# Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2039

*Nevada Division of Environmental Protection*

2019 Report

Submitted in accordance with NRS 445B.380 and SB 254 (2019 Legislative Session)

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# Disclaimer

The information contained in the *Nevada Statewide Greenhouse Gas Inventory and Projections, 1990-2039* report is for public use; every effort has been made to ensure its accuracy. Emissions estimates reflect the best and most complete datasets and currently accepted calculation methodologies at the time this report was prepared. Differences may be found in the emissions reported in previous versions of this report. The information presented is as timely and accurate as practicable; no expressed or implied guarantees are made. Information contained herein may be freely distributed and used for noncommercial, scientific, and educational purposes.

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# Table of Contents

# List of Tables

# List of Figures

# Acronyms and Abbreviations

| | |
|---|---|
| AB | Assembly Bill |
| AEO | Annual Energy Outlook |
| AMPD | Air Markets Program Data |
| BOD | Biochemical Oxygen Demand |
| CAA | Clean Air Act |
| CAFE | Corporate Average Fuel Economy |
| CNG | Compressed Natural Gas |
| CO2e | Carbon dioxide equivalent |
| COP21 | 21st Session of the United Nations' Conference of Parties |
| eGRID | Emission & Generation Resource Integrated Database |
| EGU | Electric Generating Unit |
| EIA | United States Energy Information Administration |
| EO | Executive Order |
| EPA | United States Environmental Protection Agency |
| FHWA | Federal Highway Administration |
| FIA | USDA-Forest Inventory and Analysis Program |
| GHG | Greenhouse Gas |
| GHGRP | Greenhouse Gas Reporting Program |
| GWP | Global Warming Potential |
| IECC | International Energy Conservation Code |
| IPCC | Intergovernmental Panel on Climate Change |
| IRP | Integrated Resource Plan |
| LBE | Lead by Example |
| LEV | Low Emission Vehicle |
| LFGTE | Landfill-Gas-to-Energy |
| LMOP | Landfill Methane Outreach Program |
| LNG | Liquefied Natural Gas |
| LPG | Liquefied Petroleum Gas |
| MMTCO2e | Million metric tons of carbon dioxide equivalent |
| MWh | Megawatt-hour |
| MSW | Municipal Solid Waste |
| NDEP | Nevada Division of Environmental Protection |
| NHTSA | National Highway Traffic Safety Administration |
| NIFC | National Interagency Fire Center |
| NPC | Nevada Power Company |
| NRS | Nevada Revised Statutes |
| NSPS | New Source Performance Standards |
| ODS | Ozone Depleting Substance |
| PACE | Property Assessed Clean Energy |
| PM | Particulate Matter |
| PUCN | Public Utilities Commission of Nevada |
| RPS | Renewable Portfolio Standard |
| SAFE | Safe and Affordable Fuel Efficient Vehicles rule |
| SB | Senate Bill |
| SIT | State Inventory Tool |
| SPPC | Sierra Pacific Power Corporation |
| TWh | Terawatt-hour |
| USDA | United States Department of Agriculture |
| VMT | Vehicle Miles Travelled |
| ZEV | Zero Emission Vehicle |

# Chemicals and Chemical Compounds

| | |
|---|---|
| C | Carbon |
| CaO | Calcium Oxide, or lime |
| $CaCO_3$ | Calcium Carbonate, or limestone |
| $CaMg(CO_3)_2$ | Dolomite |
| $CH_4$ | Methane |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon dioxide |
| $CO(NH_2)_2$ | Urea |
| HFC | Hydrofluorocarbon |
| NCO | Cyanate |
| NH | Imidogen |
| NO | Nitrogen Oxide |
| NOx | Oxides of Nitrogen |
| $N_2O$ | Nitrous Oxide |
| PFC | Perfluorocarbon |
| $SF_6$ | Sulfur hexafluoride |

# Executive Summary

## Introduction

The Nevada Division of Environmental Protection is pleased to present the *Nevada Statewide Greenhouse Gas Inventory and Projections, 1990 to 2039*. This inaugural report has been prepared pursuant to Nevada Revised Statutes (NRS) 445B.380[1] and Senate Bill (SB) 254, which was approved by the Nevada Legislature during the 2019 Legislative Session and signed by Governor Sisolak on June 3, 2019.

As required by NRS 445B.380 and SB 254, this report contains an updated inventory of greenhouse gas (GHG) emissions in Nevada and a statement of policies to help inform the development of future policy initiatives designed to reduce GHG emissions statewide. The GHG inventory is based on data from 2016, the most recent year for which comprehensive data is available. Pursuant to SB 254, an updated inventory and projection of GHG emissions for the largest emitting sectors (transportation and electricity generation) will be prepared on an annual basis; every fourth year the report will also include updates for other key emitting sectors (industry, residential and commercial, waste, agriculture, and land use, land use change, and forestry). The 2020 version of this report will be based on data from 2017, and each subsequent report will continue to refine the results from previous reports with new and/or more representative data as it becomes available. It should be noted that 2015 is the first year that GHG emissions from the transportation sector overtook electricity generation as the largest source of emissions in Nevada.

It is important to emphasize that the "statement of policies" contained in this report are not recommendations. This is intentional. Instead, the policies included under each GHG emitting sector are intended to be illustrative, but not exclusive, of potential policies for further review and consideration. Future iterations of this report will likely include more specific and detailed policies identified to help keep Nevada on track to meet the specific GHG reduction targets on the defined timeline according to the goals set forth under SB 254, as well as other climate change related commitments Nevada has pledged to fulfill.

Importantly, SB 254 also establishes a series of economy-wide GHG reduction goals. This is the first time Nevada has set GHG emissions reduction goals for all GHG emitting sectors of the state's economy. Past policy was solely focused on the electricity generation sector via a Renewable Portfolio Standard (RPS). Nevada led the nation as one of the first states to establish an RPS in 1997 and increased the RPS most recently during the 2019 Legislative Session with SB 358 that requires 50% of electricity sold in Nevada to originate from renewable energy sources by 2030. While the express purpose of Nevada's RPS is the expansion of renewable energy use statewide in Nevada, the secondary benefit has been a significant reduction in GHGs from the electricity generation sector.

Building upon the RPS, SB 254 set forth economy-wide GHG reduction goals of 28% below 2005 levels by 2025, 45% below 2005 levels by 2030, and zero or near-zero by 2050. These economy-wide GHG emissions reduction levels generally correspond to similar reductions required pursuant to Nevada joining

[1] The Department of Conservation and Natural Resources' greenhouse gas emissions inventory responsibility was established by SB 422 of the 2007 Legislative Session.

the U.S. Climate Alliance in March 2019. Further, the goals embodied in SB 254 and via the U.S. Climate Alliance are both reflected as priorities under Executive Order (EO) 2019-22, issued by Governor Sisolak in November 2019. EO 2019-22 provides a framework for state agencies to help meet Nevada's new GHG reduction goals and address the impacts of climate change throughout the state.

## Assumptions and Key Findings

Under SB 254 and EO 2019-22, Nevada has set forth an aggressive, but necessary, benchmark for reducing GHG emissions and mitigating climate impacts throughout Nevada. Under current policies, and based on the best available data, Nevada is on track to reduce economy-wide GHG emissions by 24% below 2005 levels in 2025 (4% short of the SB 254 goal of 28%) and by 26% below 2005 levels in 2030 (19% short of the SB 254 goal of 45%). This projection assumes:

- Recently increased RPS requirements are fully met (see Section 4.2, Page 28, and Section 4.4, Page 31);
- Current (Tier 3) federal passenger car and light-duty truck fuel economy standards are not rolled back (see Section 3.4, Page 23);
- Planned coal-fired electric generating unit retirements occur by 2025 (see Section 4.2, Page 28);
- Anticipated natural gas-fired electric generating unit retirements occur (see Section 4.2, Page 27); and
- Existing emissions standards for the oil and natural gas industry, including exploration, production, and delivery, remain in effect (see Section 5.4, Page 44).

Although wildland fires can produce substantial GHG emissions, because they are highly unpredictable, they are not included in this inventory. Wildland fire also undermines the ability of Nevada's forests and rangelands from sequestering a portion of GHG emissions.

Through 2030, the report projects that emissions from transportation will continue to be the largest sector of emissions and that GHG emissions from industry will be the most rapidly increasing source of emissions under current policy parameters. Managing GHG emissions from these two sectors should be a priority for policymakers in both the near- and long-term.

Based on current policies, other key findings from the report include:

- In 2016, Nevada contributed 0.68% of the U.S.'s total gross GHG emissions, despite having 0.90% of the population;
- As of 2015, transportation sector emissions make up the greatest percentage, 35%, of gross GHG emissions in Nevada;
- Under current policies, transportation sector emissions are projected to peak in 2020 and are expected to follow a very gradual downward trend, but not sufficient to meet SB 254 targets;
- GHG emissions from the electricity generation sector are expected to continue to decrease through 2030, with the conditional retirement of the North Valmy Generating Station in Nevada and the increased RPS established by SB 358 from the 2019 Legislative Session;

- Industrial process sub-sector emissions are expected to continue to increase, as the use of ozone depleting substance (ODS) substitutes continues to increase;
- Residential and commercial sector emissions are expected to remain stable, with increased emissions directly tied to increases in population and indirectly to urban land use planning decisions; and
- Nevada's forests, scrublands, urban trees, and at times, agricultural lands absorb and store carbon from the atmosphere in an amount that partially offsets GHG emissions. GHG sequestration can be further enhanced by strategic and innovative land and water management practices, but can also be significantly undermined by increased wildland fires.

Additional summary of the report findings are presented at the end of the Executive Summary below.

## Conclusions

Going forward, Nevada's pathway to reducing GHG emissions and mitigating the impacts of climate change statewide will be established through a variety of budget and policy mechanisms informed by input from this report, as well as the Nevada Climate Strategy called for under EO 2019-22, and other relevant input from state agencies, stakeholder groups, university and scientific experts, and the general public.

Heading into the 2022-23 biennium and the 2021 Legislative Session, policymakers will need to make important policy and budget decisions necessary for Nevada to meet its GHG reduction goals in 2025 and 2030, and beyond. In undertaking this challenge, it should be noted that most of the sectors included under SB 254, such as transportation, will require multiple years from policy creation to market/consumer adoption before significant GHG reductions will be realized. It is therefore critical that policymakers adopt a strategic near- and long-term approach across all emissions sectors and technologies to effectively meet our 2025 and 2030 goals.

## Summary Figures and Tables

A high-level summary of Nevada GHG inventory and projections by sector contained in this report is provided in Figure ES-1, Table ES-1, and Figure ES-2 below.

Figure ES-1 illustrates Nevada's net GHG emissions broken down by each of the seven individual sectors included in the report (transportation, electricity generation, industry, residential and commercial, waste, agriculture, and land use, land use change, and forestry) from 2005 through 2016 and projected emissions from each of these sectors from 2017 through 2030. Note that the land use, land use change, and forestry sector acts as a net sink of GHG emissions; that is, Nevada's forests, urban trees, and at times, agricultural lands absorb and store carbon from the atmosphere in an amount that offsets the carbon emissions associated with processes such as decomposition and vegetation respiration. As is standard practice with GHG inventories, net GHG emissions for each year are measured in units of millions of metric tons of carbon dioxide equivalents (abbreviated as "MMTCO2e") on the vertical axis of the graph. Net GHG emissions in 2005 are the benchmark against which the SB 254 reduction goals of 28% by 2025 and 45% by 2030 are measured. Reductions in GHG emissions from 2005 through 2016 came primarily from the electricity generation sector with some contributions from the transportation sector. Future projections indicates that current policies will achieve further reductions in the electricity generation sector primarily due to the recently increased RPS and only slight decreases in the transportation sector due to continued population growth and increases in average vehicle miles traveled (VMT).

Table ES-1 directly compares 2025 and 2030 GHG emissions projections against the SB 254 reduction goals on both a net GHG and percentage basis, and highlights the total amount of additional reductions needed beyond current projections to meet the reduction goals.

Figure ES-2 illustrates for select years (the 2005 benchmark year, 2016 most recent inventory, 2025, and 2030) the relative contribution of gross GHG emissions from each sector.

Although emissions from the transportation sector show a net decrease, it remains the leading source of Nevada GHG emissions starting in 2015 through 2030. The electricity generating sector contribution is predicted to continue to decrease from 32% in 2016, to 28% in 2025, down to 25% by 2030, while the industrial sector is expected to increase its relative contribution from 15% in 2016 to 20% by 2030. The contributions from other sectors remain relatively stable.

**Figure ES-1: Nevada Historical and Projected Net GHG Emissions and Sinks by Sector, 2005-2030, with Projections Beginning in 2017 and Comparison to SB 254's 2025 and 2030 Goals**

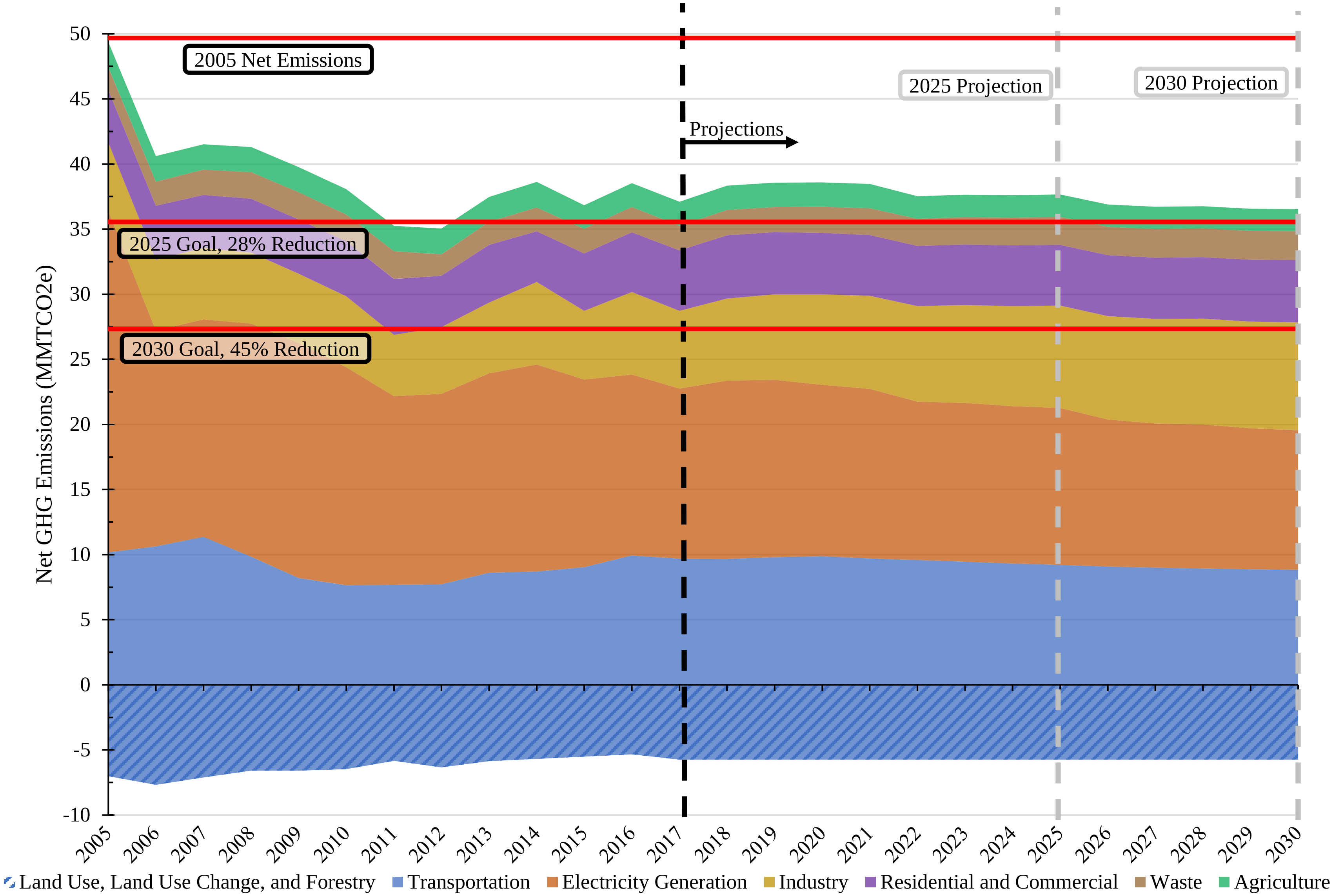
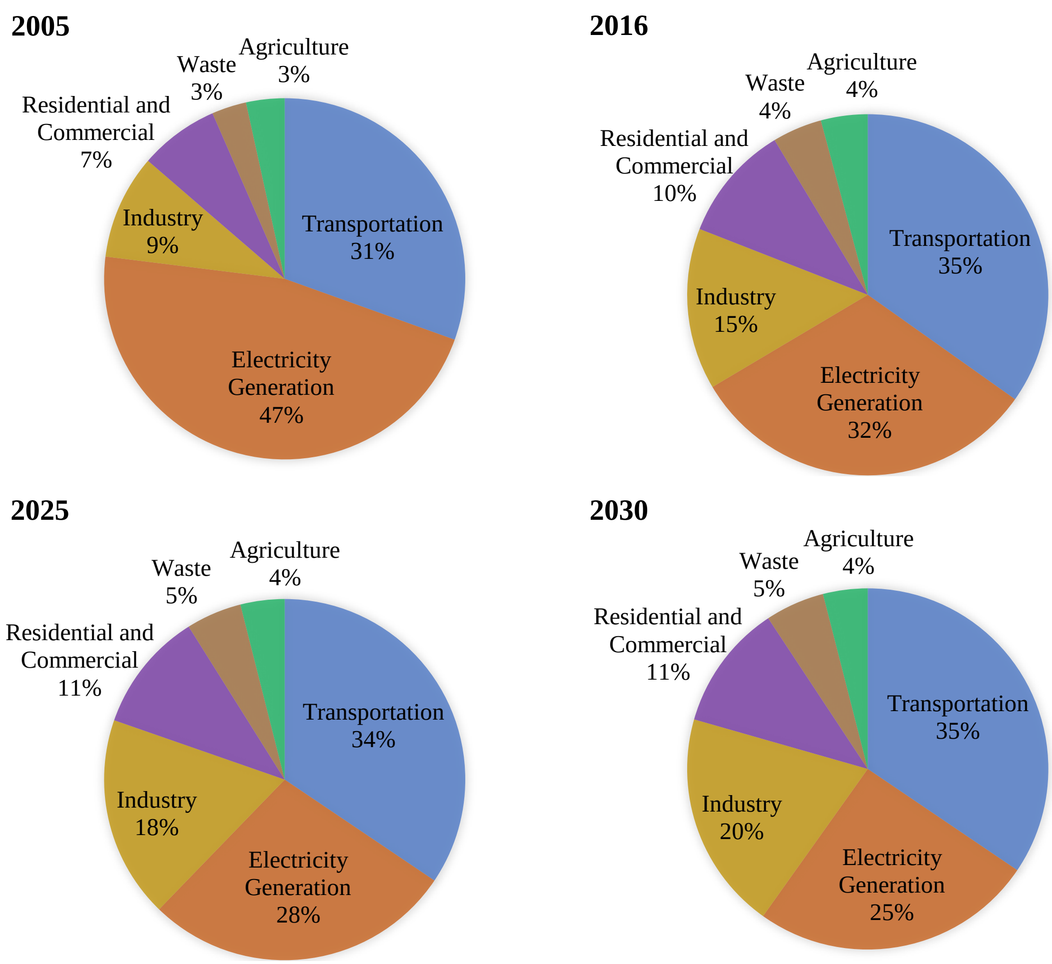


**Table ES-1: Nevada Net GHG Emissions Comparison with SB 254 Goals (MMTCO2e and Percent)**

| | 2005 | 2025 | 2030 |
|---|---|---|---|
| Net Emissions | 49.363 | 37.661 | 36.545 |
| Projected Emissions Reduction | - | 11.702 | 12.817 |
| **Projected Percent Reduction** | **-** | **24%** | **26%** |
| | | | |
| SB 254 Emissions Goals | - | 35.541 | 27.150 |
| SB 254 Emissions Reductions | - | 13.822 | 22.213 |
| SB 254 Percent Reduction | - | 28% | 45% |
| **Estimated Additional Emissions Reductions Required** | **-** | **2.119** | **9.396** |

**Figure ES-2: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2016, 2025, and 2030**



# Introduction

## 1.1 Overview

The *Nevada Greenhouse Gas Emissions Inventory and Projections, 1990-2039* is a comprehensive inventory of all greenhouse gas (GHG) emissions in Nevada from 1990 through 2016 and a projection of GHG emissions in Nevada from 2017 through 2039. In addition to the inventory and projections, this report includes, as required by Senate Bill (SB) 254 (2019 Legislative Session):

- A statement of policies that could achieve reductions in projected GHG emissions to achieve a 28% reduction in GHG emissions by the year 2025 as compared to the 2005 level of GHG emissions in Nevada;
- A statement of policies that could achieve reductions in projected GHG emissions to achieve a 45% reduction in GHG emissions by the year 2030, as compared to the 2005 level of GHG emissions in Nevada;
- A qualitative assessment of whether the identified policies support long-term reductions of GHG emissions to zero or near-zero levels by the year 2050; and
- A quantification of GHG emissions reductions required to achieve the 2025 and 2030 reduction goals.

The GHGs considered by this report are those listed in Nevada Revised Statutes (NRS) 445B.137: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), and perfluorinated compounds (PFCs) which includes sulfur hexafluoride ($SF_6$). Each of these GHGs have a characteristic global warming potential (GWP) that contributes to the atmospheric greenhouse effect differently. The GWP is used to derive a common metric, known as the carbon dioxide equivalent (CO2e), which uses the GWP of $CO_2$ as a reference unit — that is, $CO_2$ has a GWP of 1. GHG emissions in this report are quantified using units of CO2e and are presented as million metric tons of CO2e, or MMTCO2e. Table 1-1 lists the industrial designations or common names, chemical formulas, and 100 year GWPs of the GHGs considered by this report. This report uses the GWPs from the Intergovernmental Panel on Climate Change's (IPCC's) fifth assessment.[2,3]

**Table 1-1: The GHGs and 100 year GWPs without Climate Carbon Feedbacks for the GHGs Considered in this Report[4]**

| Greenhouse Gas | | 100 Year Global Warming Potential |
|---|---|---|
| **Industrial Designation or Common Name** | **Chemical Formula** | |
| Carbon dioxide | $CO_2$ | 1 |
| Methane | $CH_4$ | 28 |
| Nitrous oxide | $N_2O$ | 265 |
| | | |

[2] Previous inventories have utilized GWPs from previous IPCC assessments.
[3] IPCC (2013) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Stocker, T.F., D. Qin, G.-K., Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.
[4] IPCC (2013) Appendix 8

| **Greenhouse Gas** | | **100 Year Global Warming Potential** |
|---|---|---|
| **Industrial Designation or Common Name** | **Chemical Formula** | |
| **Hydrofluorocarbons (HFCs)** | | |
| HFC-23 | $CHF_3$ | 12,400 |
| HFC-32 | $CH_2F_2$ | 677 |
| HFC-125 | $CHF_2CF_3$ | 3,170 |
| HFC-134a | $CH_2FCF_3$ | 1,300 |
| HFC-143a | $CH_3CF_3$ | 4,800 |
| HFC-152a | $CH_3CHF_2$ | 138 |
| HFC-227ea | $CF_3CHFCF_3$ | 3,350 |
| HFC-236fa | $CF_3CH_2CF_3$ | 8,060 |
| HFC-43-10mee | $CF_3CHFCHFCF_2CF_3$ | 1,650 |
| **Perfluorinated Compounds (PFCs)** | | |
| Sulfur hexafluoride | $SF_6$ | 23,500 |
| Nitrogen trifluoride | $NF_3$ | 16,100 |
| PFC-14 | $CF_4$ | 6,630 |
| PFC-116 | $C_2F_6$ | 11,100 |
| PFC-31-10 | $C_4F_{10}$ | 9,200 |
| PFC-51-14 | $C_6F_{14}$ | 7,910 |

This report is organized into the following sectors:

- Transportation
- Electricity Generation
- Industry
- Residential and Commercial
- Waste
- Agriculture
- Land Use, Land Use Change, and Forestry

These sectors are detailed in individual sections. Details include descriptions of the sources of emissions within the sector, the methods used to estimate historical and projected GHG emissions, and the historical and projected GHG emissions estimates themselves. The kinds of activities, processes, or combustion sources found in a particular sector determine the types of GHG emitted by that sector. Table 1-2 summarizes the types of GHGs each sector emits.

**Table 1-2: GHGs Emitted by the Sectors Considered in this Report**

| **Sector** | **Greenhouse Gases Emitted** |
|---|---|
| Transportation | $CO_2$, $CH_4$, and $N_2O$ |
| Electricity Generation | $CO_2$, $CH_4$, and $N_2O$ |
| Industry* | $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, and $SF_6$ |
| Residential and Commercial | $CO_2$, $CH_4$, and $N_2O$ |
| Waste | $CO_2$, $CH_4$, and $N_2O$ |
| Agriculture | $CO_2$, $CH_4$, and $N_2O$ |
| Land Use, Land Use Change, and Forestry | $CO_2$, $CH_4$, and $N_2O$ |

* Emissions from HFCs, PFCs, and $SF_6$ are reported for this sector as a combined sum of emissions.

## 1.2 Approach, Datasets, and General Methodology

The principal goal of this report is to provide a general understanding of the sources and quantities of GHGs emitted in Nevada. The inventory and projections of GHG emissions presented in this report were developed using the 2018 release of the United States Environmental Protection Agency's (EPA's) State Inventory Tool (SIT)[5], the 2018 release of the United States Energy Information Administration's (EIA's) *Annual Energy Outlook* (AEO)[6], recommendations developed by the IPCC, and additional state and local data sources that were used to increase the accuracy of the SIT. In the absence of available data, the most technically-appropriate statistical methodology was used to either interpolate or extrapolate the missing data. The methods presented in this report are considered by the NDEP to be the most reliable methods available at the time this report was prepared. Details regarding the specific methods used by NDEP for individual sectors are included therein.

### 1.2.1 EPA's State Inventory Tool

The SIT is a regularly updated suite of Microsoft Excel-based modules designed to assist states in developing their own GHG emissions inventories and projections from 1990 through 2030 and is developed in part with the data used to prepare the EPA's national GHG emissions inventory.[7] While the SIT default input data were used as the primary resource in preparing this report, when more accurate data or methods were available they were utilized. For instance, NDEP used the IPCC fifth assessment GWPs for the GHGs considered in this report, rather than the IPCC fourth assessment GWPs. Also, projections for the electricity generation sector were prepared using Nevada specific information such as the recently updated Renewable Portfolio Standard (RPS) and utility regulatory filings. Primary sources of data used by the SIT and/or NDEP to prepare the emissions inventory and projections are listed in Table 1-3.

**Table 1-3: Primary Sources of Data Used in this Report**

| Sector | Source/Resource | Information Utilized |
|---|---|---|
| All Sectors | United States Census Bureau | U.S. population data[8] |
| | Nevada State Demographer | Nevada population data[9] |
| Transportation | EIA | Historical fossil fuel consumption data<br>AEO projections |
| Electricity Generation | EIA | Historical fossil fuel consumption data<br>Electricity Generation data[10] |

[5] State Inventory and Projection Tool. US Environmental Protection Agency; 2018 Nov 27. [accessed 2019 Apr 12]. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

[6] Annual Energy Outlook 2018: with projections to 2050. US Energy Information Administration. [released 2018 Feb 6; accessed 2019 Jul 15]. https://www.eia.gov/outlooks/archive/aeo18/

[7] The most recent release of the State Inventory Tool was in November, 2018 and included data to inventory historical emissions from 1990 through 2016 and project emissions from 2017 through 2030.

[8] 2017 National Population Projections Datasets. US Census Bureau. [updated 2018 Sep 6; accessed 2019 Jul 15]. https://www.census.gov/data/datasets/2017/demo/popproj/2017-popproj.html

[9] Hardcastle J. Nevada County Population Projections 2018 to 2037. Nevada Department of Taxation, Nevada State Demographer; 2018 Oct 1. https://tax.nv.gov/Publications/Population_Statistics_and_Reports/

[10] US Energy Information Administration Electricity Generation Data. [released 2019 Sep; accessed 2019 Sep 16]. https://www.eia.gov/state/seds/

| Sector | Source/Resource | Information Utilized |
|---|---|---|
| | EPA Emissions & Generation Resource Integrated Database (eGRID)[11] | Electric generating unit (EGU) data |
| | EPA Greenhouse Gas Reporting Program (GHGRP)[12] | EGU data |
| | Public Utilities Commission of Nevada (PUCN)[13] | Utility regulatory filings |
| Industry | EIA | Historical fossil fuel consumption data<br>AEO projections<br>Oil and natural gas production data[14] |
| | United States Geological Survey Minerals Yearbook[15] | Annual production and consumption for different minerals |
| | U.S. Department of Transportation Pipeline and Hazardous Material Safety Administration[16] | Natural gas transmission and distribution data |
| Residential and Commercial | EIA | Historical fossil fuel consumption data<br>AEO projections |
| Waste | NDEP Bureau of Sustainable Materials Management[17] | Annual solid waste emplacement data |
| | EPA Landfill Methane Outreach Program (LMOP)[18] | Waste in place data<br>In-place and planned landfill gas recovery technology information |
| Agriculture | United States Department of Agriculture (USDA) National Agricultural Statistics Service[19] | Livestock population and crop production data |
| Land Use, Land Use Change, and Forestry | USDA Forest Service Forest Inventory and Analysis[20] | Forest productivity |
| | National Interagency Fire Center (NIFC)[21] | Nevada wildland fire acreage |

[11] Emissions and Generation Resource Integrated Database. US Environmental Protection Agency; 2018 Feb 15. [accessed 2019 Aug 1]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[12] Greenhouse Gas Reporting Program. US Environmental Protection Agency [accessed 2019 Aug 1]. https://www.epa.gov/ghgreporting
[13] State of Nevada Public Utilities Commission. [accessed 2019 Apr 15]. http://puc.nv.gov/
[14] US Energy Information Administration State Energy Data System. [accessed 2019 Oct 1]. https://www.eia.gov/state/seds/
[15] National Minerals Information Center. US geological Survey. [accessed 2019 Sep 5]. https://www.usgs.gov/centers/nmic
[16] Pipeline and Hazardous Materials Safety Administration. US Department of Transportation. [accessed 2019 Sep 9]. https://www.phmsa.dot.gov/
[17] Solid Waste Facility Management and Recycling Reports. Nevada Division of Environmental Protection, Bureau of Sustainable Materials Management. https://nvwastemanagementreports.ndep.nv.gov/
[18] Landfill Methane Outreach Program: Project and Landfill Data by State. US Environmental Protection Agency; 2019 Jul. [accessed 2019 Aug]. https://www.epa.gov/lmop/project-and-landfill-data-state
[19] Quick Stats (Searchable Database). US Department of Agriculture, National Agricultural Statistics Service. [accessed 2019 Sep 12]. https://quickstats.nass.usda.gov/
[20] Forest Inventory and Analysis. US Forest Service. [accessed 2019 Oct]. https://www.fia.fs.fed.us/
[21] National Interagency Fire Center. [accessed 2019 Sep]. https://www.nifc.gov/

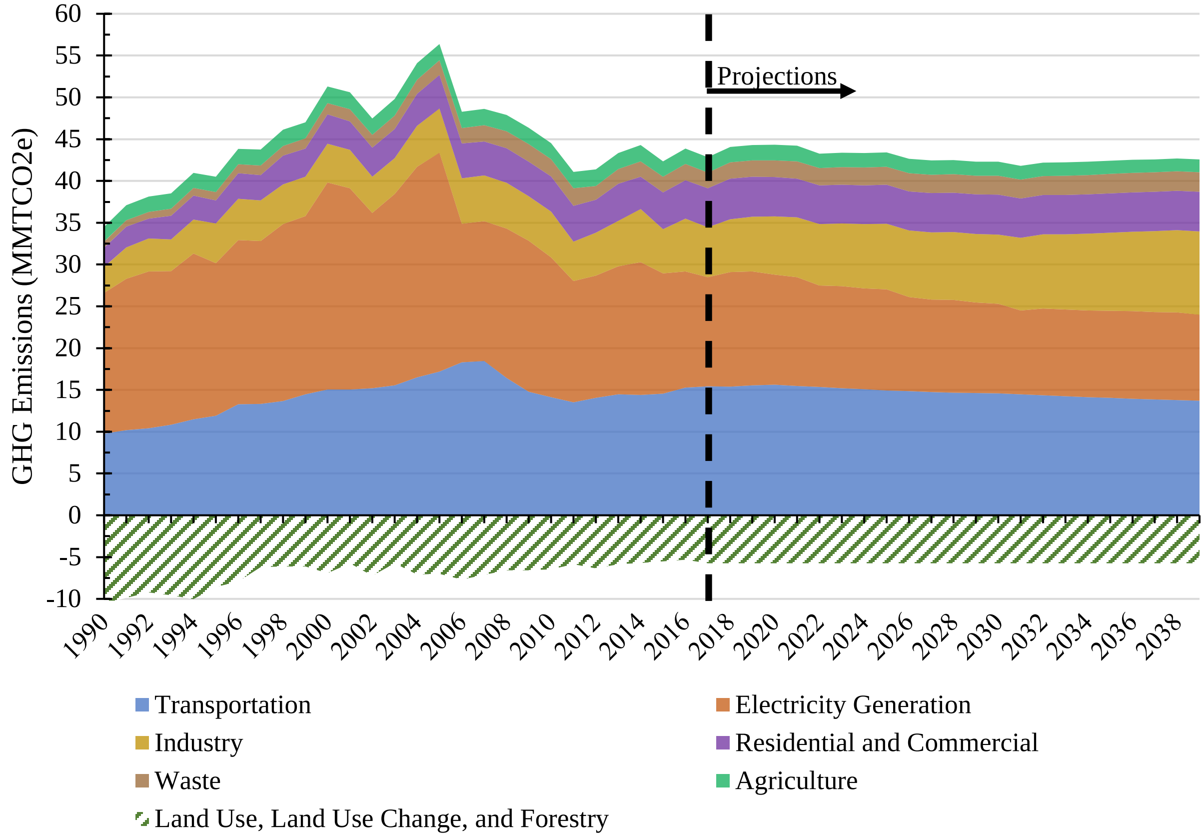
### 1.2.2 EIA's Annual Energy Outlook

The AEO is an annual report prepared by the EIA that provides modeled projections of U.S. energy usage through 2050. The AEO considers multiple cases, each with multiple assumptions, regarding "macroeconomic growth, world oil process, technological progress, and energy policies."[22] Of these cases, the Reference case is utilized by the SIT in its projections and is used by NDEP in projecting from 2031 through 2039. The sectors presented in this report that utilize the AEO are transportation, industry, and residential and commercial. Generally, the Reference case assumes trend improvements in known technologies will continue, current laws and regulations (at the time the AEO was released) affecting energy will remain unchanged, and the potential impacts of proposed legislation, regulations, and standards are not considered.

[22] Annual Energy Outlook 2018, p4.

# State of Nevada Greenhouse Gas Emissions

**Figure 2-1: Nevada Historical and Projected Total GHG Emissions and Sinks by Sector, 1990-2039, with Projections Beginning in 2017**




## 2.1 GHG Emissions, 1990-2016

GHG emissions in Nevada peaked in 2005, when net GHG emissions totaled 49.363 MMTCO2e.[23] Overall, net GHG emissions in 2016 were 22% below 2005 levels. Since 2005, significant reductions in Nevada GHG emissions have occurred due to both the Economic Downturn from 2007 through 2009 (commonly known as the Great Recession) and the permanent shutdown of Nevada's two largest coal-fired power plants — the Mohave and Reid Gardner generating stations. In 2015, transportation exceeded electricity generation and became the State's largest sector of GHGs. This shift was mainly driven by Nevada's increasing reliance on renewable energy and lower-GHG emitting natural gas, rather than any significant change in the transportation sector. For 2016, Nevada's net GHG emissions totaled 38.537 MMTCO2e, with transportation accounting for nearly 35% of total gross emissions.[24]

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[23] While historical GHG emissions associated with wildland fires are presented and discussed in Section 9: Land Use, Land Use Change, and Forestry, this report does not present the GHG emissions associated with wildland fires when illustrating statewide emissions.

[24] In this report, gross emissions describes the sum of all sectors acting as sources of GHG emissions while net emissions is used to describe the sum of all sectors acting as sources of GHG emissions minus all sectors acting as GHG emissions sinks.

For the purposes of this report, only the GHG emissions caused by activities that occurred within the geographical boundaries of the State of Nevada are considered.[25] It is however, important to recognize that GHG emissions are not always spatially associated with their related activities. For instance, the production (source of emissions) and consumption of electricity (the related activity) can take place in different states. For example, about 16% of 2016's electricity generation sector GHG emissions (about 2.2 MMTCO2e) are associated with electricity consumed out-of-state; since that electricity is generated in-state, their related GHG emissions are included in this inventory.

This distinction of production versus consumption is particularly critical in accounting for the GHG emission reduction impact of some potential mitigation strategies affecting energy demand. For example, reuse, recycling, and source reduction can lead to emissions reductions from lower energy requirements in the material production (such as paper, cardboard, aluminum, etc.) even though the emissions associated with material production may not occur within the state, and as such this reduction in emissions is not reflected in this inventory.

Of the sectors considered in this report, land use, land use change, and forestry is Nevada's only net emissions sink. That is, the natural environment has the overall capacity to absorb carbon from the atmosphere and store it. While there is a high degree of uncertainty regarding the amount of carbon stored in Nevada's natural environment, it is a sink of emissions with varying degrees of annual variability (refer to Section 9: Land Use, Land Use Change, and Forestry for more details). All other sectors are, in total, sources of GHG emissions. Figure 2-2 illustrates Nevada's GHG emissions and sinks by sector from 1990 through 2016. Table 2-1 lists Nevada's GHG emissions and sinks by sector for select years.

[25] The only exception to this being the accounting of certain industrial process emissions. Refer to Section 5.2.2 Industry Emissions from Industrial Processes, for more details.

**Figure 2-2: Nevada Total GHG Emissions and Sinks by Sector, 1990-2016**

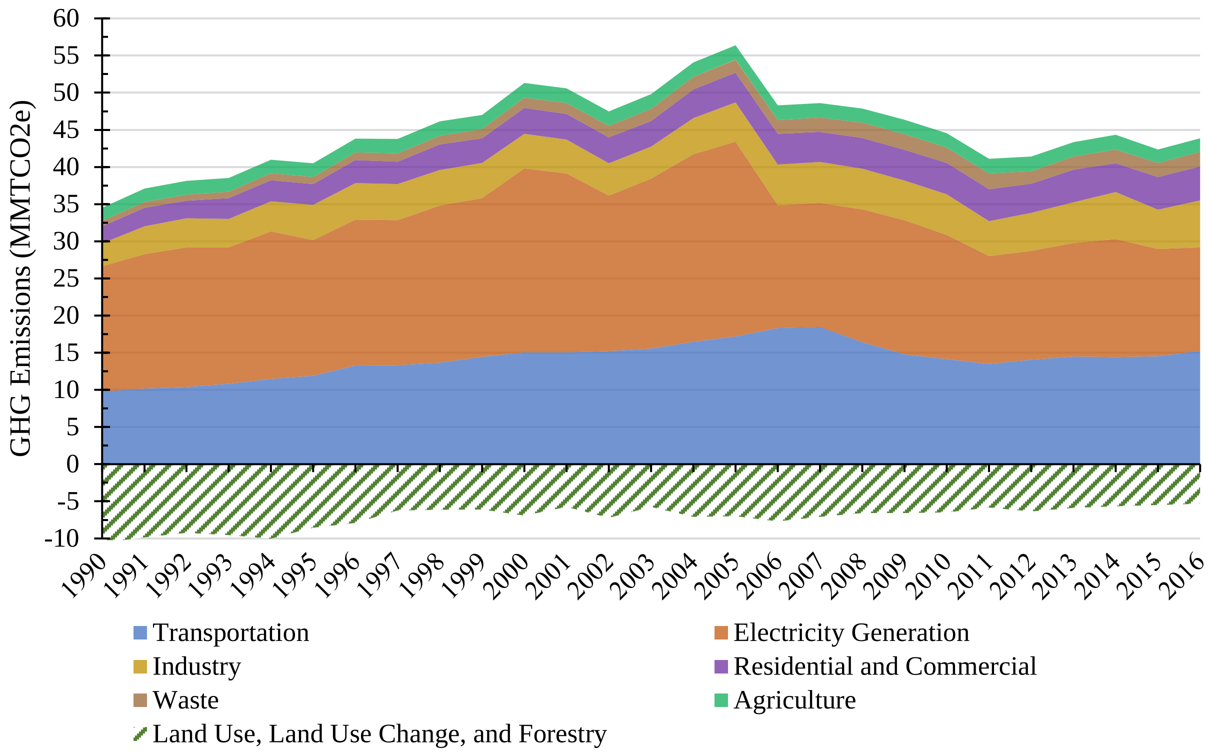



**Table 2-1: Nevada GHG Emissions and Sinks by Sector, Select Years (MMTCO2e)**

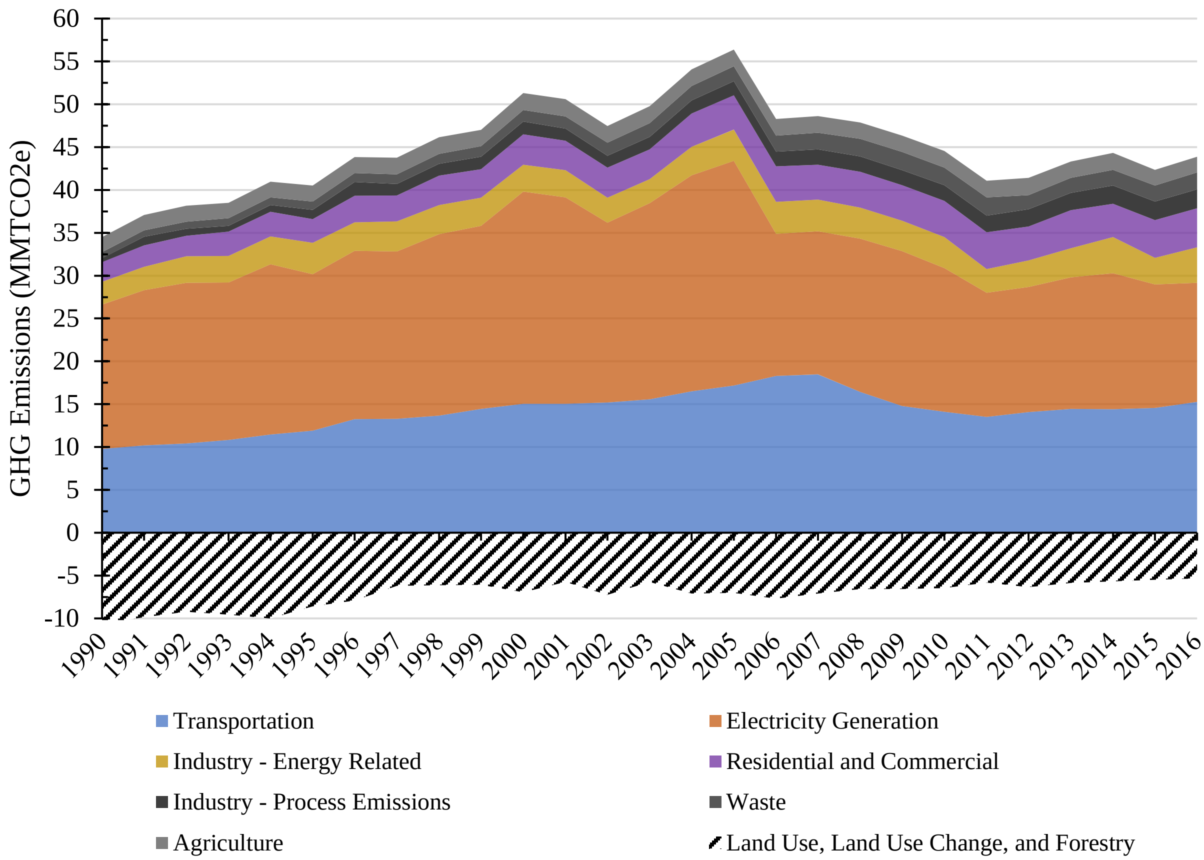
| Sector | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Transportation | 9.778 | 11.919 | 15.037 | 17.183 | 14.127 | 14.467 | 14.395 | 14.546 | 15.274 |
| Electricity Generation | 16.849 | 18.263 | 24.768 | 26.211 | 16.746 | 15.320 | 15.893 | 14.415 | 13.887 |
| Industry | 3.099 | 4.718 | 4.655 | 5.281 | 5.452 | 5.442 | 6.342 | 5.276 | 6.345 |
| Residential and Commercial | 2.295 | 2.783 | 3.512 | 4.015 | 4.219 | 4.420 | 3.881 | 4.399 | 4.578 |
| Waste | 0.731 | 0.976 | 1.340 | 1.749 | 2.060 | 1.771 | 1.831 | 1.890 | 1.950 |
| Agriculture | 1.752 | 1.863 | 1.980 | 1.942 | 1.933 | 1.910 | 1.973 | 1.822 | 1.835 |
| Land Use, Land Use, Change, and Forestry | -10.596 | -8.576 | -6.933 | -7.017 | -6.476 | -5.865 | -5.686 | -5.509 | -5.331 |
| **Gross Emissions** | **34.504** | **40.522** | **51.292** | **56.380** | **44.537** | **43.330** | **44.314** | **42.348** | **43.869** |
| **Net Emissions** | **23.908** | **31.946** | **44.358** | **49.363** | **38.061** | **37.465** | **38.628** | **36.839** | **38.537** |

Of the GHG emissions considered in this report, the overwhelming majority of them are energy-related emissions from the combustion of fossil fuels. In fact, in 2016 more than 86% of Nevada's gross emissions are energy related (that is, the transportation, electricity generation, energy-related industry, and the residential and commercial sectors). The remaining 14% of Nevada's gross GHG emissions are the result of industrial processes, the decay and treatment of waste, and agricultural activities (that is, the industrial process sub-sector and the waste and agriculture sectors).[26] Figure 2-3 illustrates Nevada's GHG emissions and sinks from 1990 through 2016 by sector, with energy-related GHG emissions emphasized.

[26] Industry emissions in this report include both the energy-related emissions from the production, transmission, and combustion of fossil fuels as well as the emissions created as a result of an industrial process. This is discussed in detail in Section 5: Industry.

Availability of potential options for reducing GHG emissions varies between sectors. GHG emissions resulting from the combustion of fossil fuels can be reduced through activities such as fuel switching — either to less carbon intense or zero emission alternatives — or through avoiding the use of the fuel altogether — energy efficiency improvements being one example.

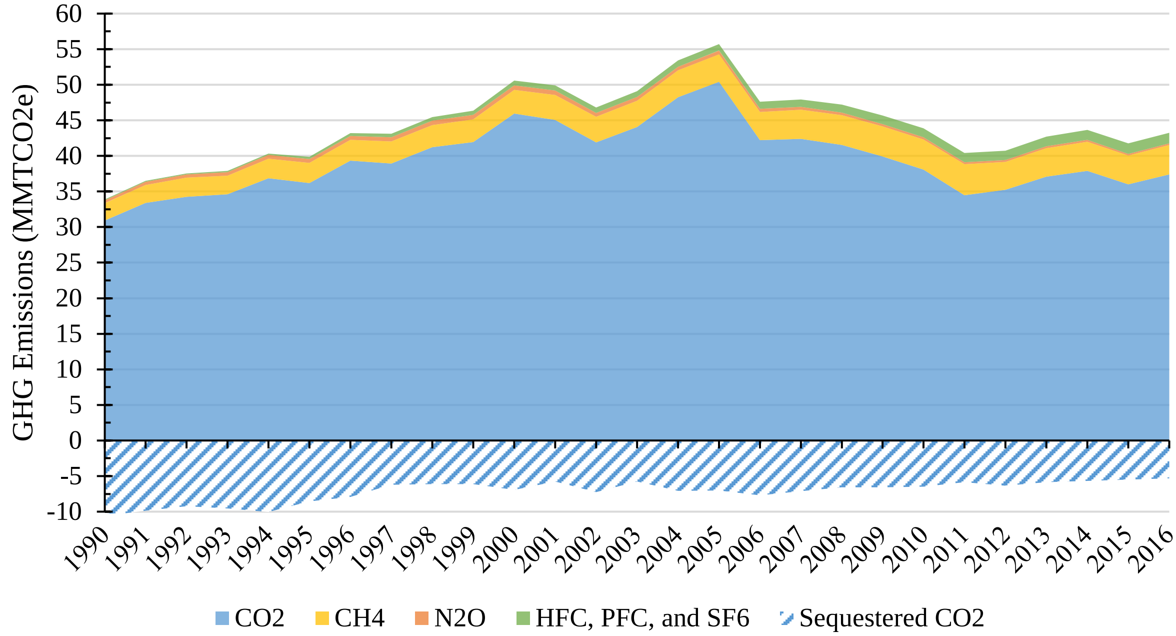
**Figure 2-3: Nevada GHG Emissions and Sinks by Sector, 1990-2016, with Energy-Related GHG Emissions Emphasized**




Of the GHGs considered in this report, $CO_2$ accounted for more than 86% of gross GHG emissions in 2016.[27] Figure 2-4 illustrates Nevada's GHG emissions and sinks by GHG for 1990 through 2016. $CO_2$ emissions are generally energy related ($CH_4$ and $N_2O$ emissions from energy-related activities are the byproduct of the fossil fuel combustion process). $CH_4$, HFC, PFC, and $SF_6$ emissions in Nevada come from the industry (specifically industrial processes and fugitive emissions from the production and transmission of natural gas) and waste sectors. While non-$CO_2$ GHGs have historically been a relatively minor source of Nevada's GHG emissions, $CH_4$, HFC, PFC, and $SF_6$ emissions are projected to continue to increase through the reporting period, as detailed in Section 2.2 and Section 5.4 of this report.

[27] The land use, land use change, and forestry sector sequesters $CO_2$ emissions.

**Figure 2-4: Nevada Total Historical GHG Emissions and Sinks by GHG, 1990-2016**




GHG emissions in Nevada are generally tied to the State's population and economy. As the population increases, activities such as the need to travel, the demand for electricity, the need for heating homes and businesses, and the total amount of waste generated all increase. This results in modest annual increases in GHG emissions. Table 2-2 lists the annual changes in GHG emissions in Nevada by sector for 2011 through 2016. Economic expansion can also lead to increases in GHG emissions. Since 2011, net GHG emissions have increased by 3.486 MMTCO2e.

**Table 2-2: Annual Changes in Nevada GHG Emissions by Sector, 2011-2016 (MMTCO2e and Percent)**

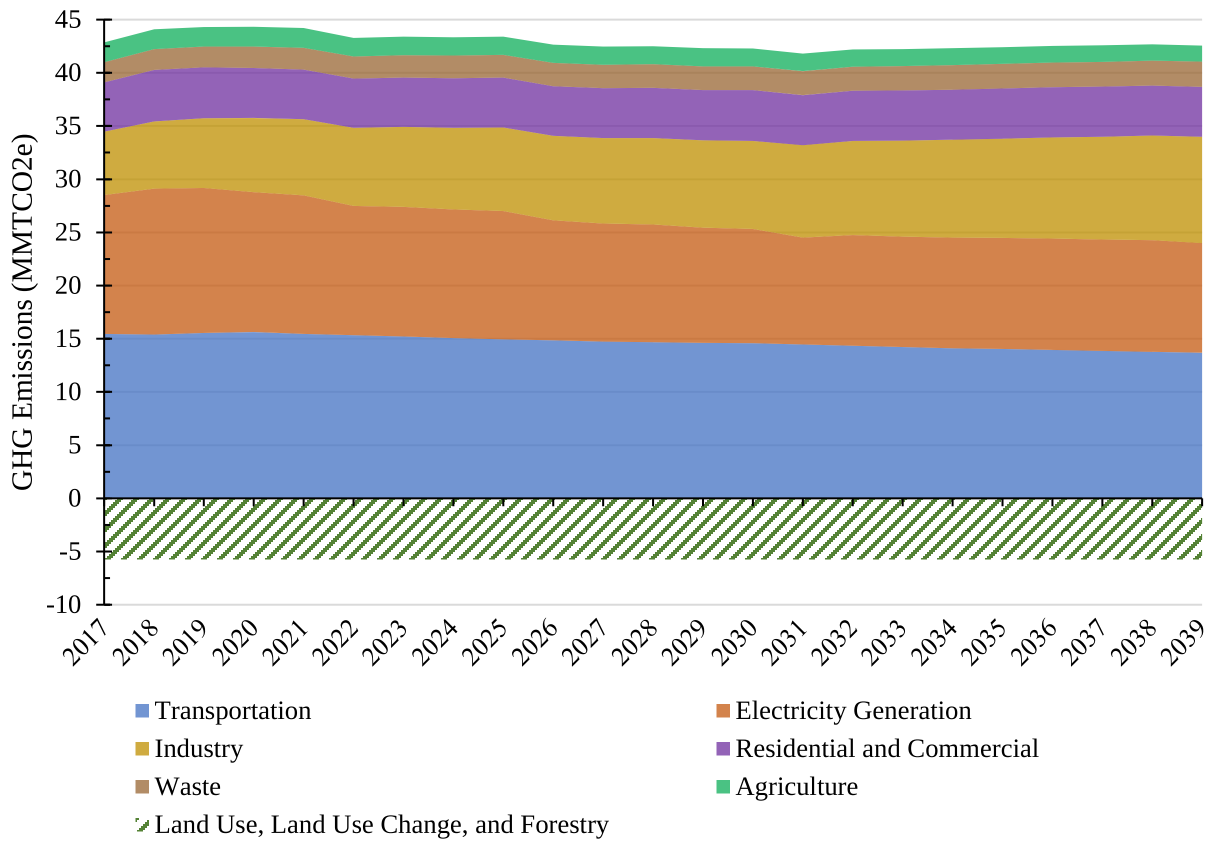
| Sector | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Transportation | 0.543 | 4.02% | 0.407 | 2.89% | -0.072 | -0.50% | 0.151 | 1.05% | 0.728 | 5.01% |
| Electricity Generation | 0.132 | 0.91% | 0.697 | 4.77% | 0.573 | 3.74% | -1.478 | -9.30% | -0.528 | -3.66% |
| Industry | 0.405 | 8.58% | 0.320 | 6.24% | 0.899 | 16.53% | -1.066 | -16.81% | 1.069 | 20.26% |
| Residential and Commercial | -0.340 | -7.92% | 0.466 | 11.78% | -0.539 | -12.20% | 0.518 | 13.35% | 0.179 | 4.08% |
| Waste | -0.477 | -22.48% | 0.125 | 7.58% | 0.060 | 3.38% | 0.059 | 3.23% | 0.060 | 3.17% |
| Agriculture | 0.042 | 2.16% | -0.078 | -3.94% | 0.063 | 3.29% | -0.151 | -7.63% | 0.013 | 0.69% |
| Land Use, Land Use, Change, and Forestry | -0.503 | 8.61% | 0.478 | -7.54% | 0.179 | -3.05% | 0.177 | -3.12% | 0.178 | -3.22% |
| **Gross Emissions** | **0.305** | **0.74%** | **1.936** | **4.68%** | **0.984** | **2.27%** | **-1.966** | **-4.44%** | **1.521** | **3.59%** |
| **Net Emissions** | **-0.198** | **-0.56%** | **2.414** | **6.89%** | **1.163** | **3.10%** | **-1.789** | **-4.63%** | **1.698** | **4.61%** |

## 2.2 Emissions Projections, 2017-2039

Considering only existing policies, total GHG emissions in Nevada are projected to remain relatively constant through 2039. Net GHG emissions in 2025 are projected to be 37.661 MMTCO2e, 24% below 2005 levels; net GHG emissions in 2030 are projected to be 36.545 MMTCO2e, 26% below 2005 levels; and net GHG emissions in 2039 are projected to be 36.815 MMTCO2e, or 25% below 2005 levels.

Figure 2-5 illustrates Nevada's projected GHG emissions and sinks by sector from 2017 through 2039. The sectors whose emissions are projected to increase through 2039 are industry (4.024 MMTCO2e), residential and commercial (0.069 MMTCO2e), and waste (0.459 MMTCO2e); uncertainty over future transportation sector emissions remains a concern. Collectively, GHG emissions from these sectors increase by 4.552 MMTCO2e between 2017 and 2039, offsetting the 4.513 MMTCO2e emissions reductions from transportation and electricity generation over the same period.[28]

**Figure 2-5: Projected Total GHG Emissions and Sinks in Nevada by Sector, 2017-2039**




Some of the state- and federal-level policies considered in developing the projections in this report are listed in Table 2-3. Table 2-3 is not a comprehensive list; generally, both the SIT and the AEO depend on the federal regulations that were in place when they were prepared. Changes have been proposed for some of the policies listed in Table 2-3 and any change that rolls back the stringency of an existing policy will generally result in an increase in emissions.

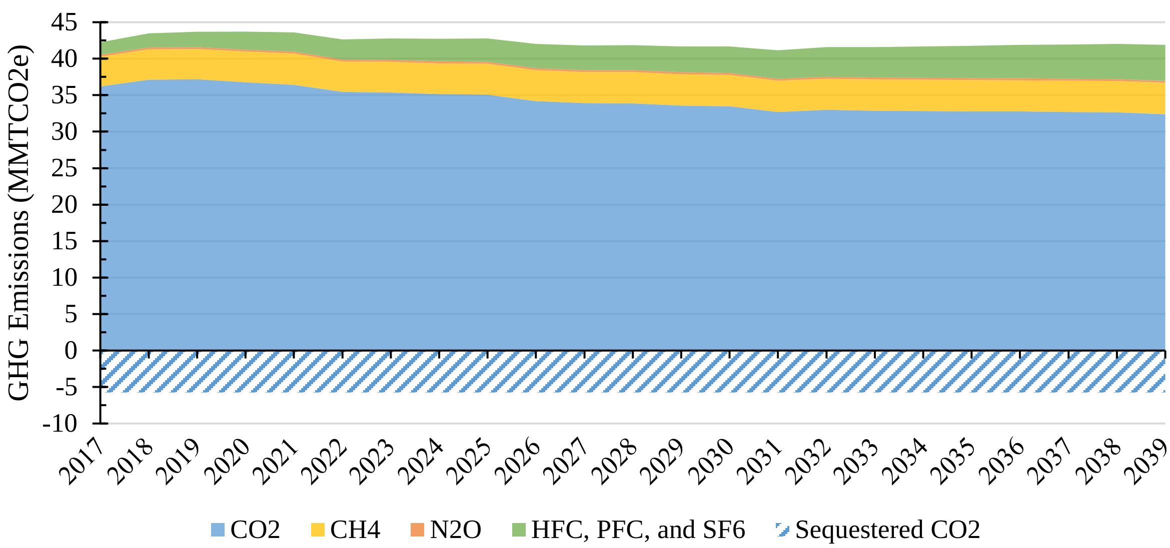
[28] The change in agriculture GHG emissions, and the uncertainty surrounding these numbers, are detailed in Section 8: Agriculture.

**Table 2-3: State- and Federal-Level Policies Considered in Projections**

| Sector | Policy |
|---|---|
| Transportation | Tier 3 passenger car and light duty truck fuel economy standards<br>Phase 2 greenhouse gas emissions standards for medium- and heavy-duty vehicles |
| Electricity Generation | SB 358's updated RPS<br>The voluntary retirement of the North Valmy Generating Station, with Unit 1 shutting down in 2021 and Unit 2 shutting down in 2025<br>The PUCN IRP-approved retirement dates and depreciation-based retirement dates of NV Energy's natural gas-fired electricity generating resources |
| Industry | 2016 new source performance standards (NSPS) for the oil and natural gas industry |

Increases in industry GHG emissions are the result of an increasing reliance on HFC, PFC, and $SF_6$ as emissions of these GHGs are projected to increase by more than 250% — nearly 12% of 2039's CO2e GHG emissions. HFCs and PFCs are classes of compounds[29] generally referred to as ozone depleting substance (ODS) substitutes and are used for a wide variety of purposes; vehicle air conditioning, industrial, residential, and commercial refrigeration and air conditioning, aerosols, solvent cleaning, fire extinguishing, foam production, sterilization, and semiconductor manufacturing. As Nevada's population continues to grow, so too will our reliance on ODS substitutes. Figure 2-6 illustrates projected GHG emissions and sinks in Nevada by GHG from 2017 through 2039.

**Figure 2-6: Nevada Projected Total GHG Emissions and Sinks by GHG, 2017-2039**




## 2.3 Nevada's Emission Reduction Goals

In late 2015, the United Nations held the 21st session of the Conference of Parties (COP21) in Paris, France. At COP21, an agreement was formalized (the Paris Agreement) to "strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2

[29] The GWPs of the various HFCs and PFCs are listed in Table 1-1.

degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius."[30] To date, the Paris Agreement has been ratified by 187 of the 197 Parties to COP21.[31] The Parties that have ratified the Paris Agreement constitute nearly 97% of the planet's GHG emissions.[32] When it originally ratified the Paris Agreement, the U.S. committed to an economy-wide goal of reducing GHG emissions by 26 to 28% below its 2005 level by 2025 and to make best efforts to reduce its emissions by 28%.[33] This goal was consistent with an emission reduction pathway that would eventually lead to an 80% or more reduction in GHG emissions by 2050. However, shortly after being elected, U.S. President Donald Trump signaled his intent in 2017 to withdraw from the Paris Agreement (this intent was formalized on November 4, 2019 via a Depositary Notification that the U.S.'s withdrawal from the Paris Agreement will take effect in one year, on November 4, 2020).[34]

After the President signaled his intent to withdraw from the Paris Agreement in 2017, the U.S. Climate Alliance was formed by the then Governors from California, New York, and Washington. The U.S. Climate Alliance is a bipartisan coalition of U.S. governors committed to meeting the Paris Agreement GHG emissions reductions that the U.S. had originally committed to. Each U.S. Climate Alliance Member State has committed to:

- Implement policies that advance the goals of the Paris Agreement, aiming to reduce GHG emissions by at least 26 to 28 % below 2005 levels by 2025;
- Track and report progress to the global community in appropriate settings, including when the world convenes to take stock of the Paris Agreement; and
- Accelerate new and existing policies to reduce carbon pollution and promote clean energy deployment at the state and federal level.[35]

On March 12, 2019 Nevada Governor Steve Sisolak announced that Nevada would become the 23rd state to join the U.S. Climate Alliance.[36,37]

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[30] "What is the Paris Agreement?" United Nations Framework Convention on Climate Change; 2019. [accessed 2019 Nov 14]. /https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement
[31] Paris Agreement – Status of Ratification. United Nations Framework Convention on Climate Change; 2019. [accessed 2019 Nov 14]. https://unfccc.int/process/the-paris-agreement/status-of-ratification
[32] Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 11 December 2015. Part one: Proceedings. United Nations Framework Convention on Climate Change; 2016 Jan 29. [accessed 2019 Nov 14]. Annex I. https://unfccc.int/resource/docs/2015/cop21/eng/10.pdf#page=30
[33] U.S.A. First NDC Submission. United Nations Framework Convention on Climate Change. [accessed 2019 Nov 14]. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/U.S.A.%20First%20NDC%20Submission.pdf
[34] United States of America: Withdrawal. United Nations Secretary-General; 2019 Nov 4. [accessed 2019 Nov 14]. https://treaties.un.org/doc/Publication/CN/2019/CN.575.2019-Eng.pdf
[35] Alliance Principles. US Climate Alliance [accessed 2019 Nov 14]. http://www.usclimatealliance.org/alliance-principles
[36] Nevada Governor Steve Sisolak Joins U.S. Climate Alliance. US Climate Alliance; 2019 Mar 12. [accessed 2019 Nov 14]. https://www.usclimatealliance.org/publications/2019/3/12/nevada-governor-steve-sisolak-joins-us-climate-alliance
[37] The U.S. Climate Alliance has since grown to 25 members.

During the 2019 Nevada Legislative Session, SB 254 was signed into law.[38] SB 254 makes several changes to NRS 445B.380. In addition to requiring annual GHG reporting by the Nevada Department of Conservation and Natural Resources, it requires a statement of policies that could achieve statewide reductions in GHG emissions, relative to 2005 emissions, of 28% by 2025 and 45% by 2030. SB 254 also requires a quantification of the reduction in GHG emissions necessary to achieve those goals. Additionally, SB 254 requires a qualitative assessment of whether the statement of policies included with this report support long-term GHG emissions reductions to zero or near-zero levels by the year 2050. These goals are closely aligned to the U.S. Climate Alliance 2025 commitment and the U.S.'s original commitment to meeting the Paris Agreement. The goal of zero or near zero GHG emissions by 2050 is an additional threshold adopted by Nevada under SB 254. This goal is similar to a subset of other U.S. Climate Alliance member states that have adopted similar goals of zero, near zero, or net zero GHG emissions by 2050, including California, Hawaii, and New York.[39]

NDEP considers net GHG emissions in its quantification of the reductions that would be required to achieve statewide reductions of 28% and 45% by 2025 and 2030, respectively, as compared to 2005 levels.

Table 2-4 lists Nevada's net GHG emissions by sector for 2005, 2016, 2025, and 2030 and Figure 2-7 illustrates the relative contributions of GHG emissions from the various sectors for 2005, 2016, 2025, and 2030. Figure 2-8 illustrates Nevada's net GHG emissions by sector from 2005 through 2030 with SB 254's 2025 and 2030 emission reduction goals included for comparison. Because Figure 2-8 is illustrating net GHG emissions, the carbon sequestered by the land use, land use change, and forestry sector is shown as a negative striped region being overlaid by transportation sector emissions. Finally, Table 2-5 compares 2005 net GHG emissions against 2025, 2030, and SB 254's emission reduction goals for 2025 and 2030.

As required by SB 254, Table 2-5 provides a quantification of the reductions in GHG emissions necessary to achieve the GHG emissions reductions goals for 2025 and 2030. Based on current projections that consider only existing policies, Nevada is within 2.2 MMTCO2e (or 4%) of the SB 254 2025 goal, but Nevada is not currently projected to meet the SB 254 2030 goal for GHG emissions reductions. By 2030, it is estimated that Nevada will reduce net GHG emissions by 26% (12.817 MMTCO2e) below 2005 levels under current policies; whereas the SB 254 goal is a net GHG emissions reduction of 45% (22.213 MMTCO2e) below 2005 levels.

On November 22, 2019, Governor Sisolak signed Executive Order (EO) 2019-22.[40] The EO directs the executive branch to advance the State's SB 254 climate goals by formalizing the coordination between State agencies and requires a State Climate Strategy to be prepared by December 1, 2020. The forthcoming strategy shall include specific policy and budget recommendations to reduce GHG emissions

[38] Senate Bill 254. Nevada Legislature 80th Session (2019). [accessed 2019 Nov 24]. https://www.leg.state.nv.us/App/NELIS/REL/80th2019/Bill/6431/Overview
[39] Climate Ambition Alliance: Nations push to upscale action by 2020 and achieve net zero CO2 emissions by 2050. Gobierno de Chile: Prensa Presidencia; released 2019 Sep 23. [accessed 2019 Dec 24]. https://prensa.presidencia.cl/comunicado.aspx?id=102021
[40] Executive Order 2019-22 Directing Executive Branch to Advance Nevada's Climate Goals. State of Nevada Executive Department; released 2019 Nov 22. http://gov.nv.gov/News/Executive_Orders/Executive_Orders_2019/

and mitigate the effects of climate change. The State Climate Strategy will build on the data and statement of policies included in this report by proposing a more detailed policy roadmap specific to Nevada with near-, medium-, and long-term policy recommendations for meeting the goals and requirements of SB 254, EO 2019-22, and commitments as a U.S. Climate Alliance member state.

**Table 2-4: Nevada Net GHG Emissions by Sector, Select Years (MMTCO2e)**

| Sector | 2005 | 2016 | 2025 | 2030 |
|---|---|---|---|---|
| Transportation | 17.183 | 15.274 | 14.951 | 14.579 |
| Electricity Generation | 26.211 | 13.887 | 12.067 | 10.730 |
| Industry | 5.281 | 6.345 | 7.852 | 8.282 |
| Residential and Commercial | 4.015 | 4.578 | 4.666 | 4.772 |
| Waste | 1.749 | 1.950 | 2.159 | 2.242 |
| Agriculture | 1.942 | 1.835 | 1.713 | 1.688 |
| Land Use, Land Use, Change, and Forestry | -7.017 | -5.331 | -5.747 | -5.747 |
| **Net Emissions** | **49.363** | **38.537** | **37.661** | **36.545** |

**Figure 2-7: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2016, 2025, and 2030**

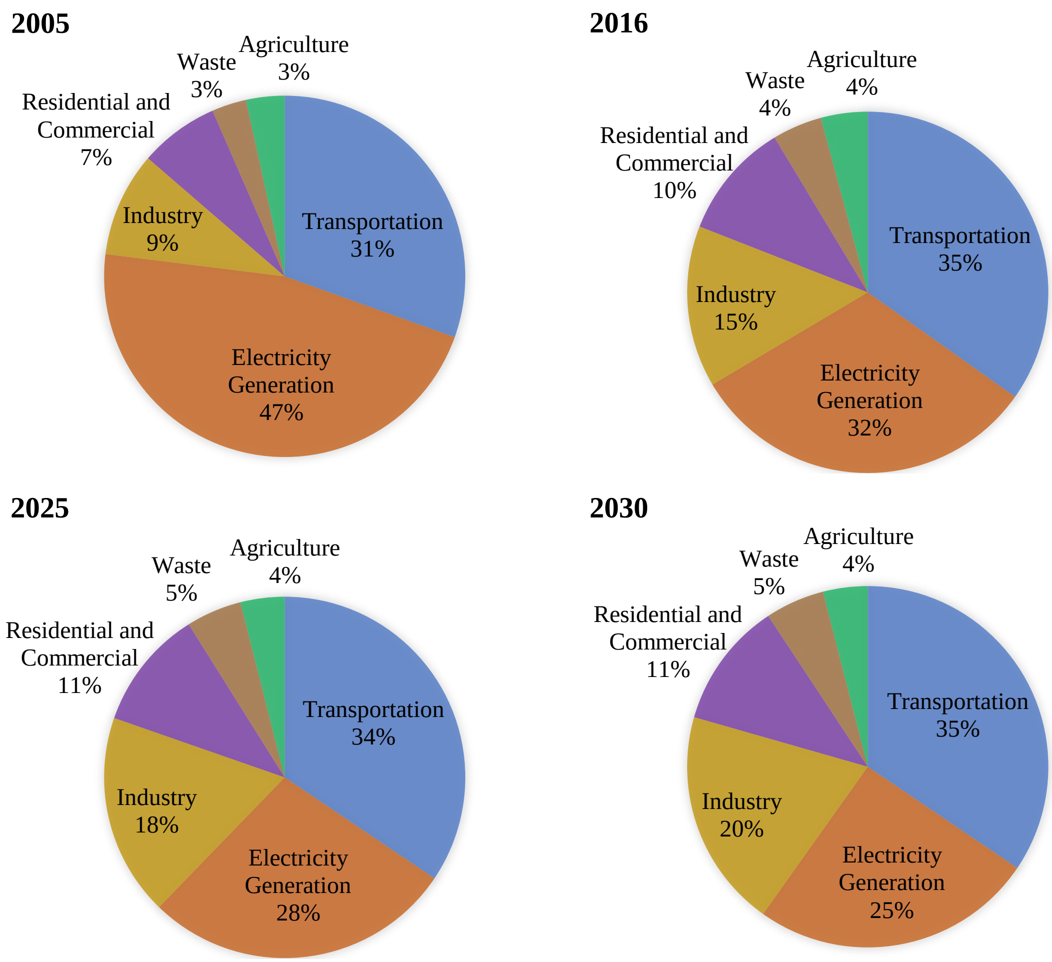


**Figure 2-8: Nevada Historical and Projected Net GHG Emissions and Sinks by Sector, 2005-2030, with Projections Beginning in 2017 and Comparison to SB 254's 2025 and 2030 Goals**

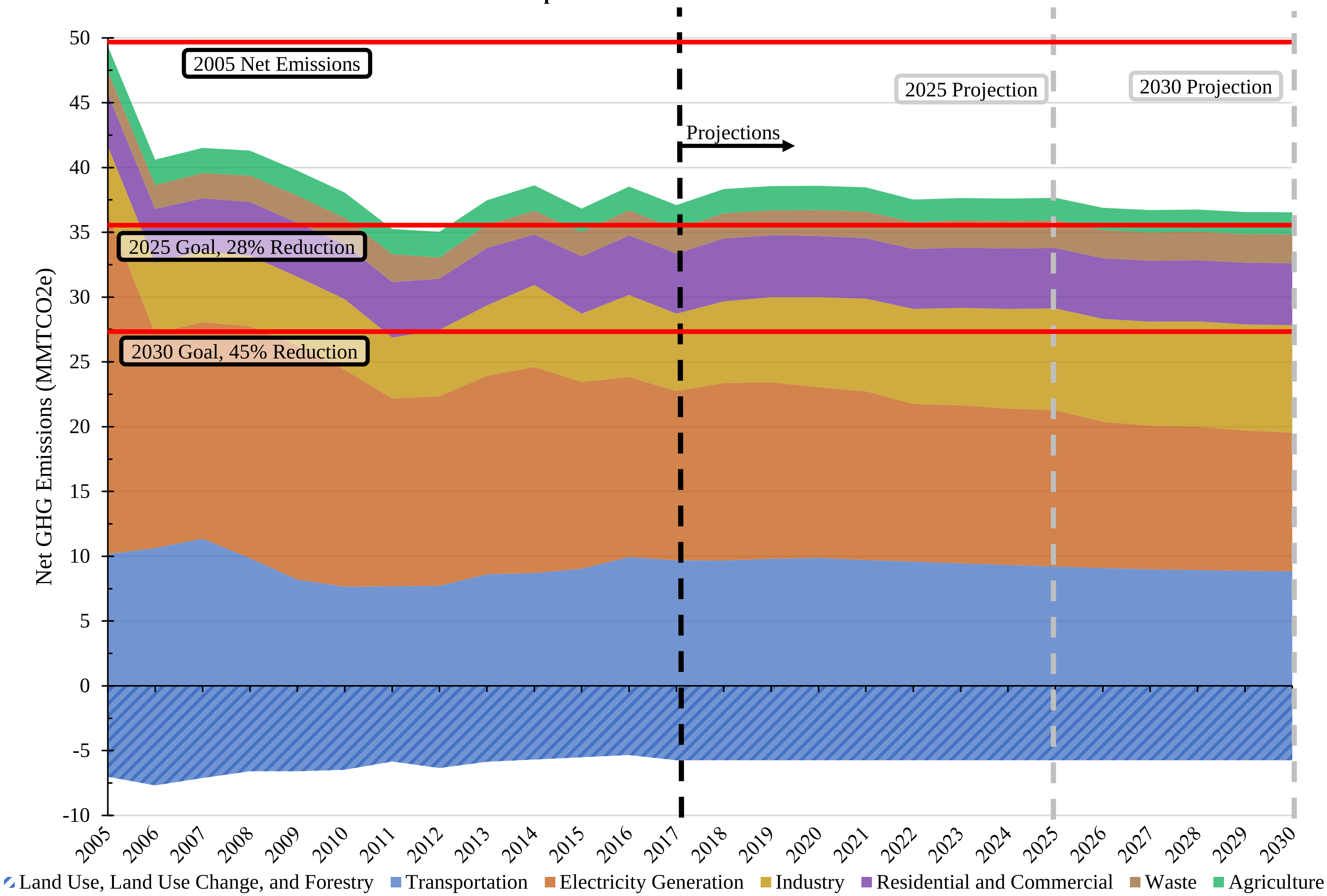


**Table 2-5: Nevada Net GHG Emissions Comparison with SB 254 Goals (MMTCO2e and Percent)**

| | 2005 | 2025 | 2030 |
|---|---|---|---|
| Net Emissions | 49.363 | 37.661 | 36.545 |
| Projected Emissions Reduction | - | 11.702 | 12.817 |
| **Projected Percent Reduction** | **-** | **24%** | **26%** |
| | | | |
| SB 254 Emissions Goals | - | 35.541 | 27.150 |
| SB 254 Emissions Reductions | - | 13.822 | 22.213 |
| SB 254 Percent Reduction | - | 28% | 45% |
| **Estimated Additional Emissions Reductions Required** | **-** | **2.119** | **9.396** |

## 2.4 GHG Emissions in Nevada and the United States

In 2016, U.S. gross GHG emissions totaled 6,492.3 MMTCO2e (compared to Nevada's 43.869 MMTCO2e emissions).[41] On average, Nevadans contributed far fewer gross GHG emissions per person in 2016 — 14.93 MTCO2e per person for Nevada versus the U.S.'s 20.07 MTCO2e per person. Further, Nevada only contributed 0.68% of the U.S.'s total gross GHG emissions in 2016, despite having 0.90% of the U.S. population. There are likely three main reasons for this: (1) Nevada's coal-fired power plant emissions are low compared to the entire U.S. fleet of coal-fired power plants; (2) natural gas and oil production, which can be a significant source of GHG emissions, are insignificant in Nevada compared to other states; and (3) our State's arid environment that significantly limits agricultural production and its associated emissions.

[41] US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017. US Environmental Protection Agency; released 2019 Apr 11. Washington D.C. EPA 430-R-19-001. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017

## Transportation

**Figure 3-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with Transportation Emphasized, 1990–2039, with Projections Beginning in 2017**

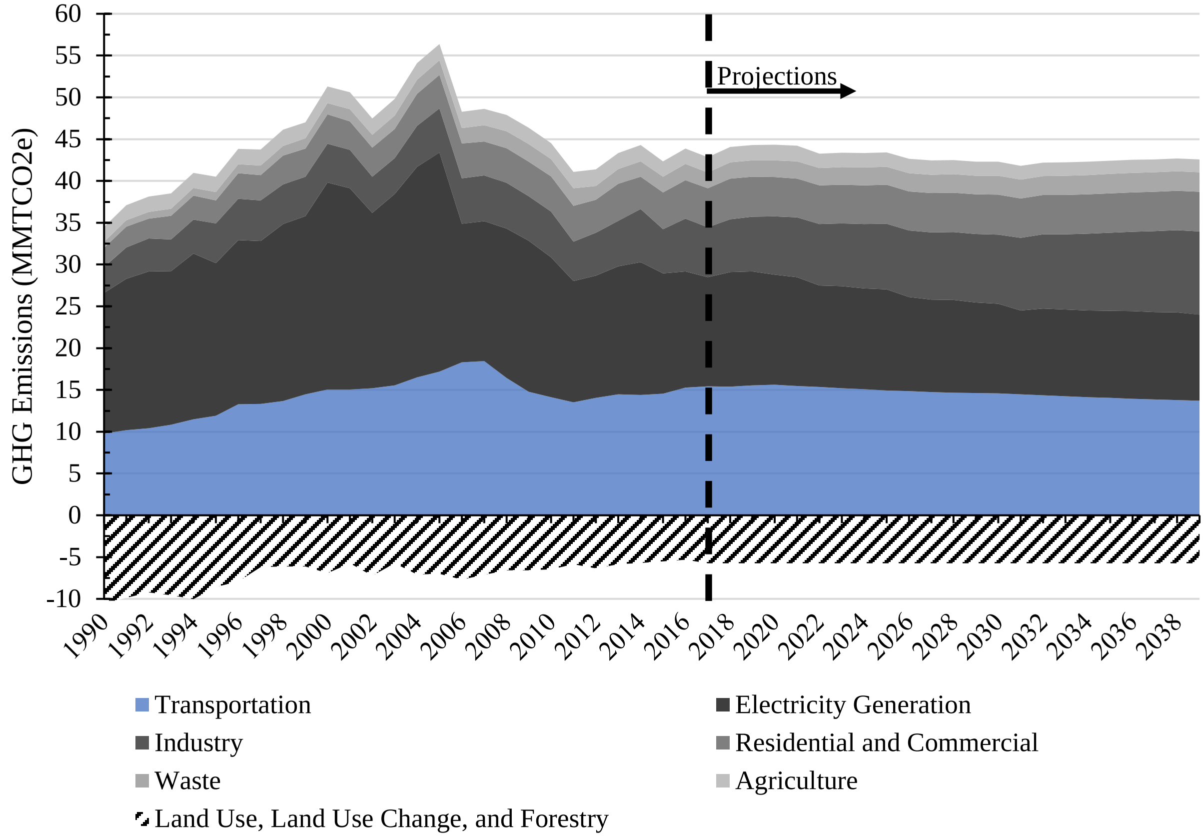
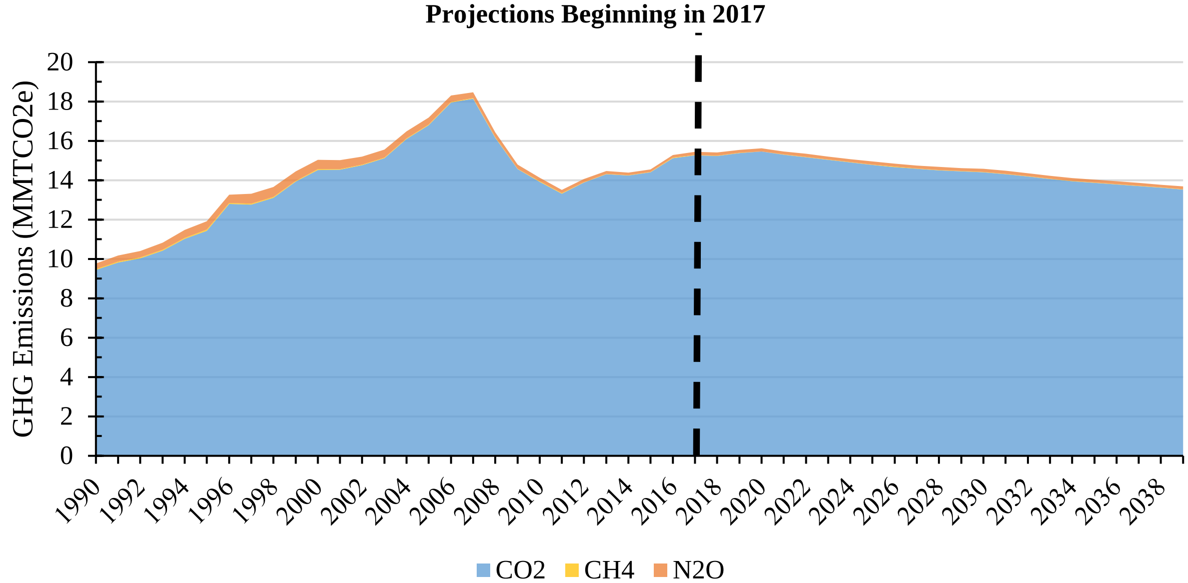



**Figure 3-2: Transportation Sector GHG Emissions by GHG, 1990–2039, with Projections Beginning in 2017**



## 3.1 Overview

The transportation sector exceeded electricity generation in 2015 becoming the largest sector of GHG emissions in Nevada. In 2016, there were 15.274 MMTCO2e emissions attributed to transportation in Nevada, that's nearly 35% of the State's total GHG emissions. Considering only existing policies, the transportation sector is projected to remain the largest sector of GHG emissions in Nevada through 2039. The types of GHGs emitted from this sector are $CO_2$, $CH_4$, and $N_2O$. $CH_4$ and $N_2O$ account for less than 1% of transportation's 2016's GHG emissions. Total transportation sector emissions for 1990 through 2039, along with the minor impact of $CH_4$ and $N_2O$, are illustrated in Figure 3-2. Sector emissions are estimated to be 17.183 MMTCO2e for 2005, and projected to be 14.951 MMTCO2e in 2025 and 14.579 MMTCO2e in 2030.

The transportation sector includes all mobile sources of emissions. That is, highway vehicles, aircraft, locomotives, marine vessels, and all manner of motorized non-road equipment and vehicles such as construction equipment, farm equipment, airport ground support equipment, and recreational vehicles. Federal regulations controlling emissions from mobile sources varies widely depending on their use and when regulations for a specific vehicle/equipment type were first adopted. Of all the mobile sources, highway vehicles are both the most tightly regulated and the largest contributor of GHG emissions. Accounting for more than 76% of sector GHG emissions in 2016, there were approximately 2.78 million highway vehicles registered in Nevada in 2018.

## 3.2 Methodology

Transportation sector GHG emissions are the result of fossil fuel combustion and, to a much lesser extent, the byproducts ($CH_4$ and $N_2O$) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *$CO_2$ from Fossil Fuel Combustion* module estimates $CO_2$ emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. $CO_2$ emissions are the direct result of the combustion of fuel and are determined by analyzing the type and quantity of fuel combusted. $CO_2$ emissions from fossil fuel combustion also include all of the carbon in fuels that are either immediately oxidized or are oxidized within a period of less than 20 years. That means that in addition to $CO_2$, estimates include gases like carbon monoxide (CO) and short-lived compounds that decompose quickly.

The *$CH_4$ and $N_2O$ Emissions from Mobile Combustion* module estimates $CH_4$ and $N_2O$ emissions (the byproducts of fossil fuel consumption) by applying emission factors to individual vehicle control technologies that exist on certain model years of certain vehicle/equipment types. The module then estimates vehicle/equipment Vehicle Miles Travelled (VMT)/usage and allocates VMT/usage across an estimated age distribution for each of the types of vehicle/equipment. As there is currently no better estimate of statewide VMT for all highway vehicles in Nevada, this report uses the default VMT estimates used in the *$CH_4$ and $N_2O$ Emissions from Mobile Combustion* module.[42] These estimates are

[42] Improved estimates of VMT in Nevada, in addition to accurate vehicle registration information, would be necessary to improve emissions estimates. Additionally, the *$CH_4$ and $N_2O$ Emissions from Mobile Combustion* module includes a method for estimating $CO_2$ emissions using a similar method. Analyzing the potential impact of

based on national averages prepared by the Federal Highway Administration (FHWA) in their *Highway Statistics* series[43] and utilize EPA's mobile emissions inventory guidance.

$CH_4$ emissions are influenced by fuel composition, combustion conditions, and control technologies. Depending on the control technologies used, $CH_4$ emissions may also result from hydrocarbons passing uncombusted or partially combusted through the engine, and then be affected by any post-combustion control of hydrocarbon emissions, such as catalytic converters. For highway vehicles, conditions favoring high $CH_4$ emissions include aggressive driving, low speed operation, vehicle idling, and cold weather operation. The lowest amount of $CH_4$ emissions are achieved when hydrogen, carbon, and oxygen are present in the ideal combination for complete combustion.

$N_2O$ formulation in internal combustion engines is not yet well understood, and data on these emissions are scarce. It is believed that $N_2O$ emissions form via two distinct processes: (1) cold temperature starts of vehicles equipped with catalytic converters; as the catalyst in a catalytic converter heats up, $N_2O$ levels decrease. (2) $N_2O$ is formed when nitrogen oxide (NO) interacts with combustion intermediates such as imidogen (NH) and cyanate (NCO). Only small amounts of $N_2O$ are produced as engine-out emissions. $N_2O$ from highway vehicles are primarily formed by the first process. $CH_4$ and $N_2O$ account for less than 1% of 2016's transportation sector GHG emissions.

GHG emissions for the transportation sector are projected using the SIT's *Greenhouse Gas Projection Tool* from 2017 through 2030 and a linear trend of these projections is applied through 2039. For $CO_2$ emissions, the projection tool uses EIA State Energy Data (aggregated at the regional level[44]) and the EIA's AEO Reference case in order to estimate state-level fuel consumption.[45] Fuel consumption estimates are then subjected to the same quantification method as the *$CO_2$ from Fossil Fuel Combustion* module. $CH_4$ and $N_2O$ emissions are projected by the SIT using data from the FHWA and the EIA.

## 3.3 GHG Emissions 1990-2016

Transportation sector emissions peaked in 2007 at 18.470 MMTCO2e. The reduced emission in the years following the 2007 peak were likely due to the Great Recession which caused a reduction in transportation activity all across the country. Sector emissions are estimated to be 17.183 MMTCO2e for 2005 and 15.274 MMTCO2e for 2016. Figure 3-3 shows transportation sector GHG emissions in Nevada from 1990 through 2016 by fuel type and Table 3-1 lists transportation sector GHG emissions in Nevada for select years. In both Figure 3-3 and Table 3-1, aviation fuels include kerosene, naphtha, and aviation gasoline and alternative fuels include the combined emissions from compressed natural gas (CNG), liquefied natural gas (LNG), and liquefied petroleum gas (LPG).

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policies affecting highway vehicles registered or sold in Nevada would likely depend on this module and the improved data necessary for it to be accurately run.

[43] Policy and Governmental Affairs: Office of Highway Policy Information Highway Statistics Series. US Department of Transportation, Federal Highway Administration. [accessed 2019 Jul 1]. https://www.fhwa.dot.gov/policyinformation/statistics.cfm

[44] Nevada is in the "Mountain" region. The "Mountain" region includes Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

[45] While the *Greenhouse Gas Projection Tool* estimates emissions through 2030, the AEO estimates energy usage through 2050. NDEP believes that the AEO estimates can be fully incorporated into future reports. This would have the effect of avoiding multiple projection methods applied to a single source over the projection period.

**Figure 3-3: Transportation Sector GHG Emissions in Nevada by Fuel Type, 1990-2016**

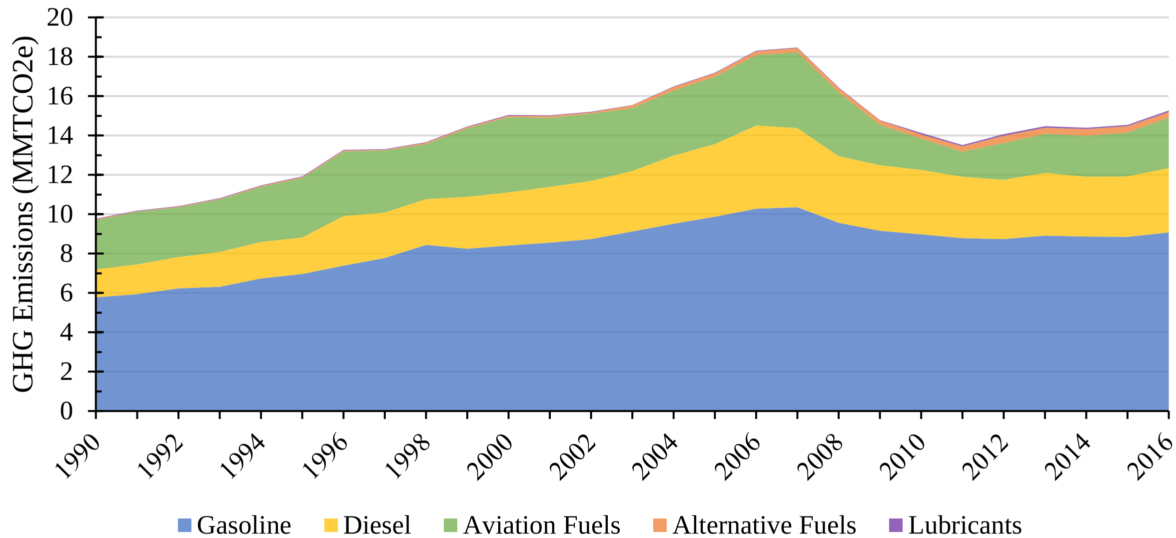



**Table 3-1: Transportation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)**

| Fuel Type | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 5.773 | 6.964 | 8.410 | 9.866 | 8.984 | 8.917 | 8.867 | 8.854 | 9.076 |
| Diesel | 1.426 | 1.857 | 2.706 | 3.695 | 3.270 | 3.186 | 3.039 | 3.069 | 3.264 |
| Aviation Fuels | 2.496 | 3.014 | 3.815 | 3.419 | 1.579 | 1.981 | 2.083 | 2.222 | 2.565 |
| Alternative Fuels | 0.049 | 0.051 | 0.071 | 0.172 | 0.216 | 0.310 | 0.334 | 0.322 | 0.292 |
| Lubricants | 0.035 | 0.033 | 0.036 | 0.030 | 0.079 | 0.073 | 0.072 | 0.079 | 0.078 |
| **Total Emissions** | **9.778** | **11.919** | **15.037** | **17.183** | **14.127** | **14.467** | **14.395** | **14.546** | **15.274** |

Transportation sector GHG emissions have increased by 11.5% (1.757 MMTCO2e) since the 2011 sector low of 13.517 MMTCO2e. This increase has been driven largely by aircraft (that is, aviation fuels) and to a lesser extent highway vehicles[46]. Emissions from aircraft continue to return to pre-recession levels as emissions have increased by 50% (1.282 MMTCO2e) since 2011. Without the increasingly stringent federal highway vehicle fuel economy standards of the 2010's, it is likely that current transportation sector emissions would be much higher. Annual changes in transportation sector GHG emissions by fuel from 2011 through 2016 are listed in Table 3-2.

[46] While the *$CO_2$ from Fossil Fuels Combustion* module does not list emissions from highway vehicles (emissions are listed by fuel type), the *$CH_4$ and $N_2O$ Emissions from Mobile Combustion* module also estimates $CO_2$ emissions and that module does list highway vehicle emissions. And while IPCC guidelines do not advise using VMT to estimate $CO_2$ emissions for the purposes of creating an inventory, the emissions associated with the vehicle/equipment types considered by the *$CH_4$ and $N_2O$ Emissions from Mobile Combustion* module were used to prorate $CO_2$ emissions to estimate highway vehicle GHG emissions for discussion purposes only.

**Table 3-2: Annual Change in Transportation Sector GHG Emissions in Nevada by Fuel Type, 2011-2016 (MMTCO2e and Percent)**

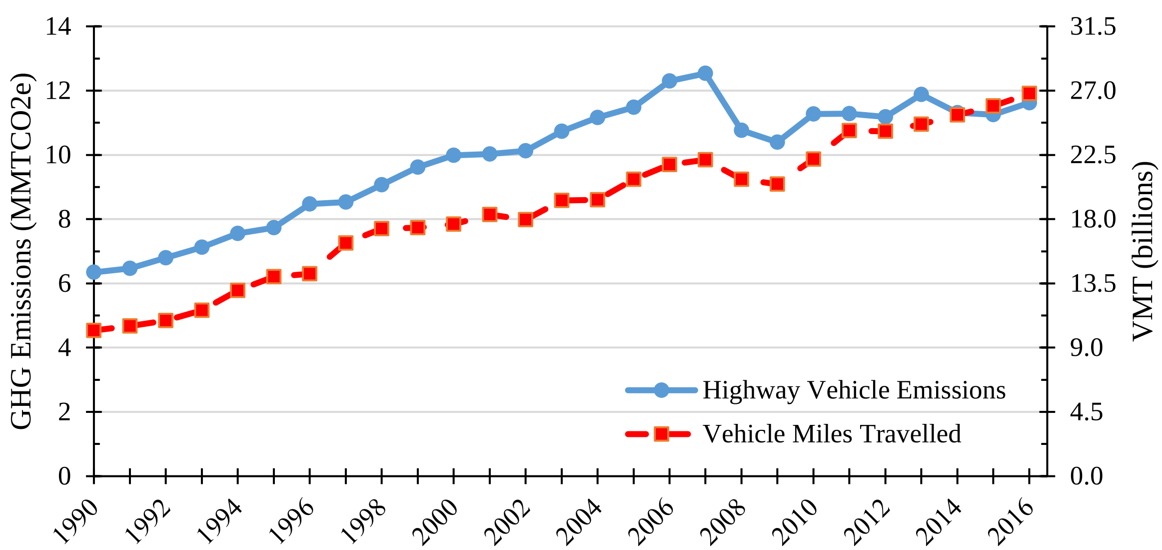
| Fuel Type | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | -0.050 | -0.57% | 0.178 | 2.04% | -0.050 | -0.56% | -0.013 | -0.15% | 0.222 | 2.51% |
| Diesel | -0.107 | -3.44% | 0.184 | 6.14% | -0.147 | -4.62% | 0.030 | 0.99% | 0.195 | 6.37% |
| Aviation Fuels | 0.588 | 45.85% | 0.110 | 5.89% | 0.102 | 5.12% | 0.139 | 6.68% | 0.343 | 15.43% |
| Alternative Fuels | 0.118 | 44.68% | -0.071 | -18.73% | 0.024 | 7.81% | -0.012 | -3.67% | -0.030 | -9.37% |
| Lubricants | -0.006 | -8.42% | 0.005 | 7.70% | 0.000 | -0.37% | 0.007 | 9.79% | -0.002 | -2.38% |
| **All Fuel Types** | **0.543** | 4.02% | **0.407** | 2.89% | **-0.072** | -0.50% | **0.151** | 1.05% | **0.728** | 5.01% |

### 3.3.1 Highway Vehicle Emissions

Highway vehicle GHG emissions are the result of passenger cars, light trucks, and medium- and heavy-duty vehicles operating on Nevada's roads and highways. These vehicles are registered by the Nevada Department of Motor Vehicles to operate on Nevada's highways. Highway vehicle standards are regulated at the federal level by the National Highway Traffic Safety Administration (NHTSA) and EPA, where NHTSA has the authority to set safety and fuel economy standards and EPA has the authority to regulate vehicle emissions (including GHGs). Federal regulations for highway vehicles are generally created for two groups, (1) passenger cars and light-duty trucks and (2) medium- and heavy-duty vehicles.

NHTSA and EPA coordinate their efforts to set standards for highway vehicles that ensure vehicle/passenger safety while improving fuel economy and reducing vehicle emissions (especially smog-forming pollutants like particulate matter, or PM, and oxides of nitrogen, or NOx). These efforts have been generally successful. Across the country, this has had the effect of minimizing the impact of highway vehicle GHG emissions in spite of increasing VMT. Since 2009 (both the recent low for highway vehicle GHG emissions and the end of the Great Recession), it is estimated that total VMT in Nevada has increased by 26% (that's more than 6.3 billion additional miles travelled annually compared to 2009) while emissions have only increased by 8%. Figure 3-4 illustrates the relationship between estimated highway vehicle GHG emissions and total VMT from 1990 through 2016 in Nevada.

**Figure 3-4: Highway Vehicle GHG Emissions in Nevada and Total VMT, 1990-2016**



## 3.4 Emissions Projections, 2017-2039

There is a high degree of uncertainty with transportation sector projections. This is due in large part to the proposed federal rollback of passenger car and light truck vehicle fuel economy standards. In 2018, NHTSA and the EPA proposed the Safer Affordable Fuel Efficient (SAFE) Vehicles Rule. This rule would freeze fuel economy standards for all passenger cars and light trucks for vehicle model years 2021 through 2026.[47] This would have the effect of rolling back the already finalized Tier 3 passenger car and light truck fuel economy standards, which requires vehicle manufacturers to produce increasingly more efficient vehicles through model year 2025.[48] Any reduction to the existing standards will result in an increase of GHG emissions.

As mentioned in 3.2 Methodology, the SIT's *Greenhouse Gas Projection Tool* depends on the EIA's AEO Reference case to project emissions. The Reference case assumes the existing Tier 3 light-duty vehicle emissions standards through model year 2025 and Phase 2 standards for medium- and heavy-duty vehicles through model year 2027. Because there are no regulations finalized beyond those model years, the EIA does not assume any further emissions reductions/efficiency gains in vehicle technology. It is unlikely that highway vehicle fuel economy standards will stagnate beyond the 2025 and 2027 model years, but in the absence of clear predictability for new standards, NDEP assumed that the trend in emission reductions observed from 2017 to 2030, will continue through 2039. The AEO provides more details on the AEO transportation sector Reference case and the key factors driving transportation projections:

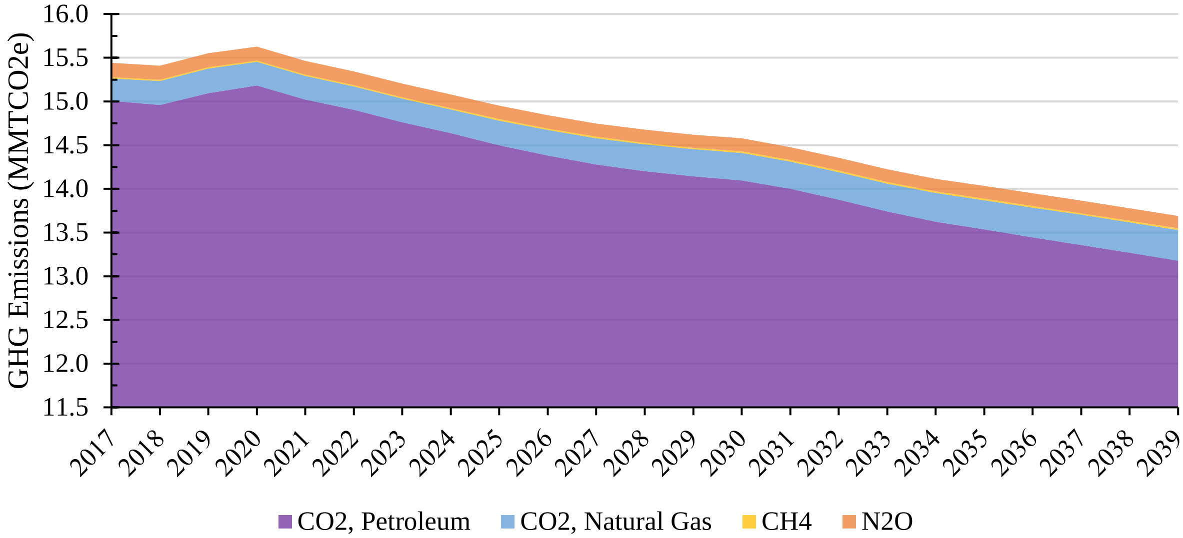
- "Increases in fuel economy standards temper growth in motor gasoline consumption, which decreases by 31% between 2017 and 2050.
- "Increases in fuel economy standards result in heavy-duty vehicle energy consumption and related diesel use ending at approximately the same level in 2050 as in 2017, despite rising economic activity that increases the demand for freight truck travel.
- "Excluding electricity and other transportation fuels, which are at comparatively low levels in 2017, jet fuel consumption grows more than any other transportation fuel over the projection period, rising 64% from 2017 to 2050, as growth in air transportation outpaces increases in aircraft energy efficiency.
- "Motor gasoline and distillate fuel oil's combined share of total transportation energy consumption decreases from 84% in 2017 to about 70% in 2050 as the use of alternative fuels increases.
- "Continued growth in on-road travel demand increases energy consumption later in the projection period, because current fuel economy and greenhouse gas standards require no additional

[47] US Department of Transportation, National Highway Traffic Safety Administration and US Environmental Protection Agency. The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks. Federal Register. 2018 Aug 24; Vol 83, No. 165, Proposed Rules, 42986. https://www.govinfo.gov/content/pkg/FR-2018-08-24/pdf/2018-16820.pdf
[48] US Environmental Protection Agency. Control of Air Pollution From Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards. Federal Register. 2014 Apr 28; Vol 79, No. 81, 23414. https://www.govinfo.gov/content/pkg/FR-2014-04-28/pdf/2014-06954.pdf

efficiency increases for new vehicles after 2025 for light-duty vehicles and after 2027 for heavy-duty vehicles."[49]

Based on the above assumptions, and with no change in current laws and regulations, transportation GHG emissions in Nevada are projected to peak in 2020 at 15.6272 MMTCO2e emissions. Emissions in 2025 are projected to be 14.951 MMTCO2e, emissions in 2030 are projected to be 14.579 MMTCO2e, and emissions in 2039 are projected to be 13.690 MMTCO2e. Figure 3-5 shows transportation sector GHG emissions in Nevada by GHG and fuel type projected for 2017 through 2039. The SIT projection tool does not provide the same level of fuel disaggregation as the SIT tool for historical estimates (see Figure 3-3).

**Figure 3-5: Transportation Sector GHG Emissions Projections in Nevada by GHG, 2017–2039**




[49] Annual Energy Outlook 2018, p108.

# Electricity Generation

**Figure 4-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with Electricity Generation Emphasized, 1990–2039, with Projections Beginning in 2017**

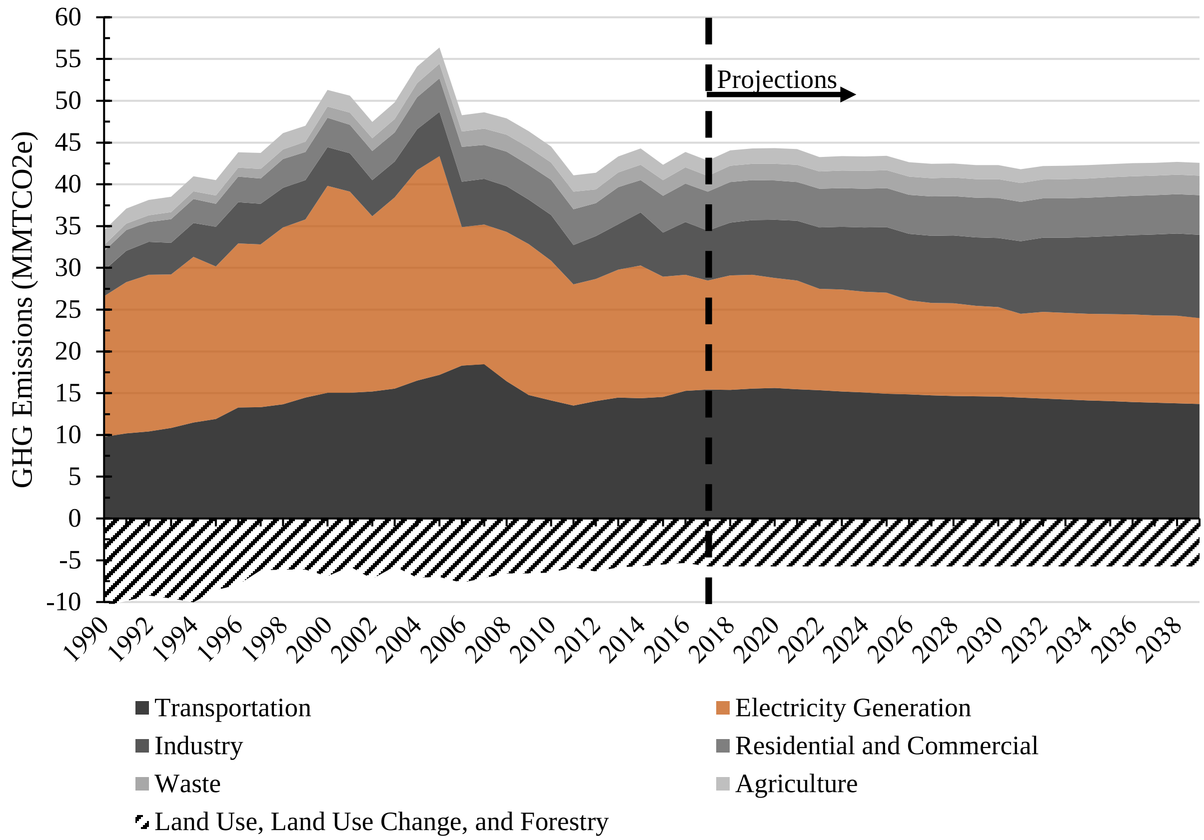
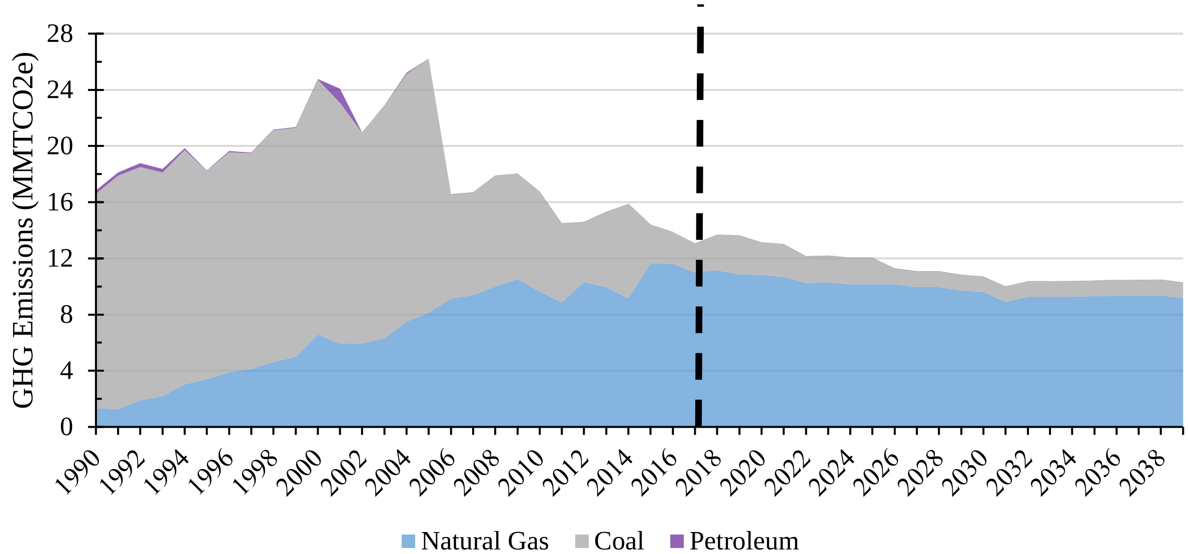



**Figure 4-2: Electricity Generation Sector GHG Emissions by Fuel Type, 1990–2039, with Projections Beginning in 2017**



## 4.1 Overview

Electricity Generation has historically been Nevada's largest sector of GHG emissions, but the retirements of two coal-fired power plants (Mohave Generating Station in 2005 and Reid Gardner Generating Station's last unit in 2017) and their partial replacement with natural gas-fired power plants and the adoption of renewable energy have led to significant emissions reductions. This change in fuel type results in a less carbon intense emissions profile for the electricity generated in Nevada. From the EPA's 2019 GHG Inventory, "[c]arbon dioxide emissions also depend on the source of energy and its carbon (C) intensity. The amount of C in fuels varies significantly by fuel type. For example, coal contains the highest amount of C per unit of useful energy. Petroleum has roughly 75 percent of the C per unit of energy as coal, and natural gas has only about 55 percent."[50]

In 2016, it is estimated that 13.886 MMTCO2e emissions attributed to electricity generation were emitted in Nevada, that's more than 31% of the State's total GHG emissions. It is projected that, by 2039, emissions from electricity generation will be approximately the same as industrial sector emissions, 10.298 MMTCO2e. Reductions in emissions and the electricity generation sector's continued decline through the projection period are largely associated with the expected retirement of the North Valmy Generating Station (one of Nevada's two remaining coal-fired power plants) and that there are currently no plans filed with the Public Utilities Commission of Nevada or (PUCN) nor any other regulatory body for new, utility-scale fossil fuel-fired electric generating units (EGUs) in Nevada through 2039. Total electricity generation sector emissions by fuel type for 1990 through 2039 are illustrated in Figure 4-2. Electricity generation sector emissions were 26.211 MMTCO2e in 2005, and are projected to be 12.067 MMTCO2e and 10.730 MMTCO2e in 2025 and 2030, respectively.

This report estimates emissions for all electricity generated in Nevada. Not all electricity that is generated in Nevada is consumed in Nevada and not all electricity that is consumed in Nevada is generated in Nevada. A generation-based accounting of emissions is considered to be more accurate of the actual GHG emissions for the State. In 2016, there were an estimated 1.984 MMTCO2e emissions associated with the electricity transmitted out-of-state.

## 4.2 Methodology

Electricity generation sector GHG emissions are the result of fossil fuel combustion and (to a much lesser extent) the byproducts ($CH_4$ and $N_2O$) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *$CO_2$ from Fossil Fuel Combustion* module estimates $CO_2$ emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. $CO_2$ emissions are the direct result of the combustion of fuel and are determined by analyzing the type and quantity of fuel combusted. $CO_2$ emissions from fossil fuel combustion also include all of the carbon in fuels that are either immediately oxidized or are oxidized within a period of less than 20 years. That means that in addition to $CO_2$, it includes gases like CO and short-lived compounds that decompose quickly.

[50] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, p3-7.

The *$CH_4$ and $N_2O$ Emissions from Stationary Combustion* module estimates $CH_4$ and $N_2O$ emissions (the byproducts of fossil fuel consumption) by applying emission factors for the individual fuel types (examples include coal, distillate fuel/petroleum, and natural gas) to annual fuel consumption (provided by the EIA). $CH_4$ and $N_2O$ emissions vary with the type of fuel burned, the size and age of the combustion technology, the maintenance and operating conditions of the combustion equipment, and the types of pollution control technologies installed.

$CH_4$ emissions are generally the product of incomplete combustion. More are released when combustion temperatures are relatively low. Larger, higher efficiency EGUs tend to reach and sustain higher temperatures and are thus less likely to emit $CH_4$. Emissions can range well above the average for EGUs that are improperly maintained or poorly operated. Similarly, during start-up periods, combustion efficiency is lowest, causing emissions to be higher than periods of standard operation. $N_2O$ is produced from the combustion of fuels and emissions are dependent on the combustion temperature. The highest $N_2O$ emissions occur at a combustion temperature of 1,340 degrees Fahrenheit (1,000 degrees Kelvin) while $N_2O$ emissions are negligible for combustion temperatures below 980 or above 1,700 degrees Fahrenheit (below 980 and above 1,200 degrees Kelvin).

The SIT's *Greenhouse Gas Projection Tool* is not used for projecting electricity generation sector emissions. Because the projection tool depends on the EIA's AEO, it neither considers the most recent Integrated Resource Plans (IRPs) filed by the utilities considered in this report, nor does it account for 2019's Nevada SB 358 and the updated Renewable Portfolio Standard (RPS). $CO_2$ emissions from coal- and natural gas-fired EGUs are projected using a method developed by NDEP that depends on historical, unit-level electricity generation and emissions data as well as the existing policies and regulations affecting the future of those units.[51,52] Information was gathered from the following sources:

- EIA Form 923[53] and EIA Form 860[54] for unit level net generation, fuel consumption, reported retirements, and nameplate capacity;
- EPA Air Markets Program Data (AMPD)[55] and the Emissions and Generation Resource Integrated Database (eGRID)[56] for $CO_2$ emissions, gross generation, heat input, and EGU nameplate capacity;

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[51] $CH_4$ and $N_2O$ emissions are projected by considering projected $CO_2$ emissions against the historical $CO_2$, $CH_4$, and $N_2O$ emissions. $CH_4$ and $N_2O$ emissions accounted for less than 0.2% of sector emissions in 2016.
[52] $CO_2$ emissions associated with the combustion of petroleum products was projected using a linear trend of 2008 through 2016 historical emissions. Petroleum-based $CO_2$ emissions accounted for less than 0.067% of sector emissions in 2016.
[53] Form EIA-923. US Energy Information Administration. [accessed 2019 Oct 2]. https://www.eia.gov/electricity/data/eia923/
[54] Form EIA-860. US Energy Information Administration. [accessed 2019 Oct 2]. https://www.eia.gov/electricity/data/eia860/
[55] Air Markets Program Data. US Environmental Protection Agency. [accessed 2019 Oct 2]. https://ampd.epa.gov/ampd/
[56] Emissions and Generation Resource Integrated Database. US Environmental Protection Agency; 2018 Feb 15. [accessed 2019 Aug 1]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

- NV Energy's 2019-2038 IRP[57] submitted to the PUCN for sales projections, power purchase agreements, supply side plans, and reported remaining useful lives of their fossil fuel-fired fleet;
- Idaho Power's 2019 IRP[58] for information on North Valmy Generating Station[59]; and
- The updated RPS from 2019's SB 358[60].

EIA and EPA data are combined to create a single set of $CO_2$ emissions and net electricity generation from fossil fuel-fired electricity generators in Nevada. While there is some overlap, not all EGUs operating in Nevada are required to report data in the same way to EIA and EPA, so multiple sources of data need to be compiled in order to get an accurate accounting of emissions and generation. Future emissions and generation are estimated using unit-level averages from the compiled historical dataset. NV Energy's IRP is applied to the dataset and units scheduled for closure are zeroed out from the year following closure through 2039. In the case of Idaho Power's 2019 IRP, they plan to cease "participation in North Valmy Unit 1 at year-end 2019 and Unit 2 no later than year-end 2025."[61]

For EGUs within NV Energy's control, the RPS and NV Energy's base-case sales projections are applied to the projected net generation to find instances where projected generation is greater than projected demand; this is done for both Sierra Pacific Power Company (SPPC) and Nevada Power Company (NPC) projections.[62] When this happens, NDEP simulates fossil fuel peaker and intermediate load units (as identified by NV Energy in their IRP) being curtailed until generation is equal to projected demand by reducing generation from these types of units. Reduced emissions due to the reduced generation are estimated using the utility's average emission rates for SPPC and NPC peaker and intermediate load units. For years when projected demand is greater than projected generation, it is assumed that the wholesale market (that is, generally, electricity generated outside of Nevada) is used to provide coverage.

For EGUs outside of NV Energy's control, that is, EGUs owned by Nevada Goldmines LLC (Western 102), Newmont Nevada Energy Investment LLC (TS Power), Southern California Public Power Authority (Apex Generating Station), and San Diego Gas and Electric Company (Desert Star Energy Center), no additional steps for projecting emissions beyond the historical average have been taken. While this method may exclude the minor emissions associated with smaller electric generating facilities and some renewable energy providers (for example, geothermal power plants), it provides an estimate of electricity generation sector GHG emissions in Nevada through 2039.

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[57] Nevada Power Company d/b/a NV Energy and Sierra Pacific Power Company d/b/a NV Energy. Joint 2019-2038 Integrated Resource Plan, for the three year Action Plan period 2019-2021, and the Energy Supply Plan period 2019-2021. Public Utilities Commission of Nevada. 2018 Jun 1; Docket 18-06003, Original Filing. [accessed 2019 Oct 2]. http://puc.nv.gov/

[58] Idaho Power Company. Idaho Power Integrated Resource Plan 2019. 2019 Jun. [accessed 2019 Oct 2]. https://www.idahopower.com/energy-environment/energy/planning-and-electrical-projects/our-twenty-year-plan/

[59] North Valmy Generating Station is co-owned by NV Energy and Idaho Power.

[60] Senate Bill 358. Nevada Legislature 80th Session (2019). [accessed 2019 Oct 2]. https://www.leg.state.nv.us/App/NELIS/REL/80th2019/Bill/6651/Overview

[61] Idaho Power Company. Idaho Power Integrated Resource Plan 2019, p79.

[62] While NV Energy can now report a single IRP to the PUCN for SPPC and NPC, they provide plans for each of the companies in the single report.

## 4.3 GHG Emissions, 1990-2016

Electricity generation sector emissions peaked in 2005 at an estimated 26.211 MMTCO2e emissions. Significant emissions reductions following 2005 are the result of coal-fired EGU shutdowns, their partial replacement with natural gas-fired EGUs (natural gas accounted for 83% of 2016 emissions, 11.604 MMTCO2e), and an ever-increasing reliance on renewable electricity (that is, hydroelectric, solar thermal and photovoltaic, wind, and geothermal resources). Figure 4-3 shows electricity generation sector GHG emissions in Nevada from 1990 through 2016 by fuel type and Table 4-1 lists electricity generation sector GHG emissions in Nevada for select years.

**Figure 4-3: Electricity Generation Sector GHG Emissions by Fuel Type, 1990–2016**

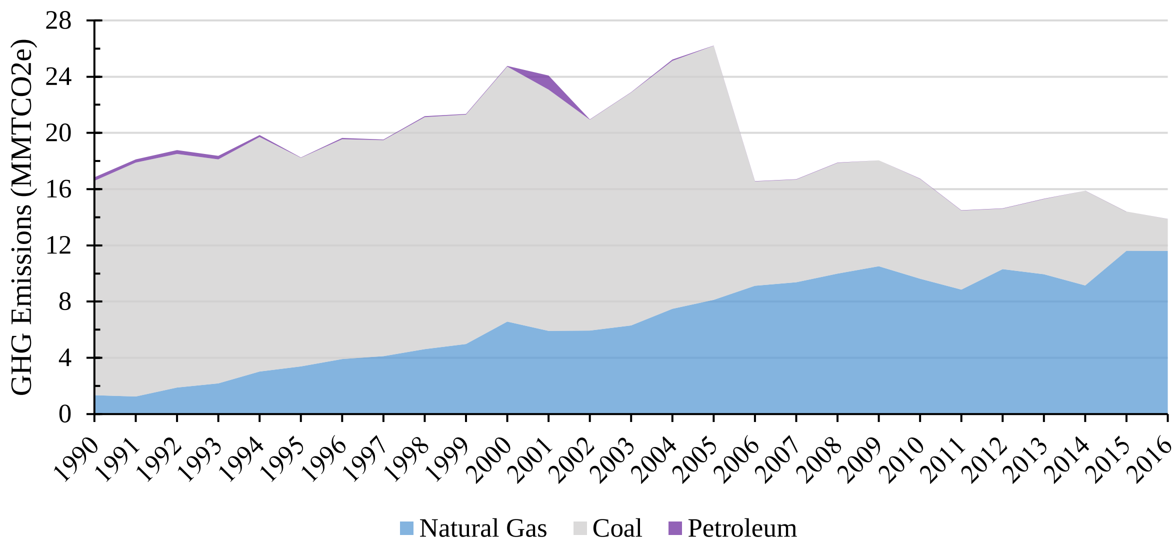



**Table 4-1: Electricity Generation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)**

| Fuel Type | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 1.333 | 3.380 | 6.582 | 8.133 | 9.627 | 9.952 | 9.159 | 11.614 | 11.604 |
| Coal | 15.266 | 14.859 | 18.132 | 18.060 | 7.108 | 5.352 | 6.722 | 2.787 | 2.274 |
| Petroleum | 0.250 | 0.024 | 0.055 | 0.019 | 0.011 | 0.015 | 0.012 | 0.013 | 0.009 |
| **Total Emissions** | **16.849** | **18.263** | **24.768** | **26.211** | **16.746** | **15.320** | **15.893** | **14.415** | **13.887** |

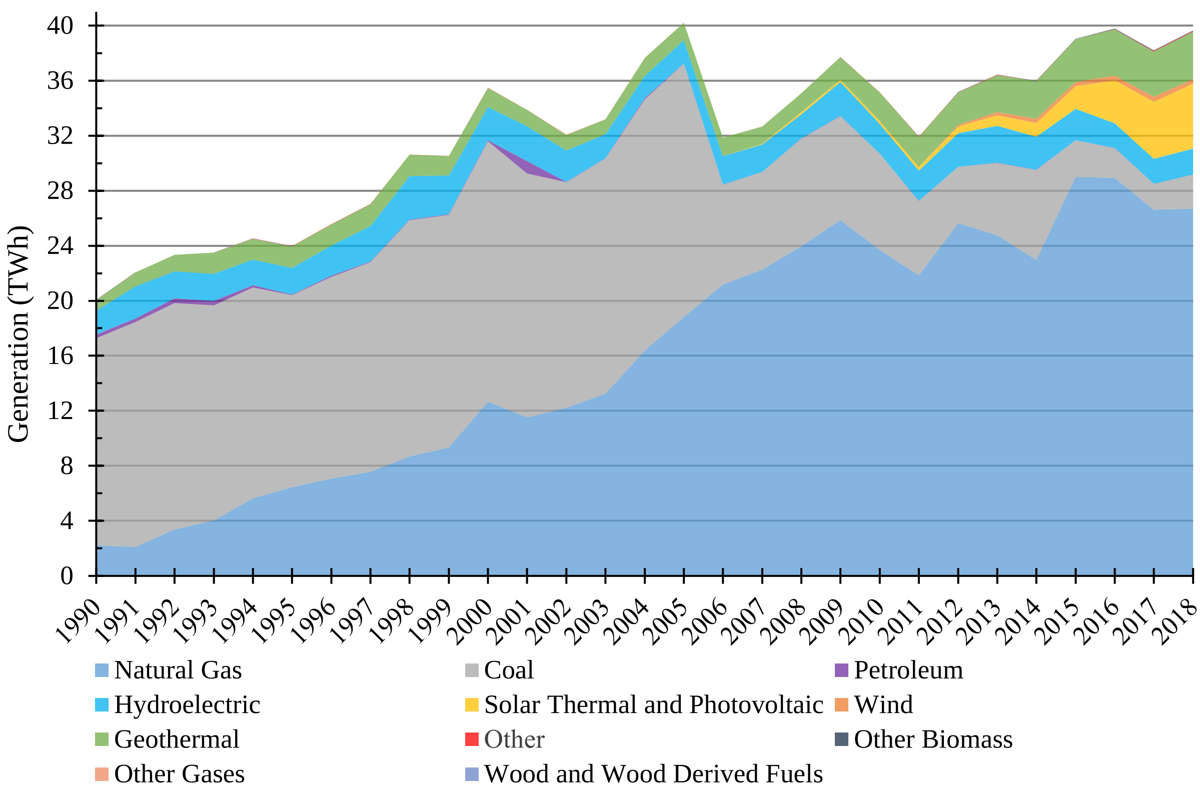
Large changes to the State's GHG emissions are often driven by the opening or closing of EGUs (for example, emissions in 2005 versus 2006 clearly show the impact of the Mohave Generating Station shutting down). Smaller inter-annual variability is likely associated with factors such as weather variability and the economy. An especially hot summer could mean higher demand for air conditioning, which would not be otherwise utilized in cooler conditions, resulting in an increase in emissions. Annual changes in electricity generation sector GHG emissions by fuel from 2011 through 2016 are listed in Table 4-2.

**Table 4-2: Annual Change in Electricity Generation Sector GHG Emissions in Nevada by Fuel Type, 2011-2016 (MMTCO2e and Percent)**

| Fuel Type | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 1.461 | 16.51% | -0.359 | -3.48% | -0.794 | -7.98% | 2.456 | 26.82% | -0.010 | -0.09% |
| Coal | -1.334 | -23.71% | 1.059 | 24.66% | 1.370 | 25.60% | -3.935 | -58.54% | -0.514 | -18.43% |
| Petroleum | 0.005 | 45.06% | -0.003 | -15.32% | -0.002 | -16.08% | 0.001 | 7.19% | -0.004 | -30.17% |
| **All Fuel Types** | **0.132** | **0.91%** | **0.697** | **4.77%** | **0.573** | **3.74%** | **-1.478** | **-9.30%** | **-0.528** | **-3.66%** |

Using EIA data, Figure 4-4 shows the amount of electricity generated in Nevada from 1990 through 2018 by source, in terawatt-hours (TWh)[63].[64] Table 4-3 shows the amount of electricity generated in Nevada for select years by source, in TWh. While emissions from the electricity generation sector have reduced by nearly half, the amount of electricity generated has remained largely unchanged. A benefit of viewing the sector in this way is that all sources of electricity are considered, not just the ones that emit GHGs. It also shows that renewable energy has long been a part of Nevada's diverse generation mixture. The generation of electricity via hydroelectric dams and geothermal deposits was present before 1990 and the relatively recent introduction of solar and wind demonstrates that renewable energy has become a relied upon portion of the state's generation mix. Renewable energy accounted for 26% of the electricity generated in Nevada in 2018; that percent is expected to rise as the RPS increases and new renewable energy projects are constructed.

**Figure 4-4: Amount of Electricity Generated in Nevada by Source, 1990-2018, TWh**




[63] For reference, 1 TWh is the same as 1,000,000 megawatts-hours (MWh).
[64] US Energy Information Administration Electricity Generation Data. [released 2019 Sep; accessed 2019 Sep 16]. https://www.eia.gov/state/seds/

**Table 4-3: Electricity Generated in Nevada by Source, Select Years (TWh)**

| Source | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| Natural Gas | 18.836 | 23.688 | 24.767 | 22.961 | 29.000 | 28.922 | 26.626 | 26.689 |
| Coal | 18.384 | 6.997 | 5.255 | 6.548 | 2.657 | 2.167 | 1.866 | 2.485 |
| Petroleum | 0.021 | 0.011 | 0.019 | 0.015 | 0.016 | 0.011 | 0.009 | 0.010 |
| Hydroelectric | 1.702 | 2.157 | 2.682 | 2.389 | 2.264 | 1.789 | 1.813 | 1.881 |
| Solar Thermal and Photovoltaic | 0.000 | 0.217 | 0.745 | 1.014 | 1.657 | 3.124 | 4.146 | 4.719 |
| Wind | 0.000 | 0.000 | 0.251 | 0.300 | 0.310 | 0.344 | 0.361 | 0.312 |
| Geothermal | 1.263 | 2.070 | 2.670 | 2.729 | 3.111 | 3.353 | 3.292 | 3.462 |
| Other | 0.000 | 0.000 | 0.025 | 0.015 | 0.001 | 0.021 | 0.032 | 0.029 |
| Other Biomass | 0.000 | 0.000 | 0.024 | 0.025 | 0.026 | 0.055 | 0.058 | 0.053 |
| Other Gases | 0.008 | 0.006 | 0.006 | 0.005 | 0.006 | 0.001 | 0.000 | 0.000 |
| Wood and Wood Derived Fuels | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **Total Generation** | **40.214** | **35.146** | **36.444** | **36.001** | **39.047** | **39.787** | **38.201** | **39.640** |

## 4.4 Projected Emissions, 2017-2039

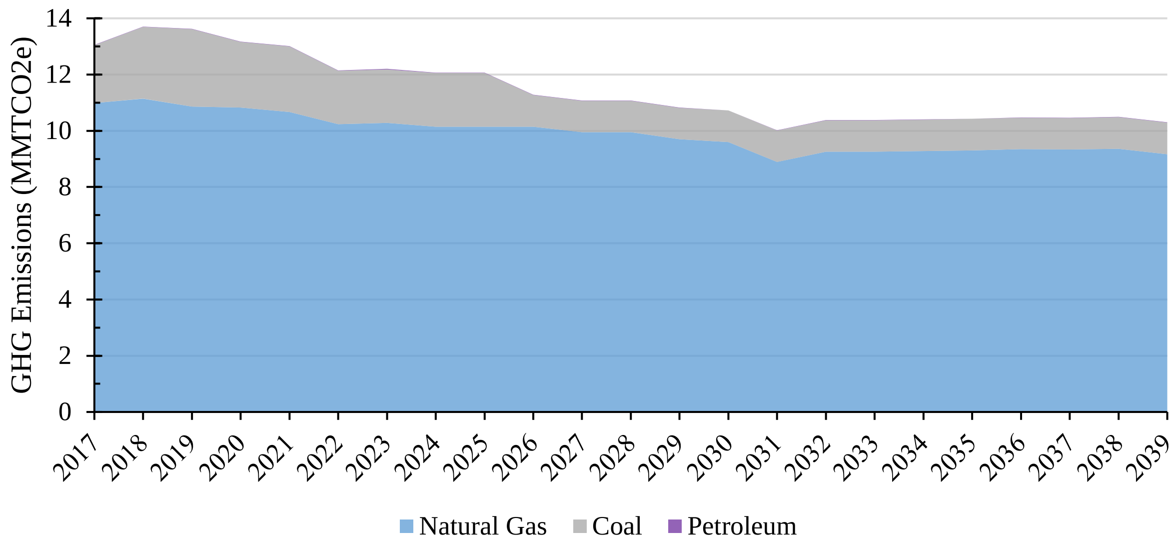
In 2018, there were 19 fossil fuel-fired power plants — 17 natural gas-fired and two coal-fired — operating in Nevada. Of these 19, three are transmitting some or all of their electricity out-of-state. Table 4-4 provides some information for these power plants. These power plants, in addition to the natural gas generator that intermittently operates at Nevada Solar One (a concentrating solar thermal power plant in Clark County) were considered in the projections.

**Table 4-4: Information for Power Plants Operating in Nevada in 2018**

| Power Plant Name | County Located | Destination for Electricity | Combined Facility Nameplate Capacity (MW) |
|---|---|---|---|
| **Coal-Fired Power Plants** | | | |
| North Valmy Generating Station | Humboldt | Nevada and Idaho | 567 |
| TS Power | Eureka | Nevada | 242 |
| **Natural Gas-Fired Power Plants** | | | |
| Apex Generating Station | Clark | California | 600 |
| Chuck Lenzie Generating Station | Clark | Nevada | 1,465 |
| CityCenter Central Plant Cogen Units | Clark | Nevada | 8.6 |
| Clark Mountain Combustion Turbines | Storey | Nevada | 170 |
| Desert Star Energy Center | Clark | California | 536 |
| Edward W. Clark Generating Station | Clark | Nevada | 1,375 |
| Fort Churchill Generating Station | Lyon | Nevada | 230 |
| Frank A. Tracy Generating Station | Storey | Nevada | 863 |
| Harry Allen Generating Station | Clark | Nevada | 745 |
| Las Vegas Generating Station | Clark | Nevada | 359 |
| Nevada Cogeneration Associates #1 and #2 | Clark | Nevada | 191 |
| Saguaro Power Plant | Clark | Nevada | 127 |
| Silverhawk Generating Station | Clark | Nevada | 664 |
| Sun Peak Generating Station | Clark | Nevada | 222 |
| Walter M. Higgins Generating Station | Clark | Nevada | 688 |
| Western 102 Power Plant | Storey | Nevada | 117 |

Without any additional changes to Nevada's RPS, electricity generation sector GHG emissions are expected to remain above 10 MMTCO2e through 2039 with emissions in 2025 projected to be 12.067 MMTCO2e, and emissions in 2030 projected to be 10.730 MMTCO2e. Emissions reductions are largely associated with the expected retirement of the North Valmy Generating Station (one of Nevada's two remaining coal-fired power plants) and the lack of published/filed plans for new fossil fuel-fired EGUs through 2039. Figure 4-5 shows electricity generation sector GHG emissions in Nevada by fuel type projected for 2017 through 2039.

**Figure 4-5: Electricity Generation Sector GHG Emissions Projections in Nevada by Fuel Type, 2017-2039**




As mentioned above, these are conservative projections that may slightly overestimate projected emissions. They consider the recently updated RPS and the retirement dates[65] of the fossil fuel-fired EGUs operating in Nevada. These projections could be improved in future years with a more complete understanding of the effects of the wholesale market on electricity produced and consumed in Nevada. Again, for years when projected demand is greater than projected generation, it is assumed that the wholesale market is used to provide coverage. When projected generation is greater than projected demand, the analysis only assumes that EGUs are curtailed until projected generation is equal to projected demand. It is likely however, that wholesale purchases of electricity will sometimes be more cost effective than operating peaker and intermediate load units.

[65] In considering retirement dates for Nevada's existing fossil fuel-fired EGUs, the analysis looked at planned retirement dates (as submitted to the EIA), depreciation-based retirement dates (as included in the utility IRP and approved by the PUCN), and the remaining useful life of the EGUs (as determined using an historical average of similarly-sized and operated EGUs when the first two options are unavailable).

# Industry

**Figure 5-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with Industry Emissions Emphasized, 1990–2039, with Projections Beginning in 2017**

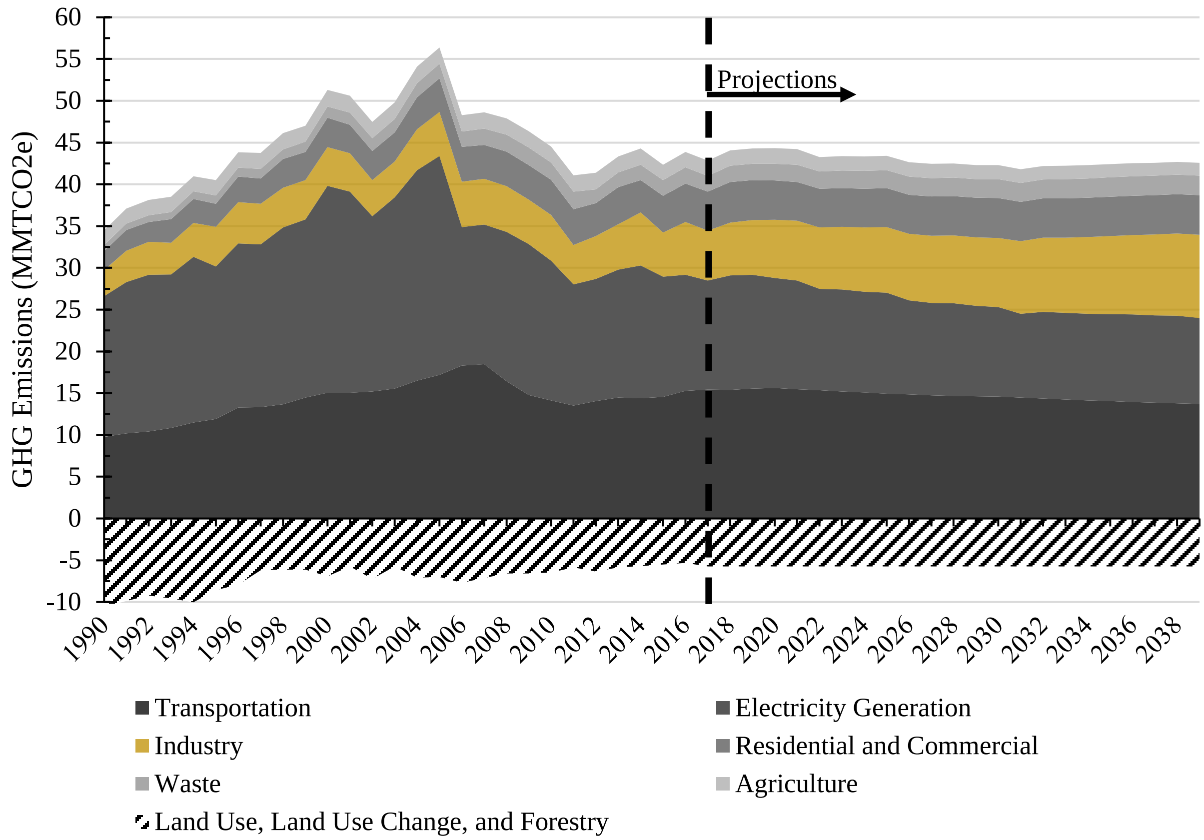
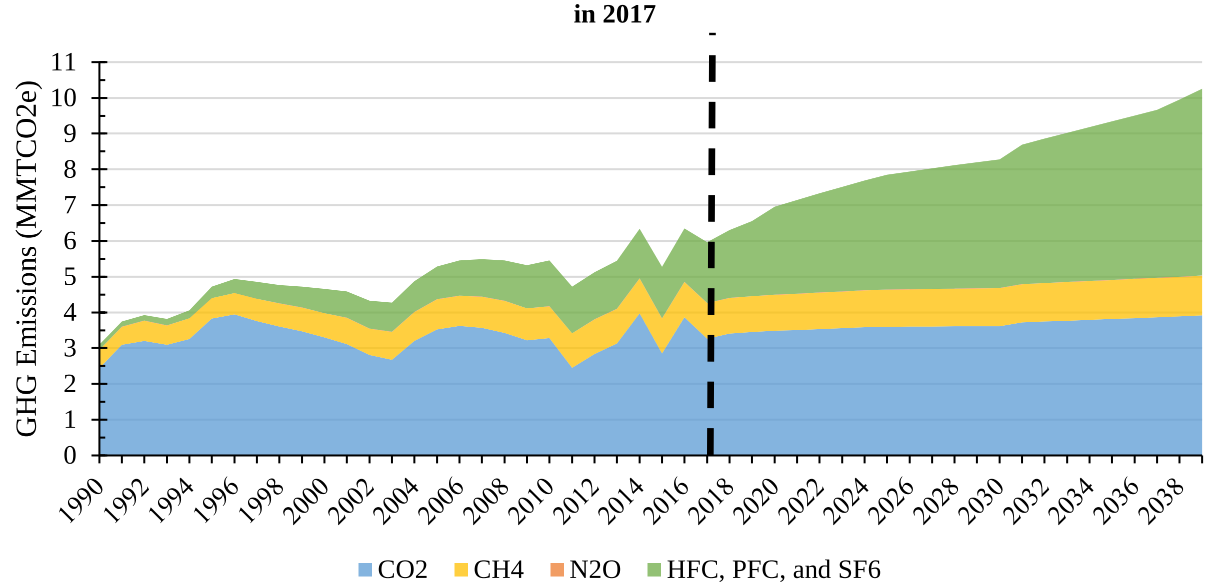



**Figure 5-2: Industry GHG Emissions by GHG, 1990–2039, with Projections Beginning in 2017**

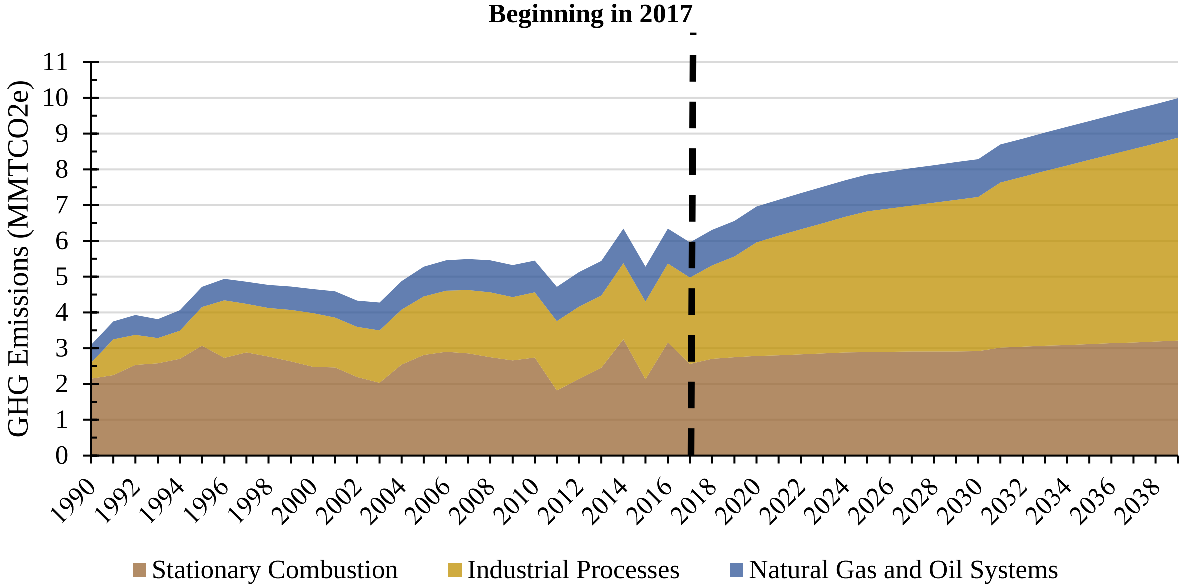


## 5.1 Overview

Industrial sector GHG emissions for 2016 are estimated to be 6.345 MMTCO2e and accounted for 14.5% of the State's total GHG emissions. This sector includes the emissions from the stationary combustion of fossil fuels utilized by industry (hereafter, stationary combustion), the emissions created as a byproduct of industrial processes (either from the manufacturing process or the usage/consumption of the final product) (hereafter, industrial processes), and the fugitive emissions from natural gas (production, flaring, and transmission) and oil (production refining and transportation) systems (hereafter, natural gas and oil systems). The GHGs emitted in this sector are $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, and $SF_6$.[66]

Total industry emissions are illustrated by GHG for 1990 through 2039 in Figure 5-2 and Figure 5-3 shows the relative contributions of the three sub-sectors on total industry GHG emissions for 1990 through 2039. Stationary combustion was still the largest sub-sector of industry emissions in 2016 (apart from 2015), but industrial process emissions are projected to continue to increase and become the largest sub-sector of industry emissions by 2019, as emissions associated with Ozone Depleting Substance (ODS) substitutes increases to more than 5.100 MMTCO2e. Emissions from this sector were 5.281 MMTCO2e in 2005, and are projected to be 7.852 MMTCO2e in 2025 and 8.282 MMTCO2e in 2030. As a whole, industry will account for more than 23% of the GHG emissions in Nevada in 2039.

**Figure 5-3: Industry Total GHG Emissions by Sub-Sector, 1990-2039 with Projections Beginning in 2017**




Emissions from the stationary combustion of fossil fuels utilized by industry includes the combustion of natural gas, coal, and petroleum products. This sub-sector accounted for 3.160 MMTCO2e emissions in 2016. The SIT also considers in this sub-sector some industrial processes (examples include, road asphalting or synthetic rubber production) that consume fossil fuels in a manner that permanently stores that fuel into the final product with no emissions into the atmosphere (these potential emissions are

[66] The GWPs of various HFCs and PFCs are listed in Table 1-1.

subtracted from the sub-sector total). Table 5-1 lists the fossil fuels consumed by this sub-sector and considered by the SIT.

**Table 5-1: Industrial Stationary Combustion Sub-Sector Fuels Consumed**[67]

| Fuel Type | Fuel Sub-Type |
|---|---|
| Coal | Coking Coal<br>Independent Power Coal<br>Coal<br>Other Coal |
| Natural gas | Natural Gas |
| Petroleum Products | Distillate Fuel<br>Kerosene<br>LPG<br>Motor Gasoline<br>Residual Fuel<br>Lubricants<br>Asphalt and Road Oil<br>Crude Oil<br>Feedstocks<br>    Naphthas < 401 degrees Fahrenheit<br>    Other Oils > 401 degrees Fahrenheit<br>Miscellaneous Petroleum Products<br>Petroleum Coke<br>Pentanes Plus<br>Still Gas<br>Special Naphthas<br>Unfinished Oils<br>Waxes<br>Aviation Gasoline Blending Components<br>Motor Gasoline Blending Components |
| Wood | Wood |

Industrial process emissions considers the emissions associated with cement manufacturing, lime manufacturing, limestone and dolomite use, soda ash use, urea consumption, ODS substitutes, semiconductor manufacturing, and electric power transmission and distribution systems.[68] Emissions from the industrial process sub-sector accounted for 2.204 MMTCO2e emissions in 2016. The sources of emissions from individual industrial processes are listed in Table 5-2.

**Table 5-2: Industrial Process Emissions Sources Detailed**[69]

| Process | Source of Emissions |
|---|---|
| Cement Manufacturing | Emissions are produced during the cement clinker production processes. |
| Lime Manufacturing | Lime is manufactured by heating limestone (or calcium carbonate, $CaCO_3$) in a kiln, creating lime (or calcium oxide, CaO) and $CO_2$. |

[67] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Stationary Combustion Module. US Environmental Protection Agency; 2018 Nov. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[68] The SIT considers other industrial processes that are not included in this list as there were zero emissions associated with these processes in Nevada. That is, these processes do not currently exist in-state.
[69] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Industrial Processes Module. US Environmental Protection Agency; 2018 Nov. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

| Process | Source of Emissions |
|---|---|
| Limestone and Dolomite Use | $CO_2$ is emitted as a by-product from the reaction of limestone or dolomite with the impurities in iron ore and fuels heated in a blast furnace. |
| Soda Ash Use | The soda ash production method in some states uses trona (an ore from which natural soda ash is made) and is calcined (an indirect high-temperature processing within a controlled atmosphere) in a rotary kiln and transformed into a crude soda ash that requires further processing. $CO_2$ and water are generated as a by-product of the calcination process. $CO_2$ is also released when soda ash is consumed in products such as glass, soap, and detergents. |
| Urea Consumption | $CO_2$ is released when urea is consumed. |
| ODS Substitutes | ODS substitutes, or hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), are used as alternatives to several classes of ODSs. These alternatives are used in vehicle air conditioning, industrial, residential, and commercial refrigeration and air conditioning, aerosols, solvent cleaning, fire extinguishing, foam production, and sterilization. |
| Semiconductor Manufacturing | The semiconductor manufacturing process uses multiple long-lived fluorinated gases in the plasma etching and chemical vapor deposition processes and includes the PFCs $CF_4$, $C_2F_6$, and $C_3F_8$ as well as HFC-23 and $SF_6$. |
| Electric Power Transmission and Distribution Systems | Electric power and distribution systems consume $SF_6$. It is used as an electrical insulator in electricity transmission and distribution equipment such as gas-insulated high-voltage circuit breakers, substations, transformers, and transmission lines. |

Fugitive emissions from natural gas (production, flaring, transmission, and distribution) and oil (production, refining, and transportation) systems in Nevada are generally the result of the transmission (the transport through large pipelines) and distribution (the delivery from the pipeline to end users) of natural gas. There is very little natural gas and oil production in Nevada.[70] Emissions from the transmission of natural gas are the result of chronic leaks, compressor station fugitive emissions, compressor station exhaust, vents, and pneumatic devices. Emissions from the distribution of natural gas are the result of chronic leaks, meters, regulators, and sometimes mishaps.[71]

## 5.2 Methodology

### 5.2.1 Industry Emissions from Stationary Combustion

Stationary combustion sub-sector GHG emissions are the result of fossil fuel combustion and (to a much lesser extent) the byproducts ($CH_4$ and $N_2O$) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *$CO_2$ from Fossil Fuel Combustion* module estimates $CO_2$ emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. $CO_2$ emissions are the direct result of the combustion of fuel and are determined by analyzing the type and quantity of fuel combusted. $CO_2$ emissions from fossil fuel combustion also include all of the carbon in fuels that are either immediately oxidized or are oxidized within a period of less than 20 years. That means that in addition to $CO_2$, it includes gases like CO and short-lived compounds that decompose quickly.

[70] Sources of emissions from the production of natural gas are compressor station fugitive emissions and compressor station exhaust, vents, pneumatic devices, and blowdown. Emissions from oil production and transportation can be the result of pneumatic devices, system components, process vents, starting and stopping reciprocating engines or turbines, and emissions during drilling activities.

[71] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Natural Gas and Oil Module. US Environmental Protection Agency; 2018 Nov. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

The *$CH_4$ and $N_2O$ Emissions from Stationary Combustion* module estimates $CH_4$ and $N_2O$ emissions (the byproducts of fossil fuel consumption) by applying emission factors for the individual fuel types (examples include coal, natural gas, and petroleum products) to annual fuel consumption (provided by the EIA). $CH_4$ and $N_2O$ emissions vary with the type of fuel burned, the size and age of the combustion technology, the maintenance and operating conditions of the combustion equipment, and the types of pollution control technologies installed. This module also considers the quantity of fossil fuels used for non-energy consumption in a manner that permanently stores the final product with no emissions into the atmosphere. The emissions that would be associated with these fossil fuels are considered sequestered emissions, and are subtracted from the sub-sector total. Examples include the use of LPG for the production of solvents and synthetic rubber and oil to produce asphalt.

$CH_4$ emissions are generally the product of incomplete combustion. More are released when combustion temperatures are relatively low. Larger, higher efficiency combustion units tend to reach and sustain higher temperatures and are thus less likely to emit $CH_4$. Emissions can range well above the average for units that are improperly maintained or poorly operated. Similarly, during start-up periods, combustion efficiency is lowest, causing emissions to be higher than periods of standard operation. $N_2O$ is produced from the combustion of fuels and emissions are dependent on the combustion temperature. The highest $N_2O$ emissions occur at a combustion temperature of 1,340 degrees Fahrenheit (1,000 degrees Kelvin) while $N_2O$ emissions are negligible for combustion temperatures below 980 or above 1,700 degrees Fahrenheit (below 980 and above 1,200 degrees Kelvin).

Stationary combustion GHG emissions are projected using the SIT's *Greenhouse Gas Projection Tool* from 2017 through 2030 and a linear trend of these projections is applied through 2039. The projection tool uses EIA State Energy Data and the EIA AEO Reference Case in order to estimate state level fuel consumption. Fuel consumption estimates are then subjected to the same quantification method as the *$CO_2$ from Fossil Fuel Combustion* and *$CH_4$ and $N_2O$ Emissions from Stationary Combustion* modules.

### 5.2.2 Industry Emissions from Industrial Processes

Generally, the *Industrial Processes* module estimates GHG emissions by either (1) considering the amount of a material produced (produced materials in Nevada being cement, lime, limestone, and dolomite) and applying an emission factor to the processes resulting in an estimate of emissions, or (2) by attributing emissions to the usage/consumption of a material (limestone, dolomite, soda ash, urea, ODS substitutes, semiconductors, and electric power transmission and distribution systems), either directly by knowing the quantity of the material used/consumed in the state and applying an emission factor, or indirectly by knowing the amount of the material used/consumed nationally, applying an emission factor, and prorating emissions based on a state's population or, in the case of semiconductor manufacturing, the value of a state's semiconductor shipments.

For production-based industrial process GHG emissions, projections use the post-Great Recession historical average to estimate emissions. The projection tool method of applying a linear trend to historical emissions is not used in this instance as there is uncertainty surrounding the maximum in-state production capacity of any of the materials considered by the SIT and how increased demand would be handled.

For usage/consumption-based industrial process GHG emissions, usage/consumption is first estimated. National emissions estimates for 2017 through 2030 are used for both their projected usage/consumption, and then again to project through 2039 using a linear trend. Then, estimates of US and Nevada populations are applied to the datasets to prorate Nevada's emissions from 2017 through 2039. In the case of semiconductor manufacturing emissions, there is a high degree of uncertainty as to the accuracy of the historical and projected emissions estimates for Nevada.

### 5.2.3 Industry Emissions from Natural Gas and Oil Systems

The *Emissions from Natural Gas and Oil Systems* module estimates emissions from every step of the production through to the delivery of natural gas and oil. Generally, the module considers every activity where the fossil fuel is transferred from one containment vessel to another in the production to delivery process and applies an emission factor associated with leakages that occur during that transference. As an example, for the transmission of natural gas, the module considers the miles of gathering pipeline, number of processing stations, number of LNG storage compressor stations, miles of transmission pipeline, number of gas transmission compressor stations, and the number of gas storage compressor stations before applying emissions factors and estimating emissions.

Projections for natural gas and oil systems emissions use a modified version of the projection tool's methods to project emissions from 2017 through 2039. That is, a linear trend of only post-recession emissions is used to project future emissions rather than a linear trend of the entirety of the historical dataset. This change in method results in more accurate near-term emissions estimates.

## 5.3 GHG Emissions, 1990-2016

As industry sector emissions are tied to production and consumption/usage, emissions are driven by increases in population, except if less GHG intensive replacements are introduced and widely adopted. Sector emissions are estimated to be 5.281 MMTCO2e for 2005 and 6.345 MMTCO2e for 2016. Figure 5-4 shows industry emissions in Nevada by GHG from 1990 through 2016 and Table 5-3 lists industry GHG emissions in Nevada for select years.

**Figure 5-4: Industry GHG Emissions in Nevada by GHG, 1990-2016**

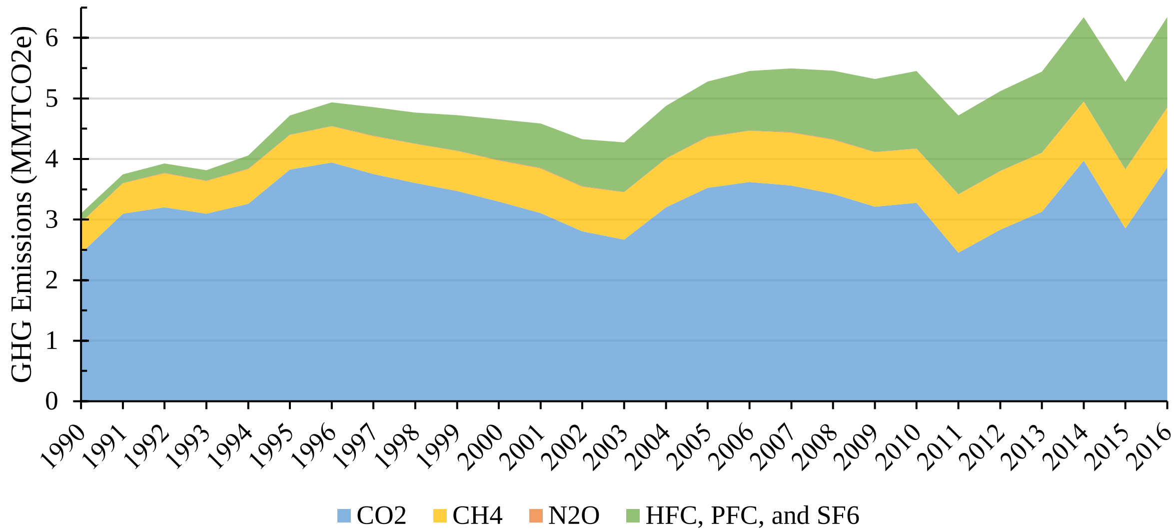



**Table 5-3: Industry GHG Emissions in Nevada by GHG, Select Years (MMTCO2e)**

| GHG | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 2.443 | 3.825 | 3.300 | 3.522 | 3.278 | 3.127 | 3.973 | 2.852 | 3.862 |
| $CH_4$ | 0.505 | 0.571 | 0.675 | 0.839 | 0.890 | 0.972 | 0.971 | 0.974 | 0.986 |
| $N_2O$ | 0.006 | 0.009 | 0.007 | 0.009 | 0.008 | 0.007 | 0.009 | 0.006 | 0.008 |
| HFC, PFC, and $SF_6$ | 0.145 | 0.314 | 0.673 | 0.912 | 1.276 | 1.337 | 1.390 | 1.444 | 1.489 |
| **Total Emissions** | **3.099** | **4.718** | **4.655** | **5.281** | **5.452** | **5.442** | **6.342** | **5.276** | **6.345** |

### 5.3.1 Industry Emissions from Stationary Combustion

The stationary combustion of fossil fuels has been the largest sub-sector of industry emissions since 1990. Figure 5-5 illustrates stationary combustion sub-sector GHG emissions in Nevada by fuel type and Table 5-4 lists stationary combustion sub-sector GHG emissions in Nevada by fuel type for select years. Petroleum-related usage is both the largest contributor of sub-sector emissions and also the most prone to significant year-to-year variability in emissions as shown in Table 5-5, which lists the annual changes in stationary combustion GHG emissions by fuel type from 2011 through 2016.

**Figure 5-5: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 1990-2016 (MMTCO2e)**

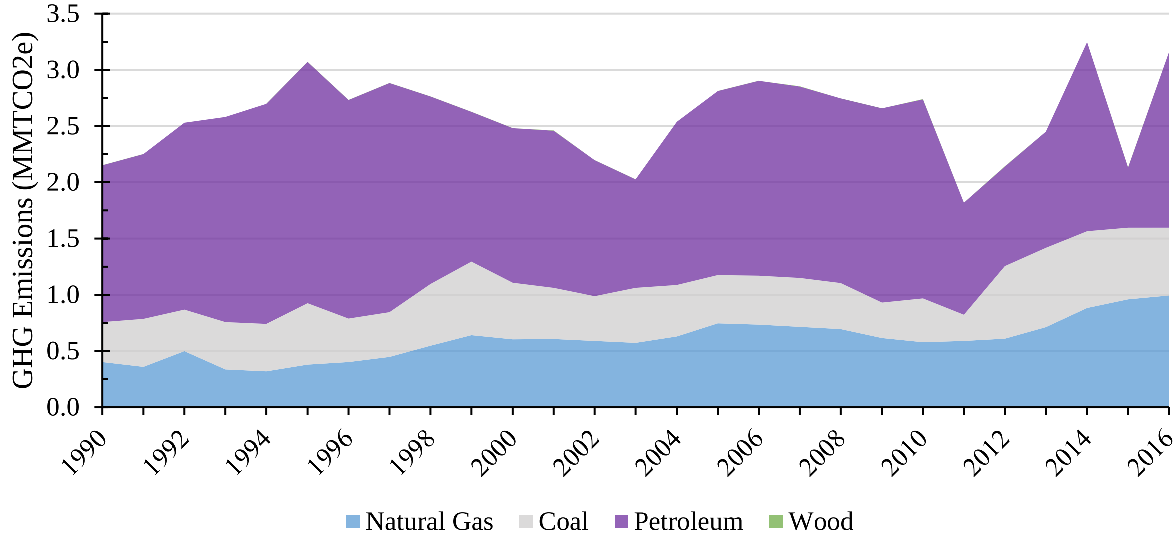



**Table 5-4: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)**

| Fuel Type | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 0.403 | 0.378 | 0.604 | 0.746 | 0.577 | 0.711 | 0.883 | 0.959 | 0.994 |
| Coal | 0.353 | 0.549 | 0.502 | 0.429 | 0.391 | 0.708 | 0.684 | 0.637 | 0.602 |
| Petroleum | 1.395 | 2.145 | 1.376 | 1.635 | 1.770 | 1.030 | 1.680 | 0.537 | 1.564 |
| Wood | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| **Total Emissions** | **2.151** | **3.072** | **2.483** | **2.812** | **2.739** | **2.449** | **3.247** | **2.133** | **3.160** |

**Table 5-5: Annual Change in Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 2011-2016 (MMTCO2e and Percent)**

| Fuel Type | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 0.019 | 3.31% | 0.102 | 16.79% | 0.172 | 24.23% | 0.076 | 8.56% | 0.035 | 3.66% |
| Coal | 0.413 | 176.88% | 0.062 | 9.55% | -0.025 | -3.47% | -0.047 | -6.83% | -0.035 | -5.50% |
| Petroleum | -0.109 | -10.95% | 0.143 | 16.18% | 0.650 | 63.12% | -1.143 | -68.01% | 1.026 | 191.00% |
| Wood | 0.000 | 0.00% | 0.000 | 0.00% | 0.000 | 2.65% | 0.000 | 0.00% | 0.000 | 0.00% |
| **Totals** | **0.323** | **17.79%** | **0.307** | **14.35%** | **0.798** | **32.58%** | **-1.114** | **-34.30%** | **1.027** | **48.12%** |

### 5.3.2 Industry Emissions from Industrial Processes

Industrial process sub-sector GHG emissions were estimated to be 2.204 MMTCO2e in 2016. Figure 5-6 illustrates individual industrial process sub-sector GHG emissions in Nevada for 1990 through 2016 and Table 5-6 lists individual industrial process sub-sector GHG emissions in Nevada for select years. As Nevada's population and economy grows, industrial process emissions have continued to grow with it. There is no immediate substitute for the final products — cement, lime, air conditioning and refrigeration, and semiconductors — of these industrial processes nor for the ways in which these materials are processed. Until there is, emissions are expected to continue to increase in Nevada and across the country.

**Figure 5-6: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, 1990-2016 (MMTCO2e)**

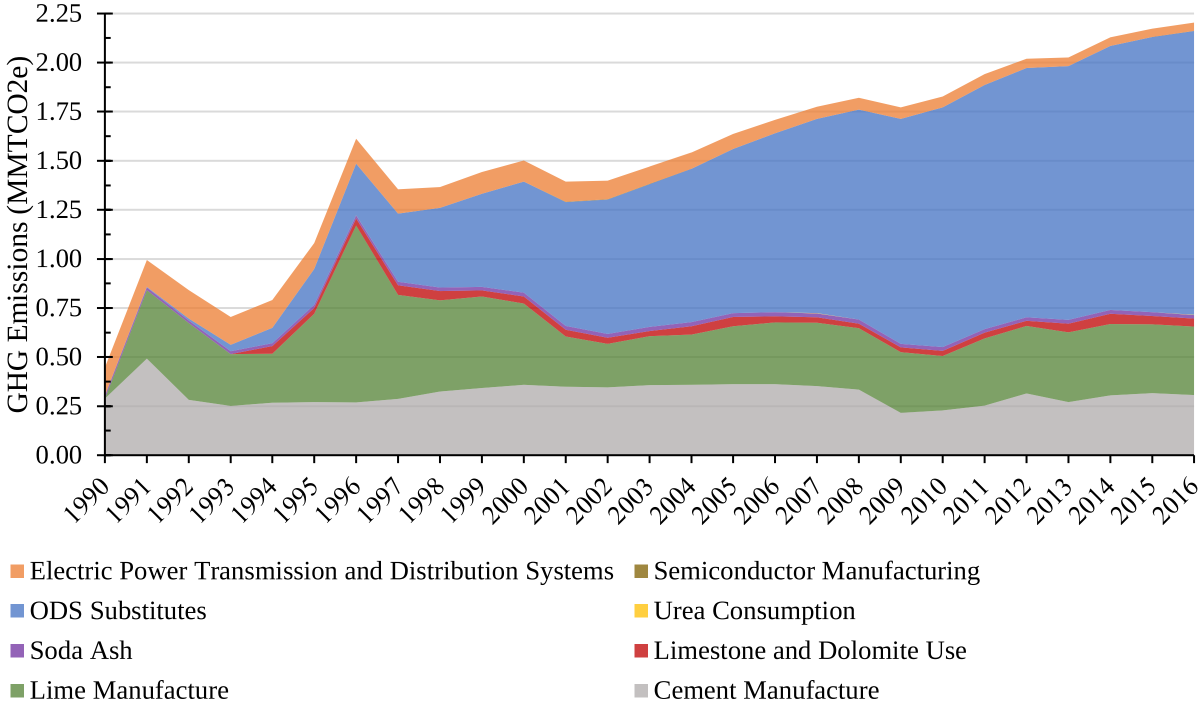



**Table 5-6: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, Select Years (MMTCO2e)**

| Process | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Cement Manufacture | 0.288 | 0.270 | 0.359 | 0.362 | 0.229 | 0.271 | 0.304 | 0.316 | 0.306 |
| Lime Manufacture | 0.000 | 0.451 | 0.414 | 0.295 | 0.276 | 0.355 | 0.365 | 0.350 | 0.350 |
| Limestone and Dolomite Use | 0.000 | 0.029 | 0.036 | 0.047 | 0.027 | 0.044 | 0.051 | 0.044 | 0.040 |
| Soda Ash | 0.013 | 0.016 | 0.019 | 0.021 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| Urea Consumption | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ODS Substitutes | 0.001 | 0.182 | 0.566 | 0.835 | 1.221 | 1.293 | 1.345 | 1.402 | 1.446 |
| Semiconductor Manufacturing | - | - | 0.001 | - | - | - | - | - | - |
| Electric Power Transmission and Distribution Systems | 0.144 | 0.131 | 0.106 | 0.076 | 0.055 | 0.043 | 0.045 | 0.042 | 0.043 |
| **Total Emissions** | **0.446** | **1.080** | **1.501** | **1.636** | **1.827** | **2.026** | **2.129** | **2.172** | **2.204** |

Consistent sub-sector annual growth in emissions is due to ODS substitutes. Emissions from ODS substitutes have increased year-over-year, every year, since 1990. ODS substitutes, or HFCs and PFCs, are used as alternatives to several classes of ODSs that are being phased out under the terms of the Montreal Protocol and the Clean Air Act Amendments of 1990.[72] Although not harmful to the ozone layer, they are potent GHGs with GWPs sometimes several orders of magnitude larger than $CO_2$ (refer to

[72] US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, p4-112.

Table 1-1). Table 5-7 lists the annual change of individual industrial process sub-sector GHG emissions in Nevada from 2011 through 2016.

**Table 5-7: Annual Change in Industrial Process Sub-Sector GHG Emissions in Nevada by Process, 2011-2016 (MMTCO2e and Percent)**

| Process | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cement Manufacture | 0.064 | 25.21% | -0.044 | -13.96% | 0.033 | 12.03% | 0.012 | 4.03% | -0.010 | -3.26% |
| Lime Manufacture | 0.000 | 0.12% | 0.012 | 3.39% | 0.010 | 2.86% | -0.015 | -4.14% | 0.000 | 0.00% |
| Limestone and Dolomite Use | -0.003 | -10.74% | 0.018 | 68.60% | 0.007 | 15.93% | -0.008 | -15.42% | -0.004 | -8.55% |
| Soda Ash | 0.000 | -1.02% | 0.000 | 1.50% | 0.000 | 1.85% | 0.000 | -2.52% | 0.001 | 3.97% |
| Urea Consumption | 0.000 | -18.72% | 0.000 | -2.22% | 0.000 | 30.48% | 0.000 | -21.35% | 0.000 | -2.24% |
| ODS Substitutes | 0.026 | 2.13% | 0.024 | 1.86% | 0.051 | 3.98% | 0.057 | 4.24% | 0.044 | 3.16% |
| Semiconductor Manufacturing | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - |
| Electric Power Transmission and Distribution Systems | -0.010 | -17.77% | -0.003 | -5.63% | 0.001 | 3.07% | -0.003 | -5.66% | 0.001 | 1.60% |
| **Totals** | **0.077** | **3.97%** | **0.007** | **0.34%** | **0.103** | **5.09%** | **0.043** | **2.03%** | **0.032** | **1.46%** |

### 5.3.3 Industry Emissions from Natural Gas and Oil Systems

Natural gas and oil systems sub-sector GHG emissions were estimated to be 0.981 MMTCO2e in 2016. Due to the absence of a coal industry in Nevada and the limited natural gas and oil production that does take place, fugitive emissions from natural gas and oil systems represent a small portion of total GHG emissions. Transmission and distribution of natural gas are the major sources of GHG emissions in this sub-sector. Nevada is both a net importer of natural gas (and oil) as well as a "throughway" for natural gas passing through Nevada from where it is produced to where it is used. Table 5-8 shows natural gas and oil systems sub-sector GHG emissions in Nevada by fuel type for select years and Table 5-9 shows the annual change in natural gas and oil systems GHG emissions by fuel type from 2011 through 2016.

**Table 5-8: Natural Gas and Oil Systems Industry Sub-Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)**

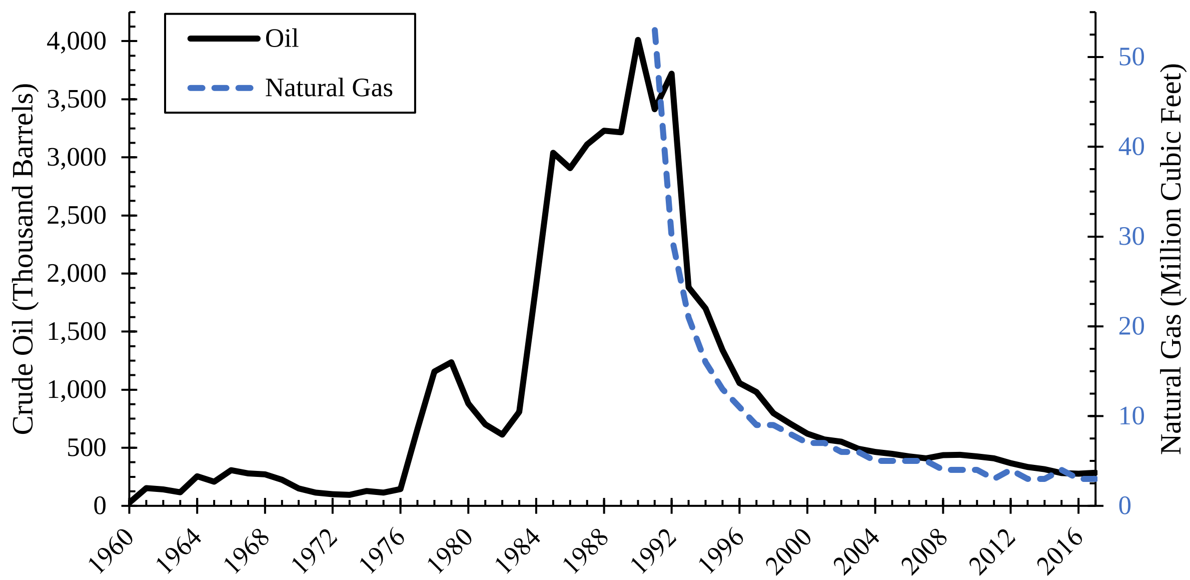
| Fuel Type | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 0.410 | 0.534 | 0.656 | 0.821 | 0.874 | 0.961 | 0.961 | 0.967 | 0.978 |
| *Production* | *0.001* | *0.001* | *0.001* | *0.001* | *0.001* | *0.001* | *0.001* | *0.001* | *0.001* |
| *Transmission* | *0.231* | *0.291* | *0.321* | *0.396* | *0.371* | *0.449* | *0.448* | *0.448* | *0.456* |
| *Distribution* | *0.177* | *0.241* | *0.333* | *0.424* | *0.501* | *0.511* | *0.512* | *0.517* | *0.521* |
| Oil | 0.092 | 0.032 | 0.015 | 0.012 | 0.011 | 0.006 | 0.005 | 0.004 | 0.003 |
| **Total Emissions** | **0.502** | **0.566** | **0.671** | **0.833** | **0.885** | **0.967** | **0.966** | **0.970** | **0.981** |

**Table 5-9: Annual Change in Natural Gas and Oil Systems Sub-Sector GHG Emissions in Nevada by Fuel Type, 2011-2016 (MMTCO2e and Percent)**

| Fuel Type | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Natural Gas | 0.007 | 0.73% | 0.007 | 0.78% | 0.000 | -0.01% | 0.006 | 0.62% | 0.011 | 1.11% |
| *Production* | *0.000* | *0.00%* | *0.000* | *0.00%* | *0.000* | *0.00%* | *0.000* | *0.00%* | *0.000* | *0.00%* |
| *Transmission* | *0.003* | *0.77%* | *0.005* | *1.21%* | *-0.002* | *-0.35%* | *0.001* | *0.15%* | *0.007* | *1.63%* |
| *Distribution* | *0.004* | *0.70%* | *0.002* | *0.42%* | *0.001* | *0.28%* | *0.005* | *1.03%* | *0.003* | *0.66%* |
| Oil | -0.003 | -24.00% | -0.002 | -24.40% | -0.001 | -21.47% | -0.001 | -23.87% | 0.000 | -3.96% |
| **Totals** | **0.011** | **0.59%** | **0.013** | **0.68%** | **-0.002** | **-0.08%** | **0.011** | **0.56%** | **0.021** | **1.10%** |

The production of natural gas and oil in Nevada peaked in the early 1990's. Natural Gas production peaked in 1991, the EIA's first year of recorded commercial production estimates, at 53 million cubic feet and oil production in Nevada peaked in 1990 when the state produced just more than 4 million barrels. From 2011 through 2017 production in the industry has been relatively stagnant with natural gas production averaging roughly 9,300 cubic feet per day and oil production averaging roughly 936 barrels per day. Figure 5-7 shows EIA historical production estimates of natural gas and oil in Nevada from 1960 through 2017.[73]

**Figure 5-7: EIA Historical Natural Gas and Oil Production Estimates for Nevada, 1960-2017**




## 5.4 Projected Emissions, 2017-2039

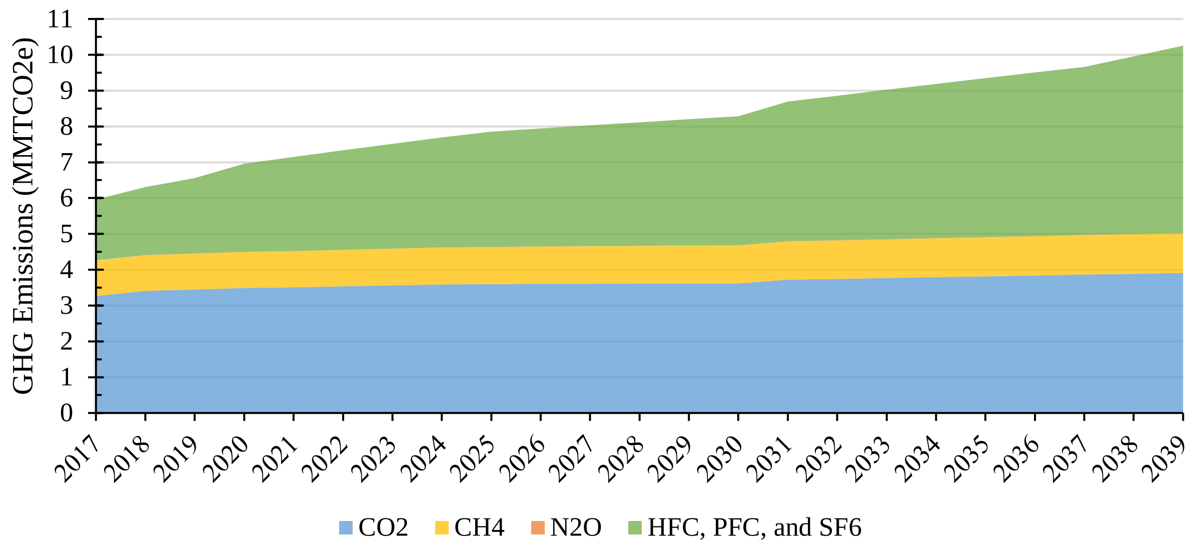
Industry GHG emissions in Nevada are projected to continue to increase through 2039 with emissions in 2025 projected to be 7.852 MMTCO2e, emissions in 2030 projected to be 8.282 MMTCO2e, and emissions in 2039 projected to reach 10.255 MMTCO2e. Figure 5-8 illustrates industry GHG emissions projections in Nevada by GHG from 2017 through 2039. HFC, PFC, and $SF_6$ emissions are projected to increase by more than 250% as our reliance on ODS substitutes, and Nevada's population, continues to

[73] US Energy Information Administration State Energy Data System [accessed 2019 Oct 1]. https://www.eia.gov/state/seds/

grow. Figure 5-9 illustrates industry emissions projections by sub-sector and shows that industrial processes are the main source of future emission increases in this sector.

It's also important to note the uncertainty surrounding future natural gas and oil systems emissions. While a relatively minor source of GHG emissions in Nevada, with projections from the sub-sector staying between 1 and 1.1 MMTCO2e from 2017 through 2039 (Figure 5-9), the projections provided in this report depend on the EIA AEO, which assumes the 2012 and 2016 air quality new source performance standards (NSPS) for natural gas and oil systems will remain in effect; which, when finalized, were intended to reduce leakage of $CH_4$ and other GHGs in the oil and gas industry through better maintenance practices. The EPA has proposed a rollback of these standards.[74] If finalized as proposed, it "would remove sources in the transmission and storage segment of the oil and gas industry from regulation. These sources include transmission compressor stations, pneumatic controllers, and underground storage vessels."[75] It would also remove emissions reporting requirements related to $CH_4$. This will result in an increase of GHG emissions in the sub-sector and in Nevada.

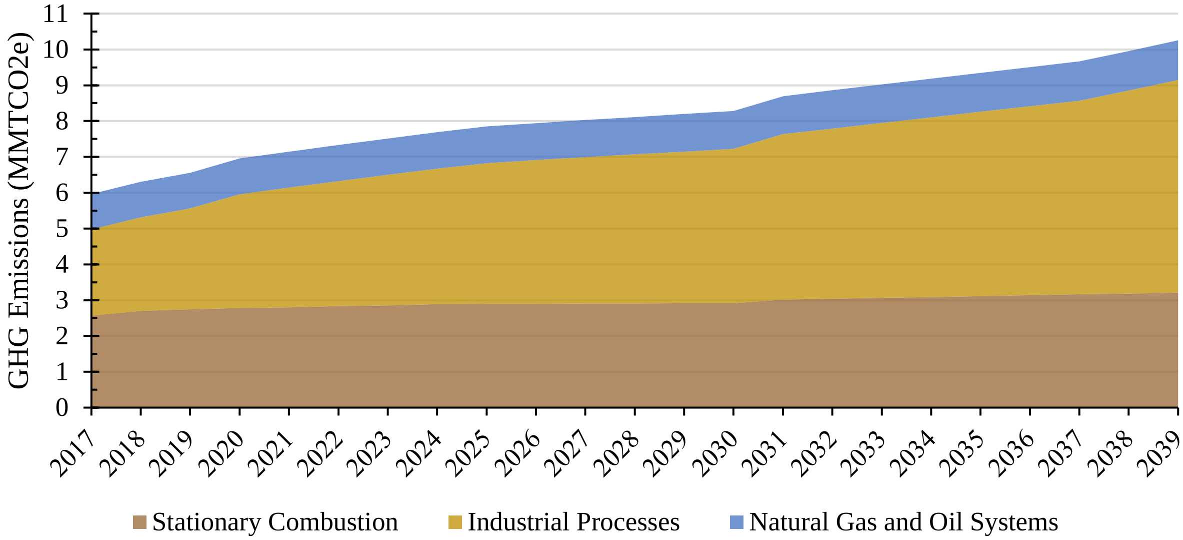
**Figure 5-8: Industry GHG Emissions Projections in Nevada by GHG, 2017-2039**




[74] US Environmental Protection Agency. Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review. Federal Register. 2019 Sep 24; Vol 84, No. 185, Proposed Rules, 23414. https://www.govinfo.gov/content/pkg/FR-2019-09-24/pdf/2019-19876.pdf

[75] US Environmental Protection Agency. Natural Gas and Oil Rule Press Release. US Environmental Protection Agency Press Office; 2019 Aug 29. [accessed 2019 Oct 30]. https://www.epa.gov/newsreleases/epa-proposes-updates-air-regulations-oil-and-gas-remove-redundant-requirements-and

**Figure 5-9: Industry GHG Emissions Projections in Nevada by Sub-Sector, 2017-2039**



# Residential and Commercial

**Figure 6-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with Residential and Commercial Sector Emphasized, 1990–2039, with Projections Beginning in 2017**

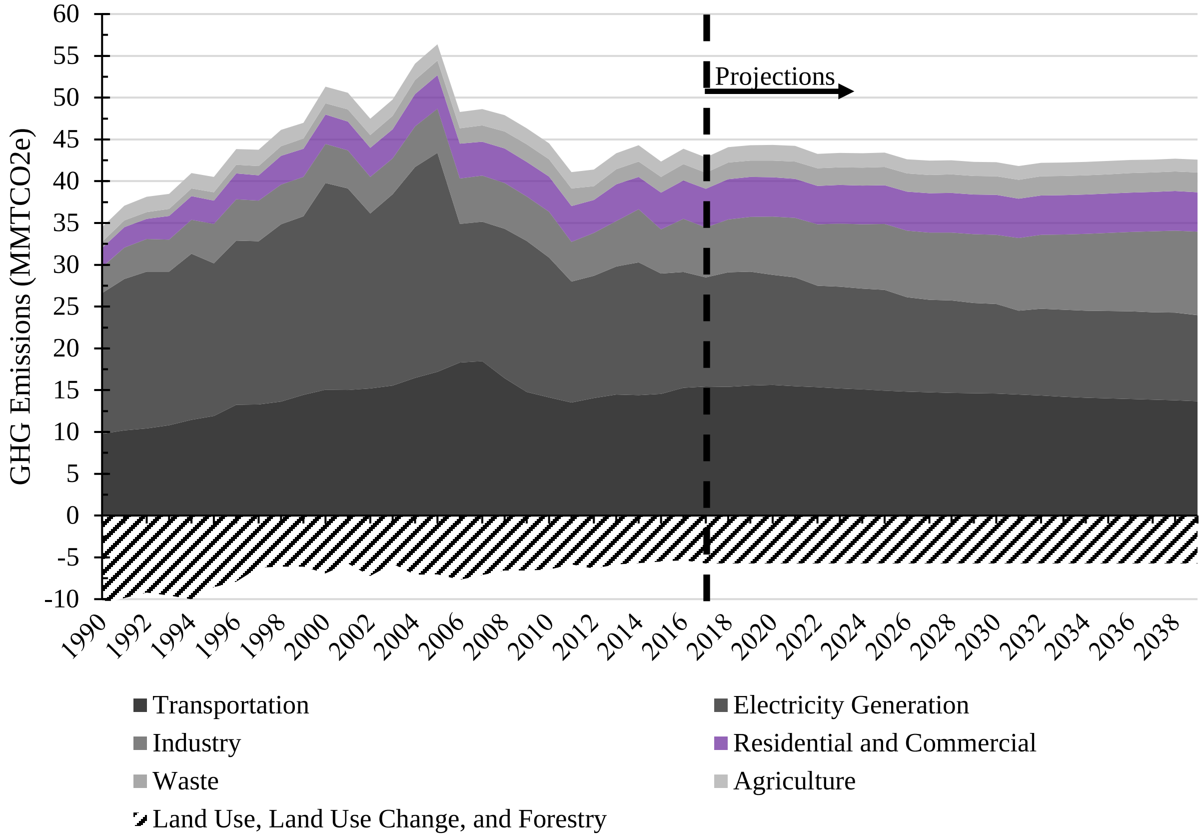
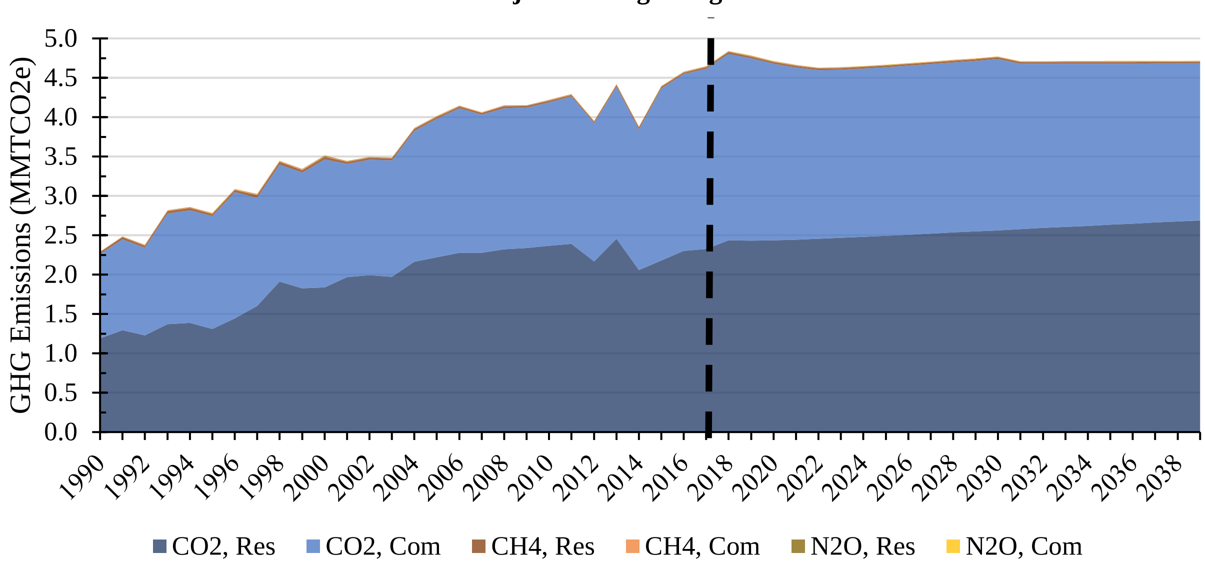



**Figure 6-2: Residential and Commercial Sector GHG Emissions by GHG, 1990–2039, with Projections Beginning in 2017**



## 6.1 Overview

GHG emissions from the residential and commercial sectors are associated with the combustion of fossil fuels by residences and commercial entities. Emissions in 2016 totaled 4.578 MMTCO2e and accounted for 10% of the State's total GHG emissions. Emissions are projected to be 4.717 MMTCO2e by 2039, an increase of 0.139 MMTCO2e above 2016 levels. Shown in Figure 6-2, residential and commercial sector emissions are predominantly $CO_2$ emissions. $CH_4$ and $N_2O$ emissions accounted for less than 1% of sector emissions in 2016. Residential and commercial sector emissions are tied directly to the population, economy, and quality of the built environment (that is, when homes and businesses were built and/or how recently they were retrofitted with new windows, insulation, and appliances). Homes and businesses use fossil fuels for heating, cooking, refrigeration, and in some cases generating electricity; more recent building codes and requirements for appliance manufacturers mean that newly constructed buildings are more energy efficient and resilient to increasingly hot summers and cold winters. Emissions from this sector were 4.015 MMTCO2e in 2005, and are projected to be 4.666 MMTCO2e in 2025 and 4.772 MMTCO2e in 2030.

## 6.2 Methodology

Sector GHG emissions are the result of fossil fuel combustion and (to a much lesser extent) the byproducts ($CH_4$ and $N_2O$) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *$CO_2$ from Fossil Fuel Combustion* module estimates $CO_2$ emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. $CO_2$ emissions are the direct result of the combustion of fuel and are determined by analyzing the type and quantity of fuel combusted. $CO_2$ emissions from fossil fuel combustion also include all of the carbon in fuels that are either immediately oxidized or are oxidized within a period of less than 20 years. That means that in addition to $CO_2$, it includes gases like CO and short-lived compounds that decompose quickly.

The *$CH_4$ and $N_2O$ Emissions from Stationary Combustion* module estimates $CH_4$ and $N_2O$ emissions (the byproducts of fossil fuel consumption) by applying emission factors for the individual fuel types (examples include coal, natural gas, and petroleum products) to annual fuel consumption (provided by the EIA).[76] $CH_4$ and $N_2O$ emissions vary with the type of fuel burned, the size and age of the combustion technology, the maintenance and operating conditions of the combustion equipment, and the types of pollution control technologies installed.

$CH_4$ emissions are generally the product of incomplete combustion. More are released when combustion temperatures are relatively low. Higher efficiency combustion is associated with higher temperatures and are thus less likely to emit $CH_4$. Emissions can range well above the average for units that are older, improperly maintained, or poorly operated. Similarly, during start-up periods, combustion efficiency is lowest, causing emissions to be higher than periods of standard operation. Examples units in this sector that could emit higher than average levels of $CH_4$ can include older furnaces or boilers as well as wood fireplaces. $N_2O$ is produced from the combustion of fuels and emissions are dependent on the combustion temperature. The highest $N_2O$ emissions occur at a combustion temperature of 1,340 degrees Fahrenheit

[76] $CH_4$ and $N_2O$ emissions have accounted for less than 1% of sector emissions since 2001.

(1,000 degrees Kelvin) while $N_2O$ emissions are negligible for combustion temperatures below 980 or above 1,700 degrees Fahrenheit (below 980 and above 1,200 degrees Kelvin).

Sector GHG emissions are projected using the SIT's *Greenhouse Gas Projection Tool* from 2017 through 2030 and a linear trend of these projections is applied through 2039. The projection tool uses EIA State Energy Data and the EIA AEO Reference case in order to estimate state level fuel consumption. Fuel consumption estimates are then subjected to the same quantification method as the *$CO_2$ from Fossil Fuel Combustion* and *$CH_4$ and $N_2O$ Emissions from Stationary Combustion* modules.

## 6.3 GHG Emissions, 1990-2016

Residential and commercial sector GHG emissions in 2016 were estimated to be 4.578 MMTCO2e, with residential emissions totaling 2.319 MMTCO2e and commercial emissions totaling 2.259 MMTCO2e. Emissions in 2005 were estimated to be 4.015 MMTCO2e. Figure 6-3 illustrates residential and commercial sector GHG emissions in Nevada by GHG from 1990 through 2016. Sector emissions are directly tied to the State's population and economy. The need for new Nevadans to have places to live and work requires new buildings; this leads to increases in sector emissions as fossil fuels are used. Table 6-1 lists residential and commercial sector GHG emissions in Nevada by fuel type for select years.

**Figure 6-3: Residential and Commercial Sector GHG Emissions in Nevada by GHG, 1990-2016**

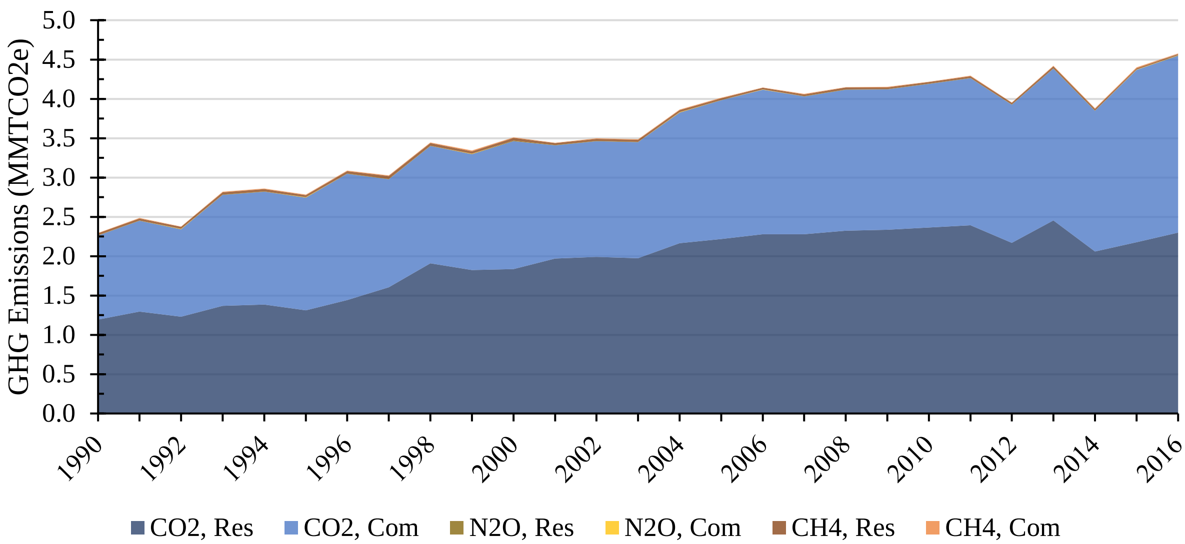


**Table 6-1: Residential and Commercial Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)**

| Fuel Type | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| **Residential Sub-Sector** | | | | | | | | | |
| Natural Gas | 0.941 | 1.137 | 1.641 | 2.021 | 2.173 | 2.294 | 1.932 | 2.049 | 2.165 |
| Coal | 0.001 | 0.000 | - | - | - | - | - | - | - |
| Petroleum | 0.255 | 0.178 | 0.202 | 0.205 | 0.199 | 0.168 | 0.134 | 0.137 | 0.143 |
| Wood | 0.023 | 0.025 | 0.032 | 0.017 | 0.014 | 0.019 | 0.019 | 0.014 | 0.011 |
| **Sub-Total** | **1.221** | **1.341** | **1.875** | **2.244** | **2.386** | **2.481** | **2.084** | **2.200** | **2.319** |
| | | | | | | | | | |
| **Commercial Sub-Sector** | | | | | | | | | |
| Natural Gas | 0.827 | 1.028 | 1.402 | 1.474 | 1.627 | 1.719 | 1.600 | 1.653 | 1.724 |
| Coal | 0.006 | 0.002 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Petroleum | 0.239 | 0.409 | 0.230 | 0.292 | 0.204 | 0.218 | 0.194 | 0.543 | 0.533 |
| Wood | 0.003 | 0.003 | 0.005 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 |
| **Sub-Total** | **1.074** | **1.442** | **1.638** | **1.771** | **1.833** | **1.939** | **1.796** | **2.199** | **2.259** |
| | | | | | | | | | |
| **Total Emissions** | **2.295** | **2.783** | **3.512** | **4.015** | **4.219** | **4.420** | **3.881** | **4.399** | **4.578** |

Table 6-2 lists the annual changes in residential and commercial GHG emissions in Nevada by fuel type from 2011 through 2016. Annual changes in GHG emissions are likely associated with factors such as weather variability and the economy. An especially cold winter means furnaces (and water heaters depending on where they're located) at homes and businesses are run more frequently, resulting in an increase in emissions.

**Table 6-2: Annual Change in Residential and Commercial Sector GHG Emissions in Nevada by Fuel Type, 2011-2016 (MMTCO2e and Percent)**

| Fuel Type | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Residential Sub-Sector** | | | | | | | | | | |
| Natural Gas | -0.169 | -7.62% | 0.250 | 12.25% | -0.362 | -15.80% | 0.117 | 6.05% | 0.116 | 5.65% |
| Coal | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - |
| Petroleum | -0.055 | -29.75% | 0.037 | 28.31% | -0.034 | -20.37% | 0.004 | 2.74% | 0.006 | 4.14% |
| Wood | -0.001 | -6.71% | 0.005 | 38.15% | 0.000 | 1.16% | -0.005 | -25.77% | -0.003 | -19.83% |
| Natural Gas | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - |
| **Sub-Total** | **-0.225** | **-9.32%** | **0.292** | **13.37%** | **-0.396** | **-15.98%** | **0.116** | **5.55%** | **0.119** | **5.40%** |
| | | | | | | | | | | |
| **Commercial Sub-Sector** | | | | | | | | | | |
| Natural Gas | -0.078 | -4.66% | 0.120 | 7.52% | -0.118 | -6.89% | 0.052 | 3.28% | 0.071 | 4.32% |
| Coal | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - |
| Petroleum | -0.037 | -18.09% | 0.053 | 31.94% | -0.025 | -11.31% | 0.350 | 180.67% | -0.011 | -1.99% |
| Wood | 0.000 | -12.40% | 0.000 | 16.04% | 0.000 | 4.07% | 0.000 | 5.08% | 0.000 | 4.83% |
| Natural Gas | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - | 0.000 | - |
| **Sub-Total** | **-0.115** | **-6.11%** | **0.173** | **9.82%** | **-0.143** | **-7.37%** | **0.402** | **22.40%** | **0.061** | **2.76%** |
| | | | | | | | | | | |
| **Totals** | **-0.340** | **-7.92%** | **0.466** | **11.78%** | **-0.539** | **-12.20%** | **0.518** | **13.35%** | **0.179** | **4.08%** |

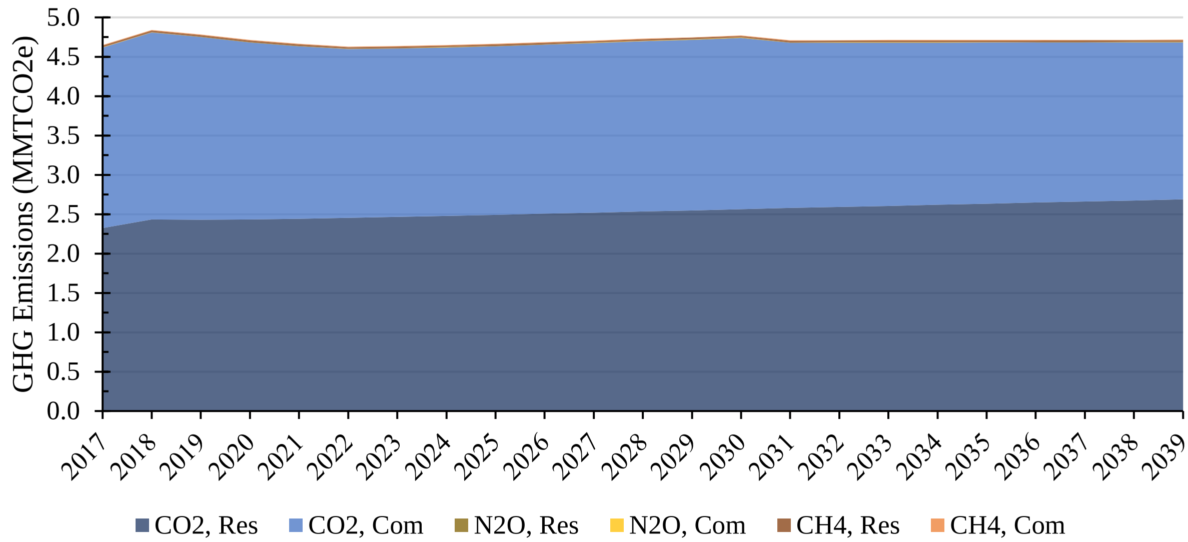
## 6.4 Projected Emissions, 2017-2039

The EIA's AEO Reference case, used by the projection tool, expects building energy consumption to grow gradually through 2050.[77] The Reference case assumes that existing building energy codes and appliance energy efficiency standards will generally offset emissions from new construction related to

[77] Annual Energy Outlook 2018, p119.

increases in the population, though these estimates may be optimistic. Emissions are projected to remain relatively flat through 2039, with emissions in 2025 projected to be 4.666 MMTCO2e, emissions in 2030 projected to be 4.772 MMTCO2e, and 2039 emissions are projected to be 4.717 MMTCO2e. Residential emissions will outpace commercial emissions as 2039 emissions are projected to be 2.714 and 2.003 MMTCO2e, respectively. Figure 6-4 illustrates residential and commercial sector GHG emissions in Nevada by fuel type from 2017 through 2039.

**Figure 6-4: Residential and Commercial Sector GHG Emissions Projections in Nevada by Fuel Type, 2017-2039**



# Waste

**Figure 7-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with the Waste Emphasized, 1990–2039, with Projections Beginning in 2017**

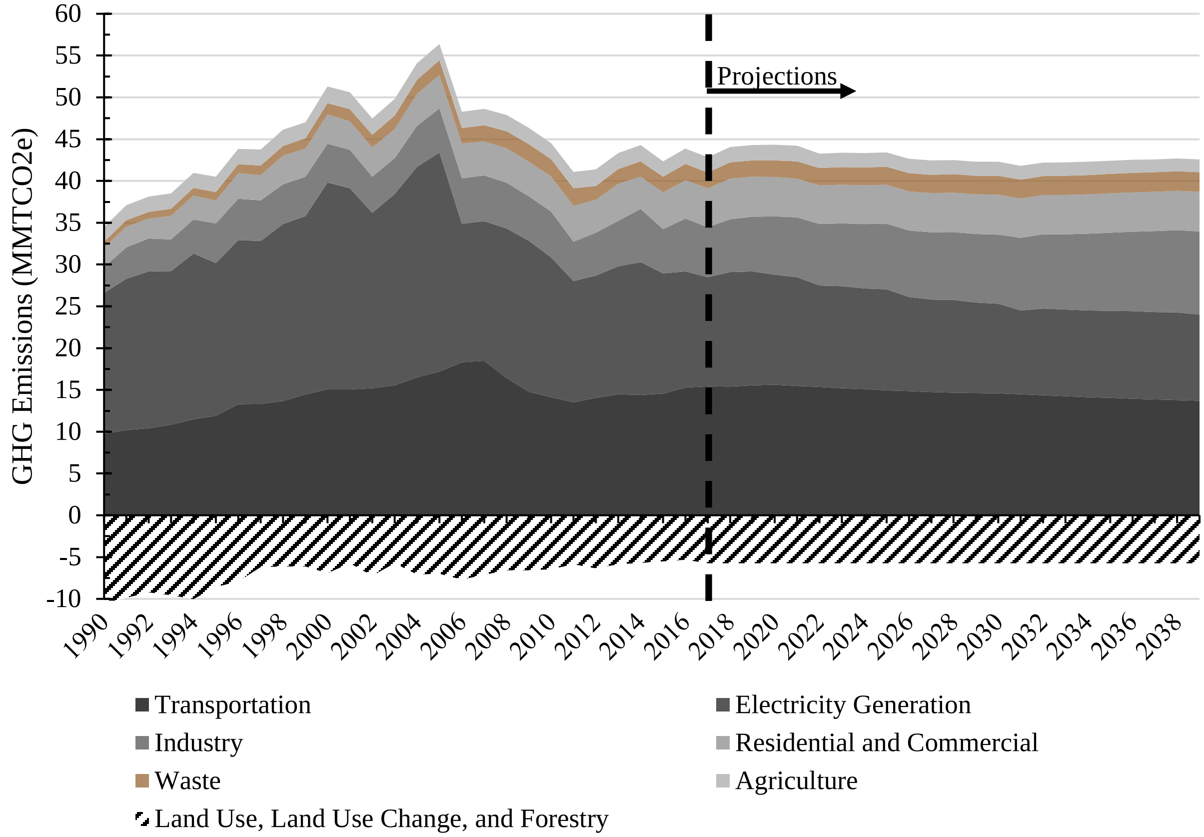
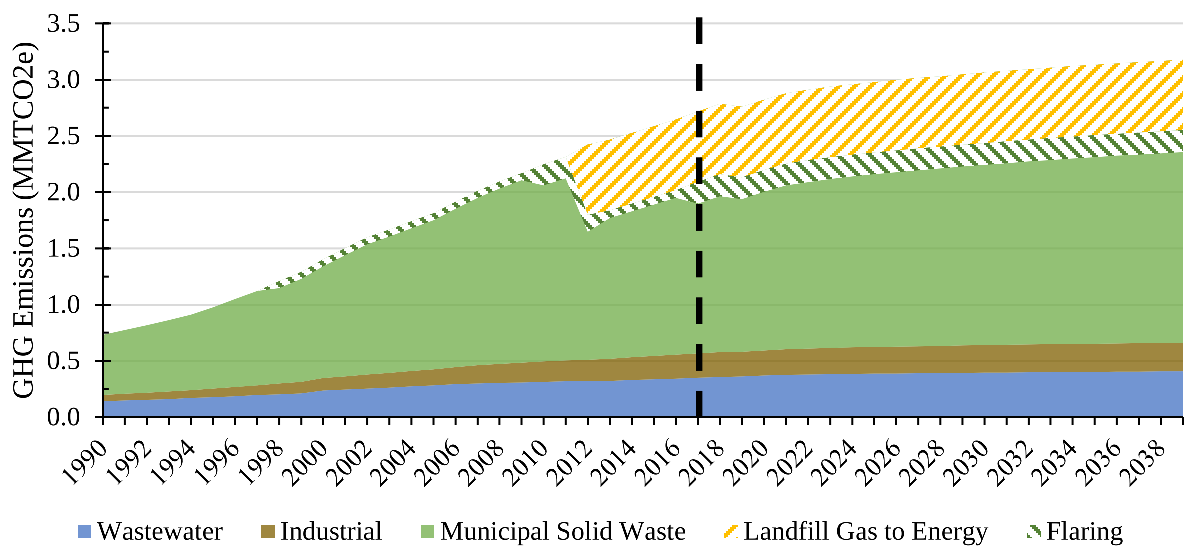



**Figure 7-2: Waste GHG Emissions in Nevada by Source, 1990–2039, with Projections Beginning in 2017 and Striped Regions Indicating Avoided Emissions**



## 7.1 Overview

GHG emissions from the waste sector totaled 1.950 MMTCO2e for 2016 (after 0.695 MMTCO2e in avoided emissions) and accounted for 4% of the State's total emissions. The waste sector includes emissions from the decay of landfilled municipal solid waste (MSW) and industrial waste (collectively, solid waste) and the disposal and treatment of municipal and industrial wastewater (hereafter, wastewater); both the decay and treatment processes require the presence of bacteria to occur. The types of GHGs emitted are $CH_4$ and $N_2O$.[78] Total waste sector emissions for 1990 through 2039 are illustrated in Figure 7-2.[79] Sector emissions are projected to total 2.159 MMTCO2e, 2.242 MMTCO2e, and 2.356 MMTCO2e in 2025, 2030, and 2039, respectively. Additionally, some landfills collect and flare recovered landfill gas[80] and some landfills collect and combust landfill gas to produce energy (known as landfill-gas-to-energy, or LFGTE). These landfill combustion processes avoid emissions by converting the $CH_4$ that would be emitted into $CO_2$ (Figure 7-2, striped lines). In 2005, emissions from this sector are estimated to be 1.749 MMTCO2e.

The disposal and treatment of municipal and industrial wastewater results in emissions of $CH_4$ and $N_2O$. Generally, the amount of $CH_4$ produced depends on the organic content (or loading) of the water (expressed in terms of biochemical oxygen demand, or BOD); the higher the wastewater's BOD, the more $CH_4$ is emitted. Emissions of $N_2O$ depend on the nitrogen content of the wastewater, which is itself dependent on human sewage levels in the wastewater. In 2016, wastewater emissions totaled 0.343 MMTCO2e.

## 7.2 Methodology

### 7.2.1 Solid Waste Methodology

Historical solid waste emissions are estimated using the SIT's *Municipal Solid Waste* module. Generally, solid waste GHG emissions are the net result of the anaerobically digested $CH_4$ minus the avoided emissions from landfill flaring and LFGTE projects. $CH_4$ emissions are derived from a first order decay model where the levels of $CH_4$ slowly diminish over the decades following the waste's initial emplacement, from the module:

$$Q_{TX} = \frac{1 - e - k}{k} \times k \times R_x \times L_o \times e^{-k(T-x)}$$

Where, $Q_{TX}$ is the amount of $CH_4$ generated in year T by the waste $R_x$
T is the year being measured
x is the year of waste input, that is, the year when the waste was landfilled

[78] While both landfill waste and wastewater emit $CO_2$ due to decomposition and flaring, $CO_2$ emissions from this sector are not counted towards the State's total GHG emissions. The $CO_2$ generated from these processes are derived from organic materials such as crops, vegetation, and human waste. It is assumed that the $CO_2$ released by these organic materials was at one point removed from the atmosphere via photosynthesis, and is therefore not contributing to GHG emissions.
[79] Waste sector GHG emissions are roughly 95% $CH_4$ every year. Because of this, sector GHG emissions are presented by source rather than by GHG throughout this section.
[80] Landfill gas is also referred to as biogas. This gas is roughly equal parts $CO_2$ and $CH_4$.

k is the $CH_4$ generation rate, in Nevada, a k value of 0.02 is used
$R_x$ is the amount of waste landfilled in year x
and $L_o$ is the $CH_4$ generation potential, assumed to be 100 $m^3$ $CH_4$ per metric ton of the waste $R_x$

The first order decay model used to derive $CH_4$ emissions is used twice as solid waste in Nevada is a combination of MSW and industrial waste.[81] MSW is solid waste that originates from residential, commercial, and institutional sources. Industrial waste is non-hazardous solid waste generated at industrial plants and construction sites, and from demolition debris. MSW and industrial waste are stored in the same landfills in Nevada, but are assumed to have different organic fractions; that is, the portion of organic matter in the waste that will decompose to form $CH_4$ is different (this is why the model is applied twice). EPA assumes that MSW has a 65% organic fraction and that industrial waste has an 11% organic fraction.[82]

GHG emissions are projected using the first order decay model with projections of MSW and industrial landfill waste generation projected using a linear trend against population estimates. There are no changes to avoided emissions from flaring and LFGTE as these projects are assumed to combust a similar amount of $CH_4$ annually and there are no known plans to increase the capacity of or introduce new flaring or LFGTE projects to Nevada's landfills through 2039.

### 7.2.2 Wastewater Methodology

Wastewater emissions are estimated using the SIT's *Wastewater* module. In most cases, $CH_4$ and $N_2O$ emissions are calculated as:[83,84]

$$E_{WW} = P \times BOD_5 \times f_{an}$$

Where, *P* is population
$BOD_5$ is the total annual biochemical oxygen demand measured over 5 days
$f_{an}$ is the anaerobically treated fraction
*e* is the production emission factor of either $CH_4$ or $N_2O$

Wastewater GHG emissions are projected through 2039 using a linear trend of historical wastewater emissions against population estimates. The SIT's *Greenhouse Gas Projection Tool* projects emissions using a simple linear trend against historical emissions. Trending emissions against projected population provides a more accurate estimate of emissions.

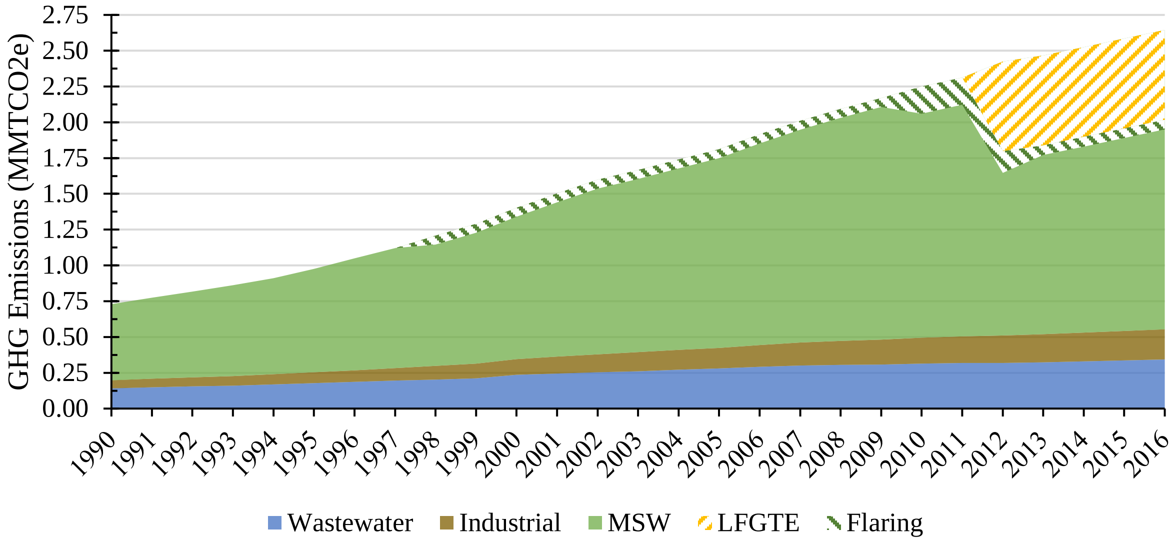
[81] Solid waste estimates from 1960 through 1992 come from the *Municipal Solid Waste* module and the NDEP Bureau of Sustainable Materials Management provides solid waste data beginning in 1993.
[82] US Environmental Protection Agency. Anthropogenic Methane Emissions in the United States, Estimates for 1990: Report to Congress, U.S. US Environmental Protection Agency, Office of Air and Radiation. Washington, D.C. EPA/430-R-93-003. 1993 Apr.
[83] For $N_2O$ emissions from wastewater, the module also, separately considers the percent of the population using septic tanks in its estimates as they are not served by municipal treatment systems to estimate direct $N_2O$ emissions, as well as estimates of protein consumption in the population to estimate $N_2O$ emissions from biosolids.
[84] The method described applies to municipal wastewater. While there is some industrial wastewater in Nevada from the processing of red meat — and their emissions are accounted for in this report — their impact on Nevada's GHG emissions is negligible so their method is not discussed here.

Additionally, the opportunity for flaring and LFGTE projects also exists with wastewater treatment facilities.[85] However, the *Wastewater* module does not provide the data nor does it provide a method for quantifying the impact of these avoided emissions.

## 7.3 GHG Emissions, 1990-2016

Nevada's waste emissions in 2005 were 1.749 MMTCO2e. In 2016, emissions were 1.950 MMTCO2e with solid waste and wastewater contributing 1.548 and 0.350 MMTCO2e, respectively. The installation of gas recover technology, that is, landfill gas flaring in 1998 and LFGTE in 2012, helped avoid 0.695 MMTCO2e, or 26% of sector emissions, in 2016. Figure 7-3 illustrates waste sector GHG emissions in Nevada by source from 1990 through 2016 with avoided emissions from landfill flaring and LFGTE indicated with striped regions and Table 7-1 lists waste sector GHG emissions in Nevada by source for select years. Because waste emissions, both solid waste and wastewater, are directly tied to population, increases in population result in increases in emissions. Table 7-2 lists the annual change in waste sector GHG emissions in Nevada by source from 2011 through 2016. Apart from the introduction of LFGTE in 2012, sector emissions increased every year.

**Figure 7-3: Waste Sector GHG Emissions in Nevada by Source, 1990-2016 with Striped Regions Indicating Avoided Emissions**




[85] For example, the Truckee Meadows Water Reclamation Facility utilizes flaring/LFGTE to mitigate facility $CH_4$ emissions.

**Table 7-1: Waste Sector GHG Emissions in Nevada by Source, Select Years (MMTCO2e)**

| Sub-Sector | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Solid Waste | 0.590 | 0.799 | 1.103 | 1.469 | 1.746 | 1.448 | 1.500 | 1.553 | 1.607 |
| *MSW* | *0.534* | *0.723* | *1.056* | *1.387* | *1.754* | *1.947* | *1.994* | *2.042* | *2.091* |
| *Industrial Waste* | *0.056* | *0.075* | *0.110* | *0.144* | *0.181* | *0.196* | *0.201* | *0.206* | *0.211* |
| *Flaring* | *0.000* | *0.000* | *-0.062* | *-0.062* | *-0.189* | *-0.068* | *-0.068* | *-0.068* | *-0.068* |
| *LFGTE* | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* | *-0.627* | *-0.627* | *-0.627* | *-0.627* |
| Wastewater | 0.141 | 0.178 | 0.236 | 0.280 | 0.314 | 0.323 | 0.330 | 0.336 | 0.343 |
| **Total Emissions** | **0.731** | **0.976** | **1.340** | **1.749** | **2.060** | **1.771** | **1.831** | **1.890** | **1.950** |

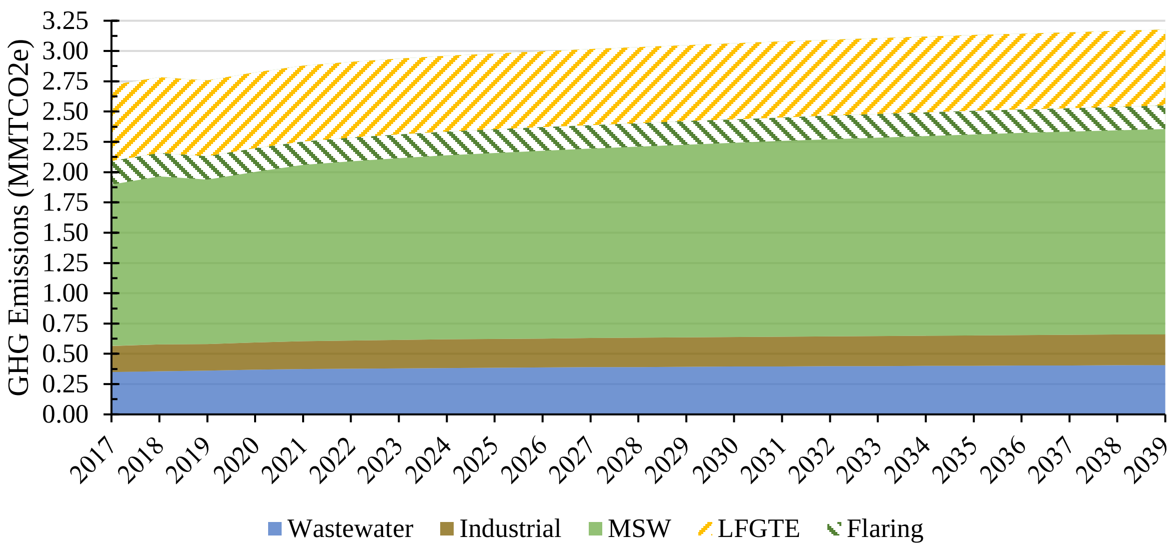
**Table 7-2: Annual Change in Waste Sector GHG Emissions in Nevada by Source, 2011-2016 (MMTCO2e and Percent)**

| Sub-Sector | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Solid Waste | -0.479 | -26.51% | 0.121 | 9.10% | 0.052 | 3.60% | 0.053 | 3.54% | 0.054 | 3.45% |
| Wastewater | 0.001 | 0.40% | 0.004 | 1.24% | 0.008 | 2.39% | 0.006 | 1.81% | 0.006 | 1.90% |
| **Totals** | **-0.477** | **-22.48%** | **0.125** | **7.58%** | **0.060** | **3.38%** | **0.059** | **3.23%** | **0.060** | **3.17%** |

## 7.4 Projected Emissions, 2017-2039

Waste sector GHG emissions in Nevada peaked in 2011 at 2.124 MMTCO2e. As no additional landfill gas recovery measures are currently planned (solid waste makes up more than 80% of sector emissions annually), it is projected that the 2011 peak will be surpassed in 2024. Emissions are projected to be 2.159 MMTCO2e in 2025, 2.242 MMTCO2e in 2030, and 2.356 MMTCO2e in 2039. Figure 7-4 illustrates waste sector GHG emissions projections in Nevada by source from 2017 through 2039 with avoided emissions from landfill flaring and LFGTE projects indicated with striped regions.

**Figure 7-4: Waste Sector GHG Emissions Projections in Nevada by Source, 2017-2039 with Striped Regions Indicating Avoided Emissions**



# Agriculture

**Figure 8-1: Nevada Historical and Projected GHG Emissions and Sinks by Sector with Agriculture Emphasized, 1990–2039, with Projections Beginning in 2017**

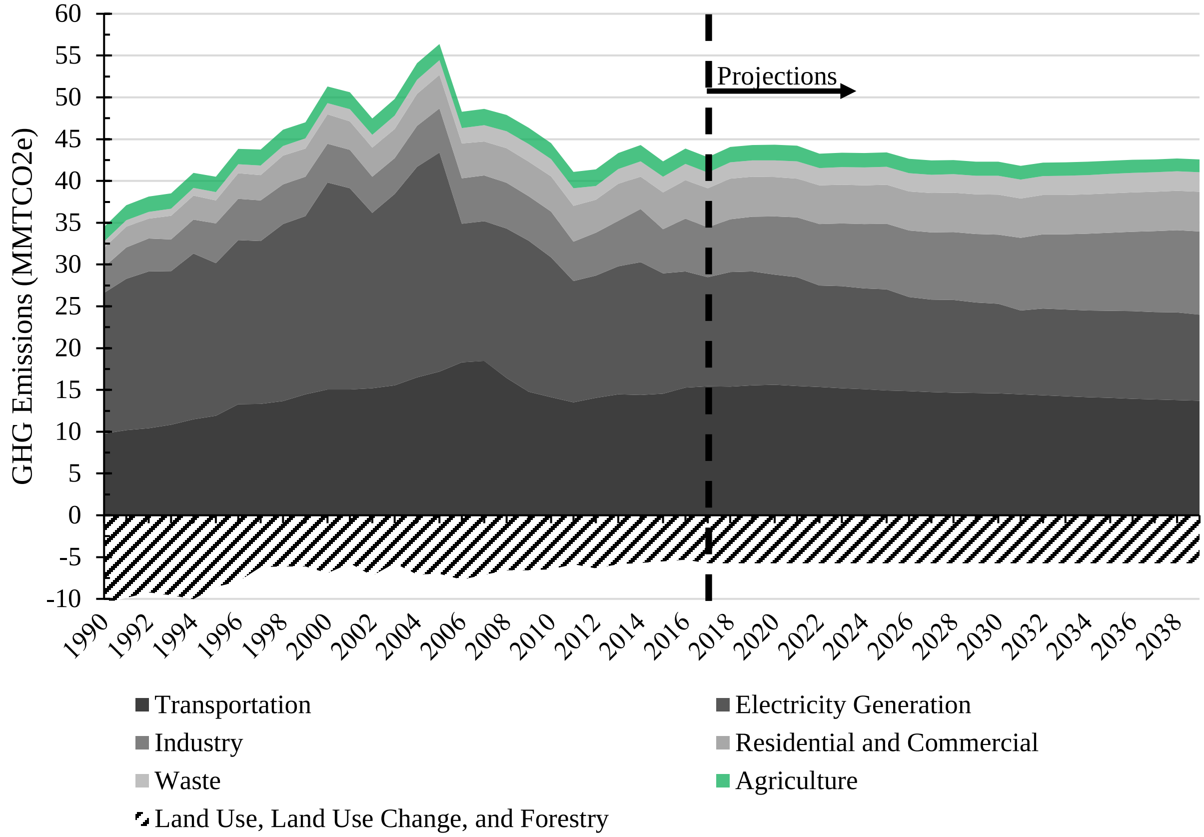
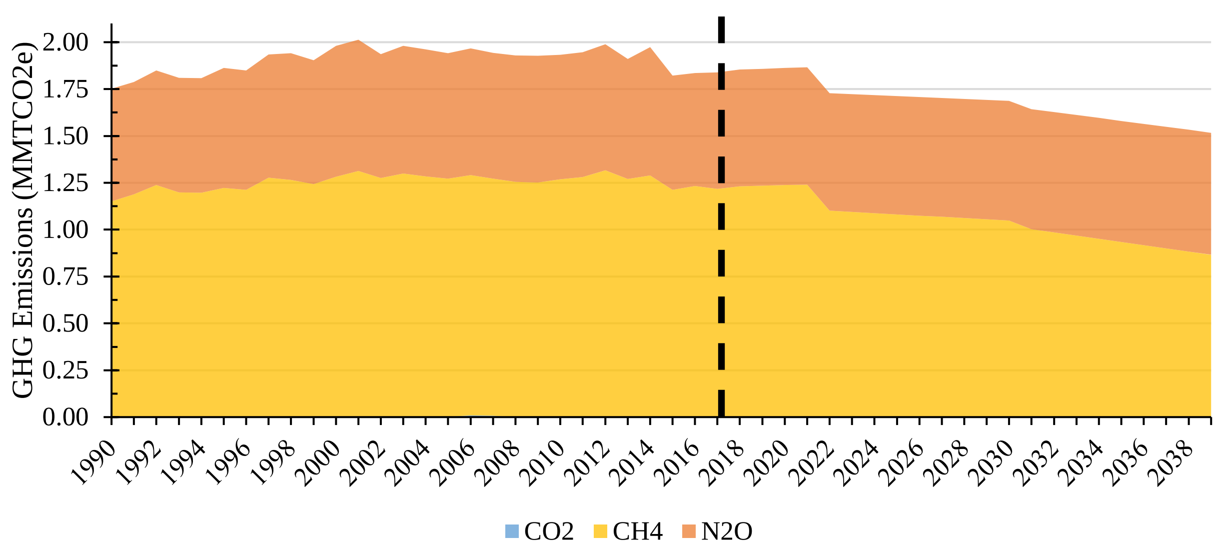



**Figure 8-2: Agriculture GHG Emissions by GHG, 1990–2039, with Projections Beginning in 2017**



## 8.1 Overview

Agricultural activities can directly emit GHGs. These activities include the liming of soils, the use of urea as a fertilizer, enteric fermentation from livestock, management of livestock manure, field burning of agricultural residues, and agricultural soil management. GHG emissions from agriculture in Nevada totaled 1.835 MMTCO2e in 2016 and accounted for 4% of the State's total emissions. The types of GHGs emitted from this sector are $CO_2$, $CH_4$, and $N_2O$. Total agriculture GHG emissions in Nevada by GHG from 1990 through 2039 are illustrated in Figure 8-2. Sector emissions are estimated to be 1.942 MMTCO2e for 2005, and projected to be 1.713 MMTCO2e in 2025 and 1.688 MMTCO2e in 2030. Sector emissions are projected to remain a minor contributor to GHG emissions in Nevada through 2039. Table 8-1 briefly explains the process of how the agricultural activities considered by this sector emit GHGs.

**Table 8-1: Agricultural Activities Resulting in GHG Emissions Explained[86]**

| Activity | Source of Emissions |
|---|---|
| Liming of Soils | The liming (adding crushed limestone, $CaCO_3$, and dolomite, $CaMg(CO_3)_2$) of soils is performed by land managers to increase soil pH, that is, make the soil more basic. $CO_2$ is released when these compounds react with the acidic (low pH) soil. |
| Urea Fertilization | The use of urea ($CO(NH_2)_2$) as a fertilizer releases $CO_2$ that was fixed to ammonia ($NH_3$) during the industrial production process. |
| Enteric Fermentation | $CH_4$ is produced during the normal animal digestive process. Ruminant animals (examples include cattle and goats) are the main source due to their unique digestive tracts, but swine and poultry will also release $CH_4$ through their normal digestive processes. |
| Manure Management | The treatment, storage, and transportation of livestock manure can produce $CH_4$ and $N_2O$. $CH_4$ is produced by the anaerobic decomposition of manure and $N_2O$ is produced both directly and indirectly from manure. Direct $N_2O$ emissions are from the nitrogen cycling of manure and urine. Indirect $N_2O$ emissions are from the volatilization and deposition of the nitrogen in the manure and urine (as ammonia and nitrogen oxides) onto soils and water surfaces and from the runoff and leaching of nitrogen into groundwater and waterways. |
| Agricultural Residue Burning | Residue burning is one of the ways in which farmers manage their land after harvest and results in $CH_4$ and $N_2O$ emissions. |
| Agricultural Soil Management | Agricultural soil management includes both direct and indirect $N_2O$ emissions. Direct pathways include fertilizers, crop residues, nitrogen-fixing crops, histosols, and livestock. Indirect pathways include fertilizers, livestock, and the leaching/runoff of both fertilizers and manure. |

## 8.2 Methodology

GHG emissions from agricultural activities are quantified using the SIT's *Agriculture* module for 1990 through 2016. Table 8-2 briefly describes how the module estimates GHG emissions from the liming of soils, the use of urea as a fertilizer, livestock enteric fermentation, livestock manure management, field burning of agricultural residues, and agricultural soil management. Generally, usage, population, and crop production data are Nevada specific (coming from the National Agriculture Statistics Service). There are however a few instances where Nevada data is unavailable, in those instances the most appropriate statistical methodology was used to interpolate or extrapolate the missing data.

[86] US Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, Section 5: Agriculture.

**Table 8-2: Descriptions of SIT Agriculture Module GHG Estimation Methods**

| Activity | SIT Method |
|---|---|
| Liming of Soils | $CO_2$ emissions are estimated by applying emissions factors to usage data. |
| Urea Fertilization | $CO_2$ emissions are estimated by applying emissions factors to usage data. |
| Enteric Fermentation | $CH_4$ emissions are estimated by applying emission factors to animal/livestock population data. |
| Manure Management | $CH_4$ and $N_2O$ are estimated by quantifying the average volatile solids produced by animals/livestock using population data and typical animal size and then applying the appropriate emissions factors (emissions factors differ for $CH_4$ versus $N_2O$ and for the various species of animal/livestock considered by the module). |
| Agricultural Residue Burning | $CH_4$ and $N_2O$ emissions are estimated by multiplying the amount of a crop produced by a series of factors (including residue-to-crop ratio, an estimate of the fraction of the residue burned, the dry matter fraction, burning and combustion efficiencies, and the carbon/nitrogen content of the residue) to calculate the amount of crop residue produced and burned. |
| Agricultural Soil Management | $N_2O$ emissions are estimated for three pathways, plant residues and legumes, plant fertilizers, and animals/livestock.<br><br>Emissions from plant residues are estimated by quantifying the nitrogen returned to soils using crop production data, the ratio of plant residue to crop mass, the fraction of dry matter in the residue, and the nitrogen content of the residue. Emissions from legumes are estimated by quantifying the nitrogen fixed by crops using crop production data (the module considers multiple crops, but in Nevada data for alfalfa is provided), the ratio of plant residue to crop mass, the fraction of dry matter in the residue, and the nitrogen content of the above-ground biomass.<br><br>Emissions from plant fertilizers are estimated by quantifying the amounts of volatilized and unvolatilized nitrogen from synthetic and organic fertilizers applied to soils and applying emissions factors.<br><br>Emissions from animals/livestock are estimated by quantifying animal/livestock nitrogen excretion rates and then determining the amounts of excreted nitrogen that result in direct $N_2O$ emissions (manure applied to soils and unmanaged manure in pastures, ranges, and paddocks) and indirect $N_2O$ emissions (leaching and runoff from manure). |

Apart from the liming of soils and urea fertilization, agriculture GHG emissions are projected using the SIT's *Greenhouse Gas Projection Tool* from 2017 through 2030 and the methods of the projection tool are then replicated for 2031 through 2039. Generally, the projection tool does not utilize state-level data in its projections. For enteric fermentation and manure management, the projection tool forecasts the US livestock population by apportioning population to the state level and applying the emissions factors used in 2016. Emissions from agricultural residue burning and agricultural soil management are projected using a forecast of the national historical emissions trend before reapportioning emissions to the state level. The projection tool also does not project emissions for the liming of soils and urea fertilization; emissions are instead projected using the historical average of 1990 through 2016 to project emissions from 2017 through 2039.

## 8.3 GHG Emissions, 1990-2016

GHG emissions from agricultural activities in Nevada totaled 1.942 MMTCO2e in 2005, and 1.835 MMTCO2e in 2016. Figure 8-3 illustrates agricultural activity emissions in Nevada by GHG from 1990 through 2016 and Table 8-3 lists agricultural activity emissions in Nevada by GHG for select years. Sector GHG emissions are predominantly $CH_4$, comprising 67% of 2016 emissions, with $N_2O$ emissions comprising 33% of 2016 emissions and $CO_2$ having a negligible impact on sector emissions.

**Figure 8-3: Agricultural Activity GHG Emissions in Nevada by GHG, 1990-2016**

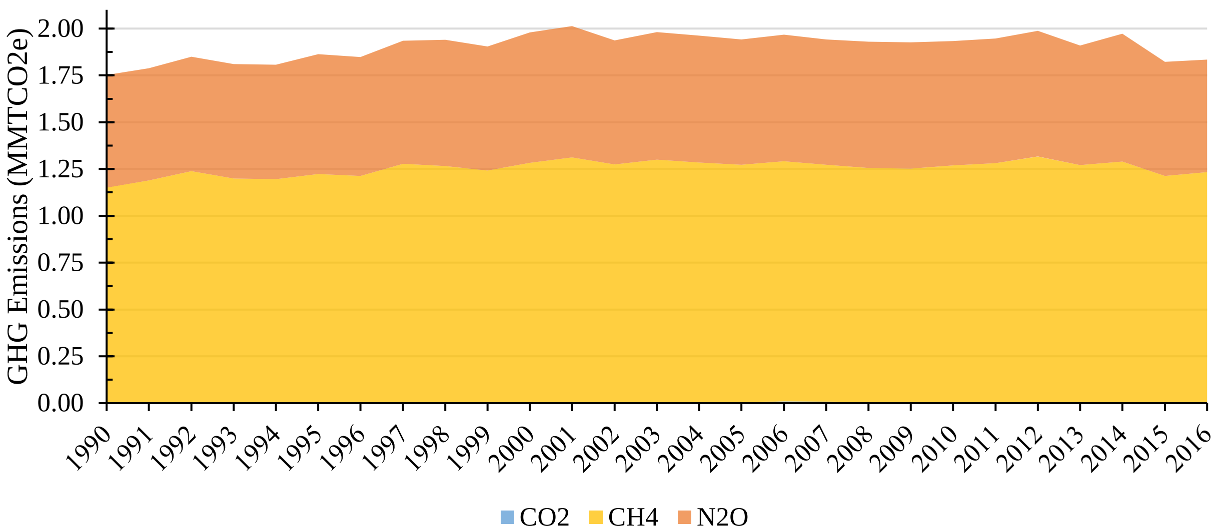



**Table 8-3: Agriculture GHG Emissions in Nevada by GHG, Select Years (MMTCO2e)**

| GHG | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.001 | 0.003 | 0.003 |
| $N_2O$ | 0.601 | 0.640 | 0.697 | 0.669 | 0.664 | 0.639 | 0.683 | 0.610 | 0.602 |
| $CH_4$ | 1.151 | 1.223 | 1.283 | 1.271 | 1.269 | 1.271 | 1.288 | 1.210 | 1.230 |
| **Total Emissions** | **1.752** | **1.863** | **1.980** | **1.942** | **1.933** | **1.910** | **1.973** | **1.822** | **1.835** |

Of Nevada's agricultural activity GHG emissions, enteric fermentation from livestock (which results in $CH_4$ emissions) and the direct $N_2O$ emissions from the management of agricultural soils are agriculture's two main sources. Table 8-4 lists agriculture activity GHG emissions in Nevada by source for select years and Table 8-5 lists annual changes in agricultural activity GHG emissions in Nevada by source for 2011 through 2016. Annual variability in emissions are likely the result of changing animal/livestock populations.

**Table 8-4: Agriculture GHG Emissions in Nevada by Source, Select Years (MMTCO2e)**

| Source | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Liming | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.001 | 0.003 | 0.003 |
| Urea Fertilization | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Enteric Fermentation | 1.026 | 1.082 | 1.115 | 1.096 | 1.060 | 1.058 | 1.062 | 0.998 | 1.018 |
| Manure Management | 0.146 | 0.164 | 0.190 | 0.193 | 0.229 | 0.233 | 0.253 | 0.231 | 0.232 |
| Agricultural Residue Burning | 0.001 | 0.000 | 0.001 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 |
| Agricultural Soils Direct | 0.523 | 0.555 | 0.605 | 0.586 | 0.578 | 0.553 | 0.587 | 0.525 | 0.520 |
| Agricultural Soils Indirect | 0.055 | 0.061 | 0.070 | 0.065 | 0.066 | 0.066 | 0.069 | 0.065 | 0.062 |
| **Total Emissions** | **1.752** | **1.863** | **1.980** | **1.942** | **1.933** | **1.910** | **1.973** | **1.822** | **1.835** |

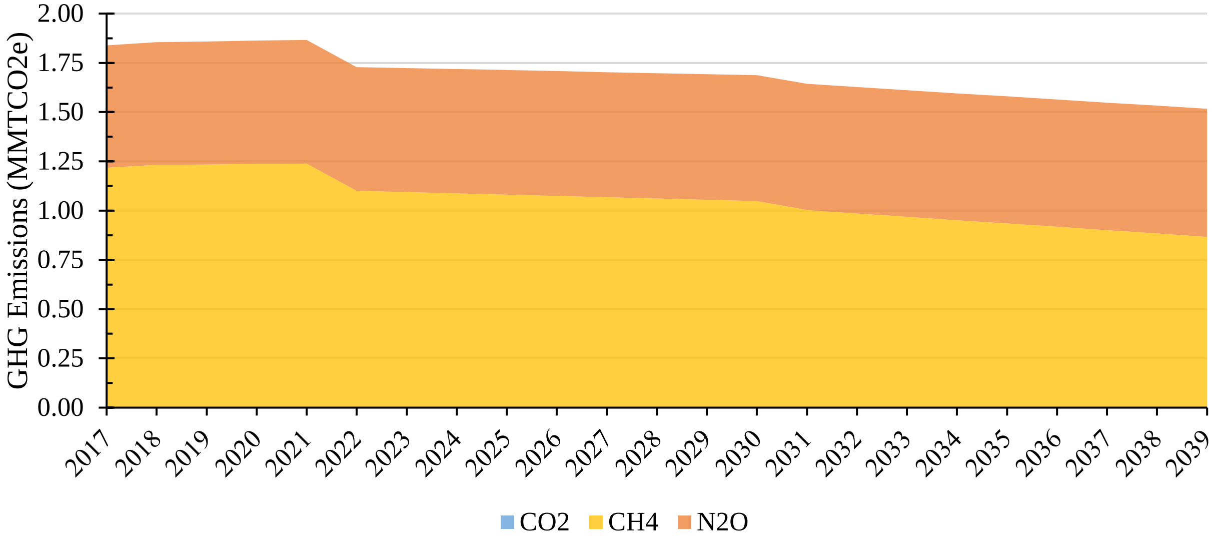
**Table 8-5: Annual Change in Agriculture GHG Emissions in Nevada by Source, 2011-2016 (MMTCO2e and Percent)**

| Source | 2011 to 2012 | | 2012 to 2013 | | 2013 to 2014 | | 2014 to 2015 | | 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Liming | 0.000 | - | 0 | - | 0.001 | - | 0.002 | 128% | 0.000 | 0.00% |
| Urea Fertilization | 0.000 | -18.72% | 0.000 | -2.22% | 0.000 | 41.14% | 0.000 | 0.00% | 0.000 | 0.00% |
| Enteric Fermentation | 0.021 | 1.96% | -0.035 | -3.18% | 0.004 | 0.36% | -0.064 | -6.04% | 0.020 | 1.98% |
| Manure Management | 0.015 | 6.72% | -0.011 | -4.66% | 0.021 | 8.89% | -0.022 | -8.61% | 0.001 | 0.37% |
| Agricultural Residue Burning | 0.000 | -11.79% | 0.000 | 11.83% | 0.000 | -19.54% | 0.000 | -38.10% | 0.000 | 0.15% |
| Agricultural Soils Direct | 0.004 | 0.76% | -0.030 | -5.07% | 0.034 | 6.09% | -0.061 | -10.47% | -0.005 | -0.90% |
| Agricultural Soils Indirect | 0.001 | 1.84% | -0.003 | -4.06% | 0.004 | 5.43% | -0.005 | -6.64% | -0.003 | -5.18% |
| **Totals** | **0.042** | **2.16%** | **-0.078** | **-3.94%** | **0.063** | **3.29%** | **-0.151** | **-7.63%** | **0.013** | **0.69%** |

## 8.4 Projected Emissions, 2017-2039

GHG emissions from agricultural activities are projected to decline slightly through 2039, with emissions in 2025 projected to be 1.713 MMTCO2e, emissions in 2030 projected to be 1.688 MMTCO2e, and emissions in 2039 projected to be 1.517 MMTCO2e, a reduction of 0.318 MMTCO2e from 2016 levels. Based on the projection tool's method for this sector, this reduction in emissions is more likely to be the result of the method's extrapolation of national usage, population, and crop production data and its subsequent apportionment to individual states than it does with any changes in agricultural activities in Nevada. Figure 8-4 illustrates the projected GHG emissions of agricultural activities in Nevada for 2017 through 2039. Overall, GHG emissions from agricultural activities in Nevada will likely continue to be a minor contributor of GHGs through the projection period, particularly as demand for limited water supply increases.

**Figure 8-4: Projected Agricultural Activity Emissions in Nevada by GHG, 2017-2039**



# Land Use, Land Use Change, and Forestry

**Figure 9-1: Nevada Historical and Projected Total GHG Emissions and Sinks by Sector with Land Use, Land Use Change, and Forestry Emphasized, 1990–2039, with Projections Beginning in 2017**

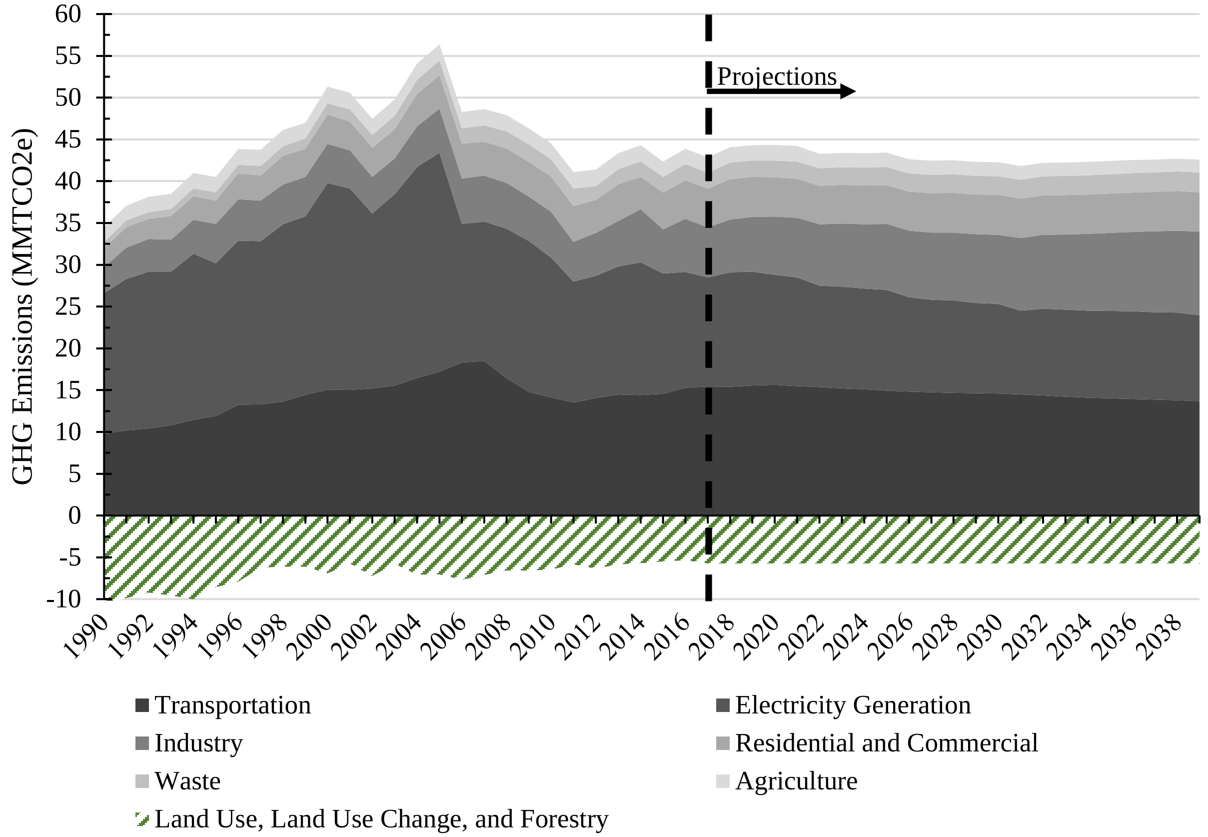
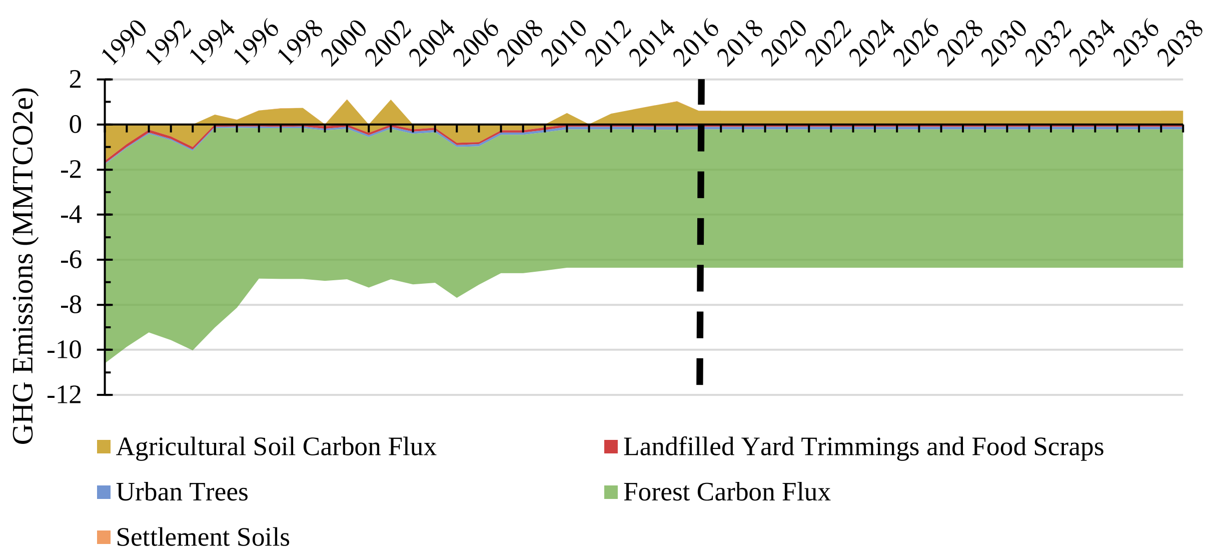



**Figure 9-2: Land Use, Land Use Change, and Forestry GHG Emissions by GHG, 1990–2039, with Projections Beginning in 2017**



## 9.1 Overview

The land use, land use change, and forestry sector acts as a net sink of GHGs. Nevada's forests, urban trees, and at times, agricultural lands absorb and store carbon from the atmosphere in an amount that offsets the carbon emissions associated with processes such as decomposition and vegetation respiration.[87] The annual variability of the carbon absorbed from the atmosphere is generally referred to as carbon flux. There is currently a high degree of uncertainty as to the methods employed by the SIT in estimating the total carbon sequestered by Nevada's forests (hereafter, forest carbon flux). It is because of this reason (discussed in detail in 9.2.1 Forest Carbon Flux below) that this report utilizes the 2016 SIT estimates of forest carbon flux. GHG emissions from the land use, land use change, and forestry sector are illustrated in Figure 9-2. In 2005, this sector sequestered 7.017 MMTCO2e and in 2016, 5.331 MMTCO2e GHG emissions were sequestered. This sector is projected to sequester 5.749 MMTCO2e in 2025 and 2030.

In addition to the GHG emissions and sinks from land use, land use change, and forestry, this section also details the historical GHG emissions associated with wildland fires in Nevada. Wildland fires are highly unpredictable and an especially large fire year can result in wildland fires becoming the single largest source of GHG emissions in the State. Emissions from wildland fires are accounted for statewide, this includes Nevada's forests, agricultural lands, and rangelands. It is because of this highly unpredictable nature, and the fact that there is uncertainty regarding the sources of wildland fires (that is, human caused or naturally ignited) that GHGs from wildland fires are tracked for reference, but are not included in Nevada's total GHG emissions.

## 9.2 Methodology

GHG emissions from land use, land use change, and forestry activities are estimated using both the 2016 and 2018 versions of the SIT's *Land Use, Land Use Change, & Forestry* module. Estimates for urban trees, landfilled yard trimmings and food scraps, settlement soils, and agricultural soil carbon flux are performed using defaults from the 2018 version of the SIT module and forest carbon fluxes are estimated using the 2016 version of the SIT module. Table 9-1 briefly describes how the 2018 module estimates GHG emissions and sinks from urban trees, landfilled yard trimmings and food scraps, settlement soils, and agricultural soil carbon flux. Emissions of $CH_4$ and $N_2O$ from wildland fires are estimated using the SIT's *Land Use, Land Use Change, & Forestry* module with wildland fire acreage data from the National Interagency Fire Center (NIFC).[88,89] The module includes, for example, estimates of average biomass density in Nevada and the relative combustion efficiency of various land types.

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[87] Nevada's grasslands/shrublands/rangelands also have the capacity to both sequester and emit GHGs. However, the SIT does not provide a method to quantify the impact of these lands so they are not accounted for in this inventory.
[88] National Interagency Fire Center. [accessed 2019 Sep]. https://www.nifc.gov/
[89] $CO_2$ emissions associated with wildland fires are not considered as the carbon released as $CO_2$ was previously sequestered from the atmosphere via photosynthesis.

**Table 9-1: Descriptions of SIT GHG Estimation Methods for Land Use and Land Use Change Activities**

| Activity | SIT Method |
|---|---|
| Urban Trees | Estimated sequestration from urban trees depends on Nevada's total urban area, estimates of the percent of the urban area with tree cover, and the higher than average carbon sequestration capability of urban trees — because urban trees grow in relatively open surroundings they are less likely to experience the competition for resources that trees in forests typically encounter. |
| Landfilled Yard Trimmings and Food Scraps | In a method similar to how emissions are estimated for MSW (detailed in Section 7.2.1 Solid Waste Methodology), estimates of the mass of landfilled carbon stocks — that is, yard trimmings and food scraps — are applied to a first order decay equation that estimates the amount of landfilled carbon stocks that remains in landfills compared to the portion of decomposed landfilled carbon stocks. |
| Settlement Soils | Emissions factors are applied to estimates of the total amount of synthetic fertilizers applied to settlement soils — that is, lawns, golf courses, and other landscaping — in Nevada. |
| Agricultural Soil Carbon Flux | Emissions factors are applied to estimates of the carbon that is cycled through cropland and grassland ecosystems. The amount of carbon sequestered or emitted by croplands and grasslands depends on the quantity and types of crops grown in Nevada, land management practices (examples of practices include crop rotation, irrigation and tillage practices, and soil drainage) applied to croplands, and soil and climate variability. |

The SIT's *Greenhouse Gas Projection Tool* does not project emissions from land use, land use change, and forestry sector emissions. Sector emissions were projected using an historical average of 2012 through 2016 emissions. Wildland fire emissions were projected using the average of all historical emissions, that is, emissions from 1990 through 2018.

### 9.2.1 Forest Carbon Flux

In order to estimate forest carbon fluxes, the SIT's *Land Use*, *Land Use Change, & Forestry* module utilizes the inventories of carbon stocks conducted by the USDA Forest Service through its Forest Inventory and Analysis (FIA) research program.[90] The FIA research program measures carbon stocks of above- and belowground biomass, deadwood, natural litters, and changes in the soil organic carbon fraction.[91] Measurements are taken on a relatively small number of plots of forest land on a regular, but infrequent basis. These limited measurements are then scaled up to the state level and interpolated over time. Forest carbon fluxes are computed as the difference between two estimates of total carbon stocks;[92] an increase in carbon stocks indicates that the forest is a sink, that is, it is absorbing carbon from the atmosphere.

A major uncertainty with this method of estimating forest carbon fluxes is that annual changes in carbon stocks are generally three orders of magnitude smaller than the total carbon stock itself. The FIA estimates that Nevada's total forest carbon stock is approximately 200 million metric tons of carbon — equivalent to 733 MMTCO2e — with annual variability generally in the tenths of a million metric tons of

[90] Forest Inventory and Analysis. US Forest Service. [accessed 2019 Oct]. https://www.fia.fs.fed.us/
[91] The FIA research program also estimates total amounts of wood products both produced and landfilled but utilizes a different method in performing these estimates. The carbon sequestered via this activity is insignificant compared to the other measurements described.
[92] The time between visits is not always performed on an annual basis. The temporal variability in visits is shown in the annual estimated GHG emissions/sinks as it leads to multiple years reporting the same GHG emissions estimates.

carbon. While NDEP does not currently have an estimate of the overall uncertainty and errors associated with forest carbon flux, it is very likely that the range of uncertainty is at least of the same order of magnitude as the estimated annual flux, if not larger.

That is to say, the consequence of the underlying uncertainties in the process can mean that significant changes in Nevada's computed forest carbon flux may be associated with the method used in generating the estimates, rather than any actual, statewide changes in forest carbon fluxes. This is very likely the case if a significant change in forest carbon flux occurs within a very short period of time; interannual climate variability (an example being drought years versus high precipitation years) can affect forest ecosystems, but significant and persistent changes at the state level — that is, affecting all or a significant percentage of Nevada's forests — should really only occur on the scale of decades or longer. In NDEP's 2012 and 2016 GHG Inventories, the then most recent versions of the SIT's *Land Use, Land Use Change, & Forestry* module were utilized to estimate historical forest carbon fluxes. In both instances, forest carbon fluxes consistently ranged between -6 and -8 MMTCO2e over their respective historical periods. However, the 2018 module estimates a range of -2 and +2 MMTCO2e, with a sudden switch from sink to source of GHG emissions occurring between 1995 and 1997.

NDEP believes, based on our knowledge and experience, that this sudden shift from sink to source is not the result of any forest ecosystem change, but rather is a possible challenge with the carbon stock measuring methodology. For this reason, NDEP is utilizing 2016 forest carbon flux estimates for this year's report.[93]

## 9.3 GHG Emissions, 1990-2016

Apart from wildland fire emissions, the land use, land use change, and forestry sector was a net GHG emissions sink of 5.331 MMTCO2e in 2016. Sequestered emissions in 2016 are 1.686 MMTCO2e less than 2005, when the sector was a net GHG emissions sink of 7.017 MMTCO2e. Figure 9-3 illustrates total land use, land use change, and forestry sector GHG emissions and sinks by source from 1990 through 2016. Table 9-2 lists total land use, land use change, and forestry sector GHG emissions and sinks in Nevada for select years.

[93] Additional research has been planned in order to provide more accurate estimates of forest carbon flux in future reports.

**Figure 9-3: Land Use, Land Use Change, and Forestry Sector GHG Emissions and Sinks by Source, 1990-2016**

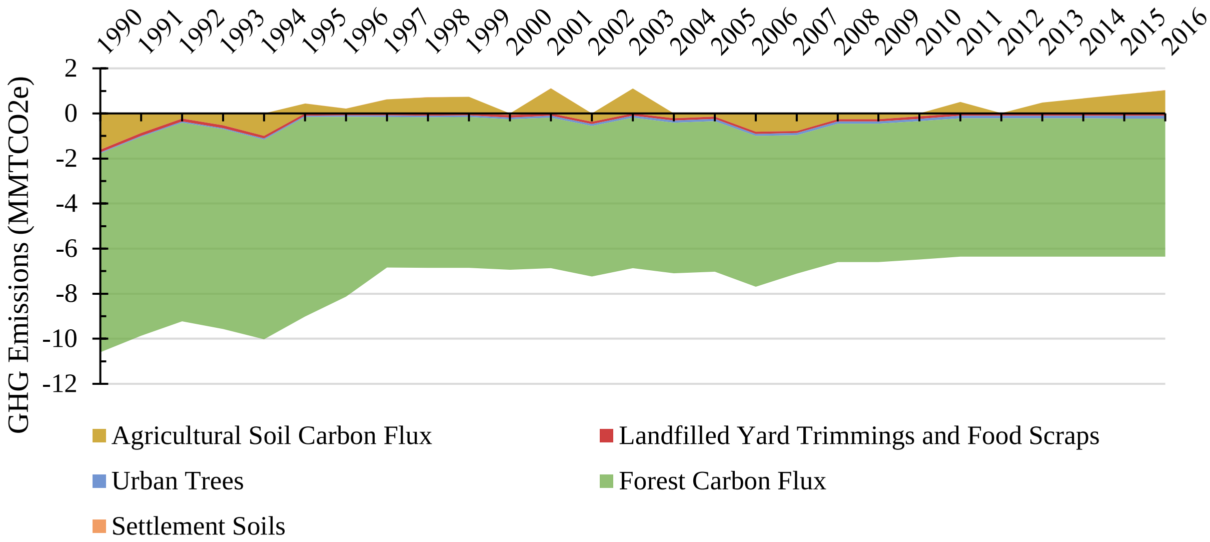


**Table 9-2: Land Use, Land Use Change, and Forestry GHG Emissions and Sinks by Source, Select Years (MMTCO2e)**

| Source | 1990 | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| Forest Carbon Flux | -8.820 | -8.858 | -6.682 | -6.682 | -6.134 | -6.134 | -6.134 | -6.134 | -6.134 |
| Urban Trees | -0.047 | -0.062 | -0.076 | -0.092 | -0.107 | -0.117 | -0.120 | -0.123 | -0.126 |
| Landfilled Yard Trimmings and Food Scraps | -0.126 | -0.096 | -0.103 | -0.101 | -0.110 | -0.102 | -0.101 | -0.102 | -0.103 |
| Agricultural Soil Carbon Flux | -1.604 | 0.436 | -0.077 | -0.146 | -0.129 | 0.483 | 0.664 | 0.845 | 1.027 |
| Settlement Soils | 0.001 | 0.003 | 0.005 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| **Total** | **-10.596** | **-8.576** | **-6.933** | **-7.017** | **-6.476** | **-5.865** | **-5.686** | **-5.509** | **-5.331** |

Wildland fire emissions are highly variable and depend on the total acres burned in a year. Figure 9-4 illustrates Nevada wildland fire GHG emissions in Nevada from 1990 through 2018 and Table 9-3 lists wildland fire GHG emissions and total acres burned in Nevada for select years. Wildland fire emissions include both prescribed and uncontrolled burns, although prescribed fire emissions are a small fraction as acreage burned is generally on the scale of thousands of acres for any given year while uncontrolled burns can get into the millions of acres burned in a year.

**Figure 9-4: Nevada Wildland Fire GHG Emissions, 1990-2018**

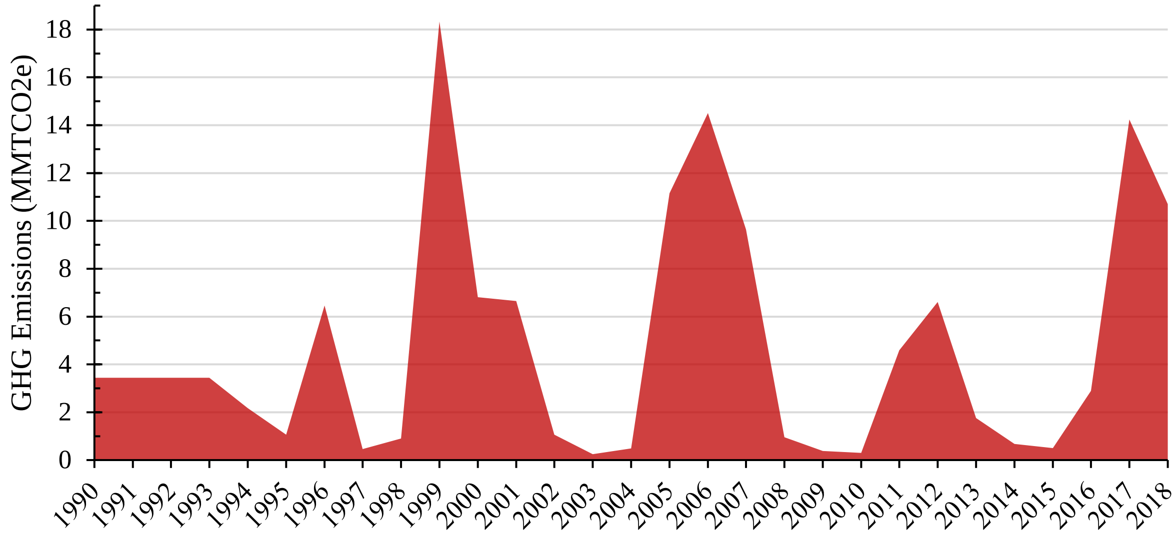


**Table 9-3: Wildland Fire GHG Emissions and Total Acres Burned in Nevada, Select Years (MMTCO2e and acres)**

| | 2000 | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Wildland Fire Emissions – $CH_4$ | 6.036 | 9.877 | 0.264 | 1.555 | 0.592 | 0.441 | 2.563 | 12.621 | 9.482 |
| Wildland Fire Emissions – $N_2O$ | 0.776 | 1.270 | 0.034 | 0.200 | 0.076 | 0.057 | 0.329 | 1.622 | 1.219 |
| **Total Wildland Fire Emissions** | **6.812** | **11.146** | **0.298** | **1.755** | **0.668** | **0.498** | **2.892** | **14.243** | **10.701** |
| Uncontrolled Fire Acres Burned | 635,713 | 1,032,111 | 23,869 | 162,906 | 59,252 | 42,479 | 265,155 | 1,329,285 | 1,001,963 |
| Prescribed Fire Acres Burned | 2,566 | 13,580 | 4,771 | 1,665 | 3,891 | 4,916 | 6,695 | 5,198 | not available |
| **Total Acres Burned** | **638,279** | **1,045,832** | **28,640** | **164,571** | **63,143** | **47,395** | **271,850** | **1,334,483** | **1,001,963** |

## 9.5 Projected Emissions, 2017-2039

Forest carbon fluxes are largely dependent on the short- and long-term variability of the climate and the effects of climate change. It is expected that climate change will have a negative impact on Nevada's forests (and thus forest carbon fluxes), as there is expected to be more severe droughts and a less consistent snowpack to provide water during the growing season. The frequency and intensity of wildland fires is expected to increase as well. However, there is no recommended method to project sector emissions over the next 20 years; because of this, projections for the land use, land use change, and forestry sector were estimated by averaging 2012 through 2016 emissions. It is estimated that, on average, the sector will sequester 5.747 MMTCO2e GHG emissions per year. Wildland fire emissions were projected using the average of historical GHG emissions from 1990 through 2018, and are projected to emit 4.734 MMTCO2e GHG emissions per year.

# Statement of Policies that Could Achieve Reductions in Projected Greenhouse Gas Emissions by Sector

As required by SB 254, this section identifies policies that could achieve reductions in projected GHG emissions, organized by the GHG emissions sectors in this report. As noted in the introduction to this report, NDEP has included GHG emission from the "waste" sector as an additional contributor to GHG emissions in Nevada necessary for monitoring and identifying policy proposals. NDEP coordinated with the Governor's Office of Energy, the Public Utilities Commission of Nevada (PUCN), the Nevada Department of Transportation, and the Nevada Department of Motor Vehicles in the identification of these policies. NDEP also reviewed policies included in climate change planning documents recently generated by the U.S. Climate Alliance[94], New Mexico[95], and Colorado[96] and other relevant sources.

This list is an initial identification of policies that could reduce Nevada's GHG emissions. It is not a list of recommendations. Individual policies listed herein need further evaluation to determine whether additional planning, legal review, economic impact and cost-benefit analyses, regulation, and/or legislation may be required prior to implementation. As required by Executive Order 2019-22, state agencies will be developing a specific set of policy and budget recommendations in a State Climate Strategy to be prepared by December 1, 2020. Policies are not listed in order of priority or feasibility.

Economy-Wide Policies

In addition to the sector-specific policies listed below, comprehensive economy-wide programs — including market-based mechanisms — need further evaluation to determine what may be appropriate for Nevada's GHG emission profile.

Establish a Lead by Example Program for State Agencies

State agencies can demonstrate leadership in reducing GHG emissions within their activities and operations. The program would identify multiple pathways to meet GHG reduction goals and provide necessary assistance to all state agencies in achieving the goals of the Lead by Example (LBE) Program. The program would promote sustainability activities within state government such as green building practices, waste reduction, alternative fuels, recycling programs, and sustainable travel.

[94] U.S. Climate Alliance 2019 Annual Report. US Climate Alliance; 2019 Dec [accessed 2019 Dec 10]. http://www.usclimatealliance.org/annual-report

[95] New Mexico Climate Strategy: Initial Recommendations and Status Update, 2019. New Mexico Interagency Climate Change Task Force; 2019 Dec [accessed 2019 Dec 3]. https://www.climateaction.state.nm.us/

[96] Polis Administration's: Roadmap to 100% Renewable Energy by 2040 and Bold Climate Action. State of Colorado; 2019 [accessed 2019 Dec 3]. https://drive.google.com/file/d/0B7w3bkFgg92dMkpxY3VsNk5nVGZGOHJGRUV5VnJwQ1U4VWtF/view

## 10.1 Transportation

Vehicle Emission Standards

Adopt California emission standards, established though a waiver application as allowable under Section 209(b) of the Clean Air Act (CAA), for certain new motor vehicles or new motor vehicle engines and certain model years (at least two years before commencement of such model year).[97] These include:

- California's Low Emission Vehicle (LEV) standards that sets vehicle manufacturer GHG emissions standards for new passenger cars and light-trucks;
- California's Zero Emission Vehicle (ZEV) standard that creates a credit-based program for vehicle manufacturers that requires an increasing percentage of ZEVs; and
- California's Advanced Clean Truck Program, which is currently in development, would create a program reducing engine emissions and increasing electrification of medium- and heavy-duty vehicles.

Reduction of Vehicle Miles Travelled

Promote the use of non-single occupant vehicle trips, including, but not limited to carpooling, transit, micro-transit bicycling, and walking.

Expand regional transit services through increases in trip frequency, service areas, and improved reliability while also providing greater incentives to increase transit service use.

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[97] The Clean Air Act (CAA Section 209) provides the EPA the exclusive authority to regulate emission standards for new motor vehicles. However, the CAA also allows for the state of California to adopt, through a waiver application, more stringent emissions standards for specific vehicle model years. For the last 50 years, California has been granted many (hundreds) waivers, covering among others, light-duty vehicles, heavy-duty diesel engines, urban buses, and non-road equipment and vehicles. Section 177 of the CAA allows for other states to adopt standards that are identical to California's for the same model years. There are 14 states, known as "Section 177" states after CAA Section 177, that have adopted California's stricter emissions standards and 11 states that have adopted California's Zero Emission Vehicle (ZEV) Program. Source: https://ww2.arb.ca.gov/sites/default/files/2019-10/ca_177_states.pdf

In a 2018 proposed rulemaking, the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule (refer to 47), and in 2019 with part one of its final version of the SAFE rule, the EPA and the National Highway Traffic Safety Administration (NHTSA) are attempting to both revoke the waiver previously granted to California (in January of 2013) — that set more stringent GHG emissions standards and authorized a ZEV Program for vehicle model years 2021 through 2025 — as well as preempt any waivers that would set vehicle GHG emissions standards. Part One of the final version of the SAFE rule does not affect California's Low Emission Vehicle (LEV) Program as it relates to the motor vehicle engine emissions standards that regulate ozone-forming vehicle emissions. The rule also seeks to prevent the adoption of these standards by other states. Nevada, along with 21 other states, Washington D.C., and the cities of New York and Los Angeles, have signed onto California's lawsuit challenging the federal government's attempt to revoke California's authority.

In the proposed version of the SAFE rule, EPA and NHTSA also proposed to amend federal standards for Corporate Average Fuel Economy (CAFE) and tailpipe $CO_2$ emissions standards for passenger cars and light trucks for vehicle model years 2021 through 2026. Specifically, the preferred option in the proposed rule "froze" model year 2020 standards for both CAFE and $CO_2$ emissions through model year 2026. This part of the proposed rule was not finalized in 2019, but its release is expected in 2020.

Adopt a statewide transportation demand management program for large employers, requiring that employers actively participate in minimizing the vehicle trips created by their business.

Provide incentives for the procurement of LEVs and ZEVs for rideshare and other for-hire transportation services.

Adopt pricing strategies such as increasing fuel taxes to reduce single occupant vehicle usage/driving of personal vehicles.

Adopt parking pricing strategies such as lowering parking costs for carpools and vanpools to encourage the use of these services.

Adopt a statewide parking policy that discourages single occupant vehicle use and encourages the use of carpools, vanpools, and other modes of high-occupancy vehicle travel.

Adopt land use policies that discourages more impactful development/encourage less impactful development, such as transportation impact fees based on projected increases/decreases in vehicle miles travelled (VMT) and incentivize mixed use, high density and/or infill development.

Evaluate a requirement for high-occupancy vehicle lanes, rather than general purpose lanes, for any proposed highway expansion.

Equitable Transportation Funding Solution
Adopt a solution to fund Nevada's transportation system in a manner that equitably addresses carbon reduction, transportation system asset management and operations, and provides safe and reliable alternatives to single occupant vehicle travel.

Exemption from Emissions Inspection for Certain Motor Vehicles
Adopt one or more of the changes to the special license plate program that were recommended by the Advisory Committee on the Control of Emissions from Motor Vehicles in 2016 in order to require motor vehicles that would not normally be considered classic vehicles, but nevertheless meet the statutory requirements necessary to obtain special license plates (Classic Vehicles, Classic Rods, or Old Timer), to be treated in a manner similar to other motor vehicles in Nevada.[98,99] The recommendations included in the 2016 study were made in consideration of preserving the interests of owners of legitimate classic vehicles.

Incentivize the Statewide Transition to Low and Zero Emission Vehicles
Adopt a program similar to the federal Car Allowance Rebate System, colloquially known as "cash for clunkers," that provides financial incentives to vehicle owners to trade in older, less fuel efficient vehicles and replace them with LEVs and ZEVs.

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[98] Report on Assembly Bill 146 Study Concerning the Inspection and Testing of Motor Vehicles and Systems for the Control of Emissions from Motor Vehicles in Nevada. Nevada Department of Motor Vehicles, Advisory Committee on the Control of Emissions from Motor Vehicles; 2016 Jun 16. https://dmvnv.com/emission.htm
[99] https://dmvnv.com/publicmeetings.htm#committee

Provide incentives for the replacement of public transit and school buses to ZEVs.

Provide outreach and education on the benefits of ZEV ownership.

Promote existing ZEV incentives and rebate programs.

Procurement
Adopt a coordinated, interagency economy of scale procurement program for state, county, municipal fleets, and school districts that supports LEV and ZEV acquisitions and realizes a reduction in individual unit costs.

Low Carbon Fuels
Adopt a low carbon fuel standard for transportation fuels.

## 10.2 Electricity Generation

Renewable Portfolio Standard
Adopt a Renewable Portfolio Standard (RPS) of 100% by or before 2050 and phase-out all portfolio energy credit (the credits used to comply with the RPS) multipliers.

Provide incentives to customers that are willing to invest in additional renewable energy and/or energy storage resources to ensure that they receive electric service from 100% renewable energy resources.

Phase-Out Fossil Fuel-Fired Electricity Generating Sources
Adopt a freeze on the approval or construction of any new fossil fuel-fired electricity generating sources.

Integrated Resource Plan Proceedings
Move away from using natural gas-fired electric generating units (EGUs) as placeholders in Integrated Resource Plan (IRP) proceedings to ensure that IRPs consider GHG emissions goals. This will improve the accuracy of future projections of GHG emissions and can occur in the absence of new legislation.

Explore accelerated retirement of remaining coal-fired electric generating units operating in Nevada, including merchant and load-serving plants.

Prioritize decarbonization in IRP proceedings as part of, or in addition to, the low-carbon base case.

Demand-Side Management Programs
Prioritize demand-side management programs that have the effect of reducing electricity use during periods of time when renewable generating facilities cannot be relied upon (for example, when the sun is not shining).

Demand-Response Programs
Prioritize demand-response programs that shift load to periods of time when renewable resources can be relied upon to serve the load.

Electric Utility Electric Vehicle Infrastructure Planning
Provide incentives to promote electric vehicle infrastructure/rate structure for more ZEV deployment.

Regional Markets
Evaluate regional markets (that is, potential extended day-ahead markets or the California Independent System Operator's Western Energy Imbalance Market) as new tools to integrate more renewables into the grid and to realize more renewable efficiency gains.

Grid Modernization
Provide for the analysis of and/or initiatives to support a modernized grid that will:

- Promote resilience and protection from future disruptive events, including natural disasters;
- Continue to rate Nevada high on the grid modernization index;
- Be optimized for a changing supply and demand profile with technologies that:
    - Provide the flexibility and optimization, without undue strain on the grid, to integrate increasing;
        i. Distributed energy resources;
        ii. Renewable energy resources; and
        iii. Electric vehicles;
- Be capable of serving as a platform to allow flexibility and the integration of non-wire solutions such as demand- and supply-side software and hardware resources; and
- Ensure the grid is optimized for additional opportunities to reduce GHG emissions.

## 10.3 Industry

Fuel Switching
Provide incentives for stationary combustion sources that fuel switch to less carbon intense fuels.

Energy Efficiency
Provide incentives for the implementation of energy efficient technologies and practices; including more efficient ways to light and heat industrial facilities or to run equipment.

Eliminate Ozone Depleting Substance Substitutes
Evaluate replacement, capture and recycling, or other measures that reduce the usage of ozone depleting substance (ODS) substitutes.

Oil and Natural Gas Production
Adopt more stringent controls on emissions from oil and natural gas exploration, production, transmission, and distribution systems beyond the current federal emissions limitation requirements.

Industrial Processes
Adopt more stringent controls to capture and prevent the release of industrial process emissions.

Sustainability
Promote the production of industrial products from materials that are recycled or renewable, rather than producing new products from raw materials.

## 10.4 Residential and Commercial

Energy Efficiency
Provide incentives for the renovation of existing homes and businesses to reduce their energy demand/make their homes more energy efficient.

Adopt a stretch code that improves energy efficiency in new construction by 20% above the currently adopted International Energy Conservation Code (IECC).

Establish a program that assists state, county, and municipal government agencies with the adoption, implementation, and compliance with the most recently published IECC on a three-year cycle.

Adopt a statewide benchmarking program utilizing the Energy Star program to track water and energy consumption within the built environment. The program would be established such that once the benchmarking is completed, within a year of the establishment of the program, the energy efficiency measures identified through an energy audit will be prioritized and implemented to reach a specific goal. The program would be open to public and private buildings and will provide a challenge and reward mechanism for the buildings that participate and achieve the GHG emissions reduction goals set forth within the program.

Perform and provide an energy audit to buyers during the purchase of a residence, similar to an appraisal or home inspection. The audit should be provided to the potential owner prior to the closing to allow for the negotiation of implementing the measures before the closing occurs. This will increase awareness of efficiency measures available to the buyer along with the cost benefit of implementing the measures to allow further insight into total home ownership costs.

Adopt disclosure documents for potential property purchasers or renters to include overall estimated cost of operating the home or business to include energy and transportation costs (similar to what is currently provided with new appliances).

Establish and adopt appliance energy efficiency standards. Create a timeline for residential and commercial properties to update appliances which include switching lighting throughout the building or residence from less efficient technologies to the most current technologies that provide a higher level of efficiency.

Establish a comprehensive on-site energy efficiency program that can be utilized by residential, commercial, and public sector buildings to increase energy efficiency. The program should include occupant engagement and provide techniques for the occupants to increase efficiencies throughout the space.

Provide incentives to increase renewable energy sourced electrification of the built environment. Incentives would be provided for new construction as well as for existing buildings, both residential and commercial, to switch from fossil fuels to all electric.

Further develop and adopt the Commercial Property Assessed Clean Energy (PACE) program statewide.

Evaluate the effectiveness of adopting a statewide Residential PACE program.

Reduce or Eliminate Fossil Fuel Use

Provide incentives for the conversion of fossil fuel dependent appliances to renewable energy sourced electric alternatives (examples include stoves, water heaters, and furnaces).

Evaluate a freeze or limitation on the installation of gas lines to newly constructed homes and businesses.

Distributed Energy Storage

Provide incentives for the purchase of distributed energy storage at homes and businesses.

- Battery packs at residential and commercial buildings could store renewable electricity and use it when fossil fuel fired-electricity is the only option, effectively reducing emissions.

Infrastructure Improvements in Homes and Businesses to Facilitate Transition to Zero Emission Vehicles

Provide incentives for installation of charging infrastructures in existing facilities.

Provide incentives for inclusion of electric vehicle charging infrastructure in new residential, commercial, and industrial settings.

Establish a planning process to develop robust ZEV infrastructure for all vehicle types across a broad set of stakeholders, including:

- A ZEV infrastructure planning process developed and implemented by an electric utility or rural electric cooperative;
- Opportunities to incentivize and increase the development of workplace charging infrastructure for electric vehicles at existing commercial and industrial facilities;
- Opportunities to incentivize and increase the development of charging infrastructure for electric vehicles for all types of existing residences, including those in underserved and rural areas;
- Opportunities to incentivize and increase electric vehicle readiness for the new built environment by facilitating the addition of charging infrastructure for electric vehicles in new residential, commercial, and industrial settings;
- Opportunities to support the increased development of electric vehicle charging infrastructure at state, county, and local government buildings; and
- Incentivize and encourage the purchase of ZEV’s that will utilize this infrastructure.

Promote awareness and utilization of existing ZEV incentive and rebate programs.

Funding Opportunities
Establish a revolving loan fund to be utilized by state and local government wherein the realized savings are collected back into the account and used to further energy efficiency measures across the existing building stock.

Provide enhanced incentives through the Nevada Clean Energy Fund for the implementation of renewable energy, energy storage systems, and energy efficiency measures in residential and commercial structures.

Establish a loan program with local credit unions to offer low-cost, long-term financing for energy efficiency and renewable energy improvements for residential properties.

Collaborate with utility companies, local municipalities, and rural cooperatives to utilize on-bill financing for energy efficiency improvements in both residential and commercial properties.

Contracting
Utilize energy saving performance contracting to identify opportunities for energy conservation measures and implement the measures that will have the largest effect on reducing GHGs. Performance contracting is well suited for large commercial buildings as well as state-, county-, and city-owned or -leased buildings.

Workforce Development
Establish a clean energy workforce development program to increase training and education around climate action policies and new energy efficiency technologies to ensure a next generation Nevada workforce with the knowledge needed to reach the statewide GHG emission reduction goals.

## 10.5 Waste

Expand Efforts to Convert Fugitive Methane ($CH_4$) Emissions to $CO_2$
Provide incentives for flaring and landfill-gas-to-energy (LGFTE) practices in solid waste landfills and wastewater treatment plants.

- Landfill Methane Outreach Program (LMOP) data can be utilized to identify landfills where the potential for flaring or LFGTE exists.

Prioritize Biogas Recovered from Landfills and Wastewater Treatment Facilities for Transportation
Promote the use of biogas recovered from landfills and wastewater treatment facilities for transportation needs, rather than for electricity generation, where renewable alternatives for electricity generation are already present or can be adopted.

Sustainability Practices to Reduce Methane Emissions
Promote or adopt practices that reduce waste production.

Promote or adopt practices that increase diversion of organic waste.

Provide incentives for construction of anaerobic digesters for the diversion of food waste and flaring and landfill-gas-to-energy (LGFTE) practices of captured methane emissions.

## 10.6 Agriculture

Agricultural Land Management Activities
Promote and provide incentives for the adoption of silvopasture practices.[100]

Promote manure and nitrogen fertilizer management practices that reduce GHG emissions.

Promote practices to reduce emissions from enteric fermentation.

Carbon Sequestration
Provide incentives to sequester carbon through land restoration and retirement, thereby removing highly erodible or environmentally sensitive land from agricultural production.

Promote "no till" and "low till" farmland management practices to protect soil from erosion.

Promote hedgerow, windbreaks, and shelterbelts best practices to protect soil from erosion.

Explore opportunities and incentives to increase carbon sequestration on agricultural and range lands.

## 10.7 Land Use, Land Use Change, and Forestry

Carbon Sequestration
Promote land management practices that increase carbon sequestration by natural lands that are typical and/or native to Nevada.

Expand specific programs (an example being nursery programs) to restore and enhance habitats, including wetlands, with measurable carbon sequestration co-benefits through the Nevada Department of Wildlife and the Nevada Department of Conservation and Natural Resources' Division of Forestry and Division of Natural Heritage.

Expand existing efforts to protect sagebrush habitat through the use of the Sage Grouse Protection Conservation Credit System to include carbon sequestration co-benefits.

Promote enhanced forest biomass utilization with stringent emissions controls, such as restarting the biomass cogeneration plant located at the Northern Nevada Conservation Camp in Carson City.

Urban Forestry
Promote urban reforestation and management.

[100] Silvopasture is an agroforestry practice that integrates livestock, forage production, and forestry on the same land-management unit.

Adopt requirements for increased tree coverage when constructing residences and commercial buildings to increase canopy coverage and reduce heat-island effects in urban areas. Strictly enforced requirements will help reduce the urban-heat island effect as a driver of record-setting temperature increases in Las Vegas and Reno.[101,102]

Decrease Risk of Catastrophic Wildfire Events

Promote land management practices that decrease the risk of catastrophic wildfire events. Such efforts must include comprehensive planning to create more resilient landscapes to prevent wildland fires, and during restoration efforts after fire events.

[101] Wilson M. Las Vegas planners discuss how to mitigate the urban heat island effect. Las Vegas Sun. 2019 Oct 16: Las Vegas, NV. [accessed 2019 Dec 20]. https://lasvegassun.com/news/2019/oct/16/las-vegas-planners-discuss-how-to-mitigate-the-urb/

[102] Burgess K and Foster E. Scorched: Extreme Heat and Real Estate. Urban Land Institute. 2019: Washington D.C. https://americas.uli.org/wp-content/uploads/sites/2/ULI-Documents/Scorched_Final-PDF.pdf

# Greenhouse Gas Inventory and Projections Data Gaps by Sector

SB 254 requires a qualitative assessment of whether the policies identified in the statement of policies supports long-term reductions of GHG emissions to zero or near-zero by the year 2050. That assessment is unavailable at this time as NDEP lacks all of the data necessary to perform a complete assessment of all of Nevada's sources of emissions as well as the potential effects of many of the policies identified in the previous section. Further, while the GHG emissions estimates in this report reflect the best and most complete datasets and currently accepted calculation methodologies, NDEP is aware of many gaps in the data. Several instances where particular data would provide a more complete inventory of Nevada's GHG emissions (both historical and projected) — or would be necessary to provide a complete, qualitative assessment of the statement of policies — are identified in this section.

## 11.1 Transportation

Emissions Inventory

Transportation sector GHG emissions, both historical and projected, currently depend on fuel sales data reported by the Energy Information Administration (EIA). Interagency coordination that provides NDEP with direct access to statewide annual fuel sales data would allow for a better understanding of transportation-related GHG emissions drivers and for more recent historical emissions estimates to be provided in future reports.

Identified Policies

Quantifying the effects of individual policies targeting transportation sector GHG emissions reductions requires data that does not currently exist or is otherwise currently unavailable. For highway vehicles, annual vehicle miles travelled, vehicle makes, models, and model years, and fuel types are all necessary to accurately quantify the effects of policies affecting highway vehicles. Further, vehicle sales data would be necessary to inform the design and effect of vehicle purchase incentive programs.

In addition to passenger vehicles, more detailed information is needed to identify the impact of freight movement to the State's GHG emissions. More detailed information may be necessary to better understand efficiency of the freight system from an energy and transportation perspective, to include, but not limited to origin/destination, if trucks are fully loaded, overloaded, empty, etc. and what the impact of those trips are.

There is uncertainty regarding the quantity and types of non-road equipment and vehicles (airport ground support equipment, construction equipment, farm vehicles, and off road personal vehicles) operating in Nevada. As the engines in these equipment and vehicles have only recently had more stringent emissions standards introduced (compared to other mobile sources), there is likely a high number of non-road equipment and vehicles in Nevada that meet older engine emissions standards. Developing an inventory of the numbers and types of these non-road equipment and vehicles would inform the effects of individual policies that target non-road GHG emissions reductions.

## 11.2 Electricity Generation

Emissions Inventory

Both historical and projected electricity generation emissions can be improved by developing a method for estimating GHG emissions from geothermal power plants. This would require electricity generation data from each of Nevada's geothermal power plants (going back as far as 1990) as well as a thorough understanding of GHG emissions rates from geothermal power plants under various operating conditions.

The effects of the wholesale energy market and access to wholesale energy market data would provide a clearer understanding of how the wholesale market can be considered in NDEP electricity generation sector projections.

## 11.3 Industry

Emissions Inventory

The data regarding ODS substitutes and the manufacturing of semiconductors needs to be investigated and verified. The SIT's estimates appear to be undercounting emissions from these two industrial processes that have especially high GWPs.

## 11.4 Residential and Commercial

Identified Policies

Projecting the effects of policies affecting residential and commercial structures requires data on the age of these structures, how recently they were renovated to a more modern building code, and what current/future building codes are/will be.

## 11.5 Waste

Emissions Inventory

The methods applied to estimate landfill solid waste emissions needs to be performed on a site-by-site basis to accurately consider the individual characteristics of Nevada's landfills. NDEP believes that the $CH_4$ generation rate applied by the SIT (a rate determined by the Intergovernmental Panel on Climate Change for arid climates used in the first order decay equation that models $CH_4$ generation from landfills) is an overestimate for many of Nevada's landfills that are not actively managed in a way that encourages $CH_4$ production (that is, landfills are watered, in part, to support the bacterial decay of organic matter that produces biogas — roughly equal parts $CO_2$ and $CH_4$ — with the $CH_4$ portion of the biogas combusted to generate electricity). Further, studies should be conducted to evaluate the accuracy of the organic fraction percent (that is, the percent of municipal solid waste that is capable of undergoing bacterial decay and producing $CH_4$) applied by the SIT in the first order decay equation.

A program gathering monitoring data at representative landfill sites to validate the calculation should also be considered.

The method of projecting landfill emissions needs to be updated to more accurately reflect incremental increases in LFGTE projects. LFGTE projects expand with new emplaced waste and the current projection method should be updated to accurately reflect this expansion.

The methods used to quantify the GHG emissions associated with the treatment of municipal wastewater need to be updated to accurately reflect existing efforts to collect and manage facility $CH_4$ emissions.

## 11.6 Agriculture

Emissions Inventory
Nevada-specific data needs to be gathered in order to ensure a more accurate emissions projection is developed. The SIT projection tool method of disaggregating national usage, population, and crop production data produces projections that are likely predicting emissions reductions that show no signs of occurring.

## 11.7 Land Use, Land Use Change, and Forestry

Emissions Inventory
The methods applied by the Forestry Inventory and Analysis (FIA) Program to analyze historical inventories needs to be evaluated to better understand the changes to forest carbon flux. Recently released estimates vary wildly from previous ones.

A method to estimate carbon emissions and sequestrations from Nevada's rangelands, grasslands, wetlands, and shrublands needs to be developed. The EPA's Inventory of Greenhouse Gas Emissions currently utilizes the National Land Cover Database and the National Resources Inventory to estimates carbon emissions and sequestrations from these lands. Note that the EPA does not provide state-by-state carbon emissions/sequestrations estimates.