidies for low-income Nevadans.

Adopt a Zero-Emission Vehicle program

In June, Governor Sisolak announced the launch of Clean Cars Nevada, a process where the state will evaluate adoption of new regulations, already adopted by multiple states around the country, that would ensure automakers deliver more electric vehicles to Nevada while requiring reductions in air pollutant and CO_2 emissions from gas-powered cars. This summer, NDEP released a draft rule and is currently hosting public outreach events, followed by a formal public rulemaking next year.[5] The adoption of a Clean Cars Nevada program is critical to getting Nevada on the pathway to achieve deep decarbonization from the sector.

The current Clean Cars Nevada proposal under consideration would establish standards to 2025. Under the federal Clean Air Act, Nevada would have an additional opportunity to consider upgraded standards for 2026 and beyond if California adopts and receives a waiver in 2021 for its new rules, currently being developed, that extend the clean cars program. As the global auto industry transitions to zero-emission technologies like EVs, Nevada should prepare by considering a future Clean Cars Nevada II program, and developing other policies that support majority market share of plug-in vehicles by 2030 and then near-100 percent market share by 2035. Nevada should engage stakeholders, experts, and the broader public on the best ways to ensure this transition occurs in a manner that lowers the costs of transportation for all, enhances equity, attracts family-supporting and high-road jobs, and maximizes public health and environmental benefits. The state should ensure that the Nevada Division of Environmental Protection, which would implement the program, is also adequately resourced and supported to lead this engagement.

While considering and adopting clean car standards, Nevada should implement complementary policies and programs that enhance zero- emission mobility options and access for socioeconomically vulnerable communities and people, who tend to live in places with higher transportation-related air pollutant emissions. Buying or leasing a new or used EVs should be a possibility for all Nevadans, and the state should target charging investments in socioeconomically vulnerable communities and develop rebate programs (discussed below) where low-income people receive higher rebates.

Implement a partial sales tax incentive for electric vehicles, with a market share and vehicle cost cap

Nevada needs to move toward mass adoption of electric vehicles. While eventually in the 2020s battery electric vehicles are forecasted to be cheaper to buy, maintain, and operate across consumer vehicle classes than gasoline-powered vehicles, today they are priced higher, posing a barrier to adoption. Given the societal benefits of EVs, there is a strong public policy justification for state rebates for EV purchases, and Nevada should aim to make purchase

5 https://ndep.nv.gov/air/clean-cars-nevada

incentives available by the middle of 2023 or sooner. Given Nevada's tax structure, if the incentive is delivered through the tax system, it should be a sales tax or registration fee rebate. Nevada should consider the following:

- Program design that ensures lower-income households are eligible to receive incentives and purchase or lease EVs from the new or used-car market in the program, including being eligible for a higher rebate amount and providing financing assistance. This will ensure low-income customers can receive the cost-saving benefits of driving an EV.
- Limiting consumer incentives based on vehicle purchase prices to exclude new vehicles priced in the luxury segment.
- Coupling the incentives with other programs from the utility or state that facilitate the establishment of charging infrastructure at a multi-unit, rental, and single-family homes/neighborhoods.
- Phasing out rebates by 2027, when price parity is expected to be reached in many vehicle classes, while retaining portions of the program that are focused on increasing access in socioeconomically and environmentally vulnerable communities.

Reform the gas tax so it is indexed to fuel sales, inflation, and apply it to EVs based on their mile-per-gallon equivalent fuel economy

Nevada uses its gas tax to fund about 17 percent of its highway expenditures, and gas tax revenue is not keeping up with highway funding needs, much less Nevada's needs for a robust public transportation system. Nationally, gas tax revenue is falling behind needs largely because of inflation and increasing fuel economy. EVs are not a significant source of revenue loss. Nevertheless, some are concerned with the long-term problem that EVs pose for the gas tax system, and some in Nevada have proposed very high EV fees, or changing the gas tax to a flat vehicle-miles-traveled (VMT) based fee that would tax gas guzzling polluters and zero-emission vehicles the same. Such VMT-based fees also place efforts to reduce VMT at odds with the collection of revenue needed to maintain the transportation system.

Instead of an EV-specific fee or a miles-traveled-based fee, we propose keeping the basic structure of the gas tax intact, index it to inflation and fuel sales, and extend it to EVs based on their fuel economy. By indexing the gas tax rate to inflation and fuel sales, Nevada would end the two major sources of revenue erosion to date: increasing construction costs and fuel economy. To determine the tax an EV owner would pay in a year, the DMV would calculate, for each EV, the equivalent "gallons" they drove in a year by dividing their miles driven (already reported to the DMV pursuant to existing law) by the miles-per-gallon equivalent efficiency of their EV, and multiplying the resulting number of e-gallons by that year's fuel tax rate. The top-up amount for plug-in hybrid electric vehicles would be determined by using the estimated number of miles driven on electricity for that vehicle.

The indexing would ensure that Nevada continues to get the needed amount of revenue, even as EV sales increase dramatically in the 2030s. Our model is neutral to any increase in the total desired amount of revenue raised by the tax: the indexing and structure work, whatever the initial tax level. Our model, unlike others, keeps with earlier, good policy decisions the state has made. Like under the current gas tax system, our model incentivizes customer adoption of efficient vehicles, whether gas- or electric-powered, and maintains the price on pollution inherent in the existing gas tax.

Change the constitution to allow gas tax revenue to be used for broader transportation system investments

Nevada has a constitutional prohibition on using gas tax revenues for anything but constructing, maintaining, or repairing public roads. The Legislature is considering removing this prohibition to allow gas tax, car registration, or driver's license fees to be used on transportation infrastructure generally, including public transportation. As Nevada grows, congestion and vehicle miles traveled will continue to increase, as shown in the Core Scenario, absent concerted action. Nevadans will save money and time if a stronger public transportation network allows more trips to be conducted on affordable, convenient, accessible, public transportation.

Paying for public transportation in part with gas tax revenues makes economic sense because congestion is one of the key external costs of driving, so raising a gas tax to fund public transportation moves the cost of driving closer to the full social cost. It is also better than funding public transportation solely from farebox revenues: the lower costs of taking the bus or tram encourages drivers to switch, and lowers costs for existing users of public transportation, who are more likely to be low-income people.

Invest in public transportation, smart growth, and walking and biking infrastructure

The Energy Efficiency Scenario shows the reductions in transportation-related emissions that come from reducing transportation demand. State and local governments must make investments, and implement programs and policies that make the use of public and zero-emission transportation attractive compared to the use of single-occupant vehicles. These investments should include several elements:

- High-quality, low-priced transit, throughout the Reno and Las Vegas metro areas, with early electric transit investments in communities with high socioeconomic and environmental vulnerability
- Widespread access to walk- and bike-friendly communities, expansion of bicycle and pedestrian networks
- Tying transportation funds to county and municipal land-use and zoning decisions that reduce vehicle use and cut emissions

- Municipal pilots of congestion pricing
- EV mandates for ridesharing companies
- Commuter incentives

Investing in public transportation can reduce CO_2 emissions by encouraging drivers to switch to transit, but also improves the travel experience for disadvantaged groups who already rely on transit.

BUILDINGS

Saving energy in Nevada's buildings would help make the state's decarbonized electricity system easier to manage by reducing the need to build solar and storage and reducing air conditioning demand in the evening when solar production quickly stops. Across the Core and Energy Efficiency Scenarios, building energy use declines about 8 percent between 2022 and 2030, from a combination of gas-to-electric fuel switching, appliance efficiency, and building shell retrofits.

However, to enable these changes, Nevada needs to increase its capacity to run programs that make it easier and cheaper for customers to save energy and electrify. NV Energy's programs in recent years, while improved from their nadir, still save less energy than programs of leading utility companies in the region and less than NV Energy's own assessments of the cost-effective, achievable potential for energy savings. Nevada, like many states, does not have a robust program for retrofitting building shells, aside from the weatherization efforts run by grantees of the Nevada Housing Division's Weatherization Assistance Program. Despite the imperative to transition from gas use in buildings, gas is still the default option for new construction in Nevada, and gas utilities can easily expand and reinvest in long-lived distribution infrastructure.

The state needs to expand existing efforts, empower others, or create new entities if it is to increase savings and electrify. It needs a mix of mandatory efforts (around gas utility infrastructure, building codes, and appliance standards), incentive programs (for ultra-efficient appliances and building shell retrofits), and efforts targeted at and inclusive of communities with high socioeconomic and environmental vulnerability.

Adopt high-level state energy efficiency, building shell retrofit, and electrification targets

As a high-level goal, to which the state can compare its efforts, the state should adopt long-term, persistent, total building energy reduction goals similar to those shown in Table 5, below. "Long-term" and "persistent" means that the state should be targeting savings that will last over time, like over the life of an appliance or a building shell, and savings that disappear (for example, a super-efficient dishwasher installed today that breaks after 15 years) should be replaced. “Total” means a metric that encompasses all building energy use, from electricity, gas, and other fuels. The high-level goal thus includes electrification efforts. In each year in Table 6 below, the savings percentage represents the impact *that year* of the efforts the state has made since 2022, compared to what would have occurred absent the efforts.

TABLE 6. INDICATIVE LONG-TERM, PERSISTENT ENERGY SAVINGS GOALS

YEAR	2030	2035	2040	2045	2050
Long-term savings	8%	18%	25%	30%	35%

Another way the state can ensure its efforts lead to long-term savings is to explicitly focus on building shell improvements in new buildings (with strong building codes) and existing buildings (with retrofits). Below are high-level targets that show the scale of effort needed in residential buildings, shown as a percent of all residential buildings, existing and new. Through 2030, about three-quarters of the needed improvement could be achieved by ensuring all new buildings are super-efficient. These retrofits should also be packaged with electrification.

TABLE 7. INDICATIVE PERCENTAGE OF RESIDENTIAL BUILDINGS (EXISTING AND NEW) THAT SHOULD HAVE HIGH-EFFICIENCY SHELLS, BY YEAR

YEAR	2025	2030	2035	2040	2045	2050
% of residential units with high-efficiency shells	8%	18%	35%	50%	63%	75%

The state should also target the portion of existing and new buildings that are all-electric. We recommend the following high-level targets, separately for commercial and residential buildings.

TABLE 8. INDICATIVE SHARE OF EXISTING AND NEW RESIDENTIAL AND COMMERCIAL BUILDINGS WITH ALL-ELECTRIC APPLIANCES, WATER AND SPACE HEATING

YEAR	2025	2030	2035	2040	2045	2050
% of residential buildings with all-electric appliances	28%	44%	62%	77%	88%	94%
% of commercial buildings with all-electric appliances	4%	21%	48%	72%	87%	95%

In designing programs to meet these targets, state agencies and program implementers should explicitly target programs to people and communities that are socioeconomically and environmentally vulnerable and those who live in multifamily apartments. This group of customers will face the highest barriers to participation—limited budgets, the split-incentive problem—and their communities have suffered disinvestment in past transitions.

Assign and clarify program implementation responsibilities and funding

Reaching these targets will require Nevada to dramatically increase funding and reach (for energy efficiency programs) or create entirely new program areas (for building retrofit and electrification programs). Given the need to change and increase program efforts, now is a good time to examine which entities should be assigned program implementation responsibilities, funding, and other aspects of the energy efficiency and electrification policy framework. We believe the state should consider giving program administration duties to a non-profit, mission-oriented, third-party program administrator, or consider doing so for at least part of the building-related effort, like the retrofit program. At the very least, the state should enact a stronger policy framework for building energy programs. Such a framework should include:

- Legislated retrofit targets, a mandate for the efficiency program administrator to capture all cost-effective savings, and specific requirements for the utility or third-party administrator to run electrification programs
- Costs of program administration collected from all program-eligible customers as a non-bypassable charge on electric and gas utility bills, based on the gas/electric share of overall savings. This ensures that the costs of building-related programs are not placed entirely on the electric bill (i.e., some will be placed on the gas bill)
- PUCN approval of budgets and spending
- An opt-out for large customers that agree to engage in a strategic energy management process and dedicate the amounts they would have contributed to the program in a company-specific energy efficiency account
- A prohibition on program support for gas equipment and appliances, unless they reduce greenhouse gas emissions relative to the efficient electric alternative, and authorization for program administrators to support efficient electric technologies for current gas customers and homes heated by wood or propane.
- Savings judged relative to a counterfactual baseline (i.e., "what would have happened without the program"), and specific direction to the efficiency program administrator to pursue program opportunities that push the market beyond current practice
- A legislatively created advisory committee, with the funding to gather outside expertise on program design, implementation, and evaluation, and members of socioeconomically and environmentally vulnerable communities included on the advisory committee

- Requirements for NV Energy and gas utilities to provide customer data and other needed information to any third-party administrator
- Requirements for NV Energy and any third party administrator to work together to use the load flexibility inherent in energy efficient appliances incentivized by the third-party administrator

In order to address multifamily and rental housing, the state will need policies to address the split incentive problem, where renters pay energy bills, and thus bear the cost of inefficient appliances and building shells, while building owners are responsible for paying for improvements. To engage low-income people in programs, implementers will need to work with one another, community groups, weatherization assistance program grantees, and social service organizations. Incentives will need to cover the full cost of retrofits for low-income people, or leverage money from other grants and funding sources, because low-income customers should not be expected to fund the co-pays that wealthier customers do. Programs will also need to be developed to specifically help low-income customers to move off of gas service, and protect remaining customers from increasing gas rates as wealthier customers cease to use gas. Nevada should ensure owners of subsidized and unsubsidized affordable housing, and tenants, have priority access to incentives and support to enable their transition from gas to electricity for both new construction and retrofits.

Provide for automatic adoption of the most recent building code by authorities having jurisdiction, with modifications that move toward all-electric new construction and EV-ready buildings

Ensuring new buildings are all-electric, with super-efficient building shells, is an important part of meeting building decarbonization goals. The most cost-effective time to add proper air sealing, ventilation, and insulation is at the time of construction; ensuring new buildings are efficient and electric from the start reduces the need for more expensive retrofits later, or the need to wait for inefficient gas appliances to break down. The 2021 version of the International Energy Conservation Code (IECC) provides at least a 10 percent efficiency improvement over the 2018 version of the code, and voters in the IECC process also approved measures requiring buildings to be built today in a manner that allows for easy adoption of electric appliances and vehicles later. While these measures were appealed by gas utilities and homebuilders, and ultimately taken out of the code, they have already been vetted and finalized, and the state should adopt them when it adopts the 2021 IECC as the state building code.

The process by which localities adopt and enforce building codes is not working well. Current law requires the Nevada Governor's Office of Energy to adopt the most recent version of the IECC as the state building code, and then local governments adopt and enforce it. But there is no requirement that local governments adopt this state code in a timely manner, and key jurisdictions in

Nevada skip a cycle, adopting new codes only every six years. If this system continues, buildings constructed in Nevada over the next few years will have sub-standard energy efficiency, and will be more difficult to electrify later.

Legislation to create strong building codes in Nevada should:

- Clarify that the NGOE is free to strengthen the building energy code in a manner that reduces total statewide energy use as it adopts the most recent version of the International Energy Conservation Code
- Require local governments to adopt and enforce, in a timely manner, this statewide energy code, with the ability to adopt stronger codes.

Adopt state appliance standards

Many states have laws that ensure energy-using appliances and devices meet minimum efficiency standards. Generally, state standards supplement federal ones: they cover products not already covered by national energy efficiency standards promulgated by the U.S. Department of Energy. Nevada has the opportunity in the next legislative session to adopt state appliance standards that would cover 20 products not already covered federally. Nevada should take advantage of this opportunity to set standards for these products and allow, via legislation, for the state to increase the stringency of standards over time. Adopting these standards will save energy, water, and money. The estimated benefit of these standards to Nevada is $1.3 billion in utility bill savings (electricity, water, gas) between 2020 and 2035.

Stop unnecessarily expanding the gas distribution system, create a gas Integrated Resource Planning process, and initiate a proceeding investigating the future of gas

Moving away from gas use in buildings, starting now, is critical to meeting Nevada's GHG reduction goals. Investing further in the existing gas distribution system, or expanding service to communities that do not already rely on gas, does not make sense given the imperative to electrify. It takes 60 years or more for gas distribution investments to pay off, and new pipe installed today is likely to go unused before it is fully depreciated. Given this reality, the state needs to change how it evaluates gas distribution system investments.

First, lawmakers should direct the Public Utilities Commission of Nevada (PUCN) to establish an Integrated Resource Planning (IRP) process for gas utilities. In this proceeding, the gas utility would have to justify planned gas infrastructure investments, present different scenarios for how gas demand may change in the future, including if customers electrify at the pace consistent with the state's climate goals, and evaluate the proposed investments against demand-side alternatives, including electric ones. The utility would also be required to analyze the equity impacts of new investments: who would bear the costs of new investments under different electrification scenarios. The Public

Utilities Commission of Nevada (PUCN), intervenors, and the public would scrutinize proposed investments and demand forecasts, and the PUCN would only approve those investments shown to be compatible with Nevada's climate goals and cost-effective compared to alternatives such as pipe repair, customer efficiency measures, and electrification of affected customers. Investments approved in the IRP process would be presumed to be prudent when brought forward for cost recovery.

Second, lawmakers should repeal the statute governing gas system expansion, which actually encourages the practice. NRS 704.9925 allows a utility to propose expansion to any place that does not already have gas service, and requires the PUCN to allow the utility to timely recover investments. Any expansion should be justified in the Integrated Resource Planning process, taking into account compatibility with Nevada's climate goals and cost-effectiveness compared to alternatives.

Related to the IRP, the legislature should also direct the PUCN to initiate a proceeding to develop rules and policies for the long-term future of gas distribution utilities in the state. Such a proceeding should investigate how gas demand in buildings may change in the future and develop rules and policies for the following issues, and others the PUCN considers important:

- Strategic electrification, where branches of the gas distribution system due for an expensive replacement are instead electrified, if electrification is shown to be cost-comparable
- Utility ratepayer subsidized allowances for new line extensions and connections
- Aligning depreciation of gas system investments with realistic projections of gas use
- Understanding and monetizing in cost-benefit analyses the health impacts of gas use in buildings.

In moving off of gas and toward all-electric buildings, the PUCN should focus on communities with high socioeconomic and environmental vulnerability, and direct incentive dollars to ensure low-income customers are prioritized in the transition off of the gas system.

INDUSTRY

Policies described above—increasing the RPS, limiting CO_2 emissions from power plants, adopting standards that require zero-emission medium- and heavy-duty vehicles—would indirectly help address CO_2 and criteria air pollutant emissions from industry. In addition to adopting these policies, the state will need to make sure that greenhouse gas emissions limits apply in some manner directly to industry, particularly mining, which is the largest industrial energy user. One reason an increased RPS, continuous energy improvement requirements, and/or a CO_2 emissions rule need to apply to entities that get energy from on-site fossil fuel-powered generators is so that large users do not have the ability or incentive to get around pollution laws by building their own power plants or importing power from outside entities. Similarly, the state needs to ensure regulations would cover diesel engines in vehicles that travel exclusively or primarily on private roads, like those within a mine site. For non-energy related fossil fuel emissions, the state could consider bringing industrial operations under the power plant or additional greenhouse gas emissions limit, ensuring these emissions are regulated and decline over time. Efficiency and fuel-switching to hydrogen or other synthetic fuels can reduce process-related fuel use. The state also should increase data collection and reporting for facility criteria pollutant emissions and sources.

AIR QUALITY DATA, MODELING, AND MAPPING

Increase air quality monitoring and modeling

Advances in low-cost sensor technologies over the last few years are helping to democratize access to air pollution data and powering a new era of "citizen science." Low-cost sensors, like Purple Air, have provided important information during the 2020 wildfire season, filling the gaps in the network of air quality monitors used by regulators. Such low-cost monitors could help identify pollution hotspots and identify locations where additional regulatory-grade monitoring may be required. To improve community monitoring, NDEP could provide funding for third parties like environmental justice and community organizations to install low-cost sensors around suspected pollution hotspots.

The analysis of air pollution impacts tends to be solely within the jurisdiction of air regulatory agencies. However, an integrated cross-agency analytical approach is needed to more fully understand the air quality and health impacts of energy policies that may fall under multiple agencies' jurisdictions. For example, to understand the air quality and health impacts of various energy policies, NDEP could work with non-air quality agencies, like the PUCN, Nevada Governor's Office of Energy, Nevada Department of Transportation, and Regional Transportation Commissions to adopt EPA's Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool in urban planning, transportation planning, and energy program planning.

Develop Nevada EJ screen

The environmental and demographic indices used in this analysis attempt to identify census tracts that have dealt with racism, exclusion, poverty, disinvestment, and environmental pollution: those communities who are at risk of being left behind or ignored in big investment pushes. The State of Nevada should formalize these criteria, engaging community members to identify geographic areas most in need of attention and objective metrics that can be used to identify these areas. With areas identified, and a definition to point to, new policies that address greenhouse gases and local pollution can more easily target communities for investment in pollution reduction and clean energy access.