Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2043

Nevada Division of Environmental Protection
2023 Report

Submitted in accordance with NRS 445B.380

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Disclaimer

The information contained in the *Nevada Statewide Greenhouse Gas Inventory and Projections, 1990-2043* 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

A4A	Airlines for America
ACC II	Advanced Clean Cars II
AEO	Annual Energy Outlook
AIM	American Innovation and Manufacturing Act
AMPD	Air Markets Program Data
BTS	United States Department of Transportation Bureau of Transportation Statistics
BTU	British Thermal Unit
CAA	Clean Air Act
CARB	California Air Resources Board
CNG	Compressed Natural Gas
CO2e	Carbon dioxide equivalent
DMV	Nevada Department of Motor Vehicles
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
EV	Electric Vehicle
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Reporting Program
GOE	Nevada Governor's Office of Energy
GWP	Global Warming Potential
IECC	International Energy Conservation Code
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
LCFS	Low-Carbon Fuel Standard
LEV	Low Emission Vehicle
LFGTE	Landfill-Gas-to-Energy
LNG	Liquefied Natural Gas
LULUCF	Land Use, Land Use Change, and Forestry
MMTCO2e	Million metric tons of carbon dioxide equivalent
MWh	Megawatt-hour
NCI	Nevada Climate Initiative
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transportation
NHTSA	National Highway Traffic Safety Administration
NPC	Nevada Power Company
NRS	Nevada Revised Statutes
NSPS	New Source Performance Standards
ODS	Ozone Depleting Substance
PACE	Property Assessed Clean Energy
PUCN	Public Utilities Commission of Nevada
RPS	Renewable Portfolio Standard
SAFE	Safe and Affordable Fuel-Efficient Vehicles
SB	Senate Bill
SC-GHG	Social Cost of Greenhouse Gases
SEDS	State Energy Data System
SNAP	Significant New Alternatives Policy
SIT	State Inventory Tool
SPPC	Sierra Pacific Power Corporation
TTM	Total Ton-Miles
TWh	Terawatt-hour
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
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon dioxide
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 2023 report, *Nevada Statewide Greenhouse Gas Inventory and Projections, 1990 to 2043*. This report has been prepared pursuant to Nevada Revised Statutes (NRS) 445B.380[1], which was approved by the Nevada Legislature during the 2019 Legislative Session and signed into law on June 3, 2019.

As required by NRS 445B.380, 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 2023 report includes an updated inventory of actual GHG emissions through 2021 and projection of GHG emissions through 2043 for the largest emitting sectors (transportation and electricity generation) as well as other key emitting sectors (industry, residential and commercial, waste, agriculture, and land use, land use change, and forestry). It should be noted that 2015 marked the first year that GHG emissions from the transportation sector overtook electricity generation as the largest source of emissions in Nevada.

The report also provides updates to the "statement of policies" included in previous reports. The statement of policies was developed in consultation with the Public Utilities Commissions of Nevada, the Office of Energy, the Department of Transportation, and the Department of Motor Vehicles.

NRS 445B.380 sets emission reduction goals for all GHG emitting sectors of the State's economy: 28% below 2005 levels by 2025, 45% below 2005 levels by 2030, and zero or near-zero by 2050. Nevada led the nation as one of the first states to establish a renewable portfolio standard (RPS) in 1997 and later increased the RPS during the 2019 Legislative Session through SB 358 by requiring 50% of electricity sold in Nevada to originate from renewable energy sources by 2030[2]. While the purpose of Nevada's RPS is the expansion of renewable electricity ***use*** statewide in Nevada, the secondary benefit has been a significant reduction in GHG emissions from the electricity generation sector through expanded ***production*** of renewable electricity in Nevada. Note that renewable electricity ***use*** and ***production*** in Nevada are not synonymous.

On March 21, 2023, Governor Lombardo signed Executive Order 2023-07[3]. The Executive Order outlines Nevada's energy policy objectives including:

- Achieving 50% renewable energy portfolio standard by 2030, as established by SB358 in 2019;
- Developing and maintaining a diverse energy supply portfolio and a balanced approach to affordability and reliability for consumers; and
- Developing sufficient in-state electric generation resources to ensure the needs of all Nevadans are met and ensuring that Nevada has sufficient electric generation resources to mitigate risks during peak usage periods.

Furthermore, Executive Order 2023-07 directs the review and revision of the Nevada Climate Strategy, involving a broad-based stakeholder effort.

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

[2] Not all the electricity sold in Nevada is produced in Nevada, and not all the electricity produced in Nevada is sold in the state (see Section 4).

[3] Executive Order 2023-7. https://gov.nv.gov/Newsroom/ExecOrders/2023/Executive_Order_2023-007. [accessed 2023 Nov 15]

Assumptions and Key Findings

Based on the policies considered in this report and best available data, Nevada is anticipated to reduce economy-wide GHG emissions by 24.5% below 2005 levels in 2025 (3.5% below the NRS 445B.380 target of 28%) and by 27.8% below 2005 levels in 2030 (17.2% below the NRS 445B.380 target of 45%). Policies considered in this report, and used in developing emission projections, do not always match with the policies in effect at the time of the publication of the report (see Section 2.2 and Table 2-3 of the full report for more information). These projections assume the following:

- The impact of the COVID-19 pandemic is captured by actual emissions for 2020 and 2021; however, 2022 and later years are projected and therefore the rate at which emissions are recovering is uncertain (see Section 1.3);
- Recently increased RPS requirements are fully met (see Section 4.3 and Appendix A);
- Part Two of the Safer Affordable Fuel-Efficient (SAFE) Vehicle Rule is implemented (see Section 3.3);
- Clean Cars Nevada, which implements the California Advanced Clean Cars I program (ACCI), is implemented (see Section 3.3);
- Certain coal- and natural gas-fired electric generating units are retired based on current depreciation dates (see Section 4.3 and Appendix A);
- Existing emission standards for the oil and natural gas industry, including exploration, production, and delivery, remain in effect (see Section 5.3);
- Changes in emissions from Ozone Depleting Substance (ODS) substitutes are affected by large uncertainties as previous federal regulations were vacated, but the U.S. Environmental Protection Agency (EPA) finalized a hydrofluorocarbon (HFC) phasedown rule in October 2021 that, while not considered in this report, is anticipated to result in substantial reductions (see Section 5.3 and Appendix A). An updated projection of national HFC emissions that quantifies anticipated reductions from the HFC phasedown rule is expected from the EPA and will be incorporated into this report in following years once the data becomes available;
- On November 30, 2022, Nevada Power Company and Sierra Pacific Power Company filed a joint application with the Public Utilities Commission of Nevada (PUCN) for approval of the Fourth Amendment to the 2021 Joint Integrated Resource Plan[4]. This amendment, approved by the PUCN on May 12, 2023, extended the depreciation dates for several generation facilities across the State. These new projected closure dates are outlined in Table 4-4 and have been incorporated into this report's GHG projection estimates;
- On August 22, 2023, Nevada Power Company and Sierra Pacific Power Company filed a joint application with the PUCN for approval of the Fifth Amendment to the 2021 Joint Integrated Resource Plan[5]. The Amendment introduces uncertainty into the closure of the North Valmy Generating Station and, subsequently, the reported emission projections. The impact of the submitted Amendment on future emissions will be considered after approval by the Public Utilities Commission and likely included in the next year's annual report;
- Due to uncertainties with the State Inventory Tool's (SIT) new carbon stock measuring methodology, NDEP continues to rely on 2016 forest carbon flux estimates for this year's report (see Section 9); and
- The Nevada Division of Natural Heritage commissioned the Desert Research Institute to prepare a report on potential carbon sequestration of native ecosystems of Nevada. The results are briefly discussed in Section 9.

[4] Public Utilities Commission Docket No. 22-11032. [accessed 2023 Nov 09]. https://pucweb1.state.nv.us/puc2/Dktinfo.aspx?Util=Electric

[5] Public Utilities Commission Docket No. 23-08015. [accessed 2023 Nov 09]. https://pucweb1.state.nv.us/puc2/Dktinfo.aspx?Util=Electric

Through 2043, this report projects that emissions from the transportation sector will continue to be the largest emitting sector and that GHG emissions from the industrial sector will be the most rapidly increasing source of emissions under current policies.

Other key findings from the report include:

- In 2021, Nevada contributed 0.67% of the U.S.'s total gross GHG emissions, despite having 0.93% of the population;
- As of 2015, the transportation sector accounts for the greatest percentage of GHG emissions, with 34% of gross GHG emissions in Nevada in 2021;
- Actual transportation emissions show a significant decline in 2020 due to the COVID-19 pandemic, followed by a rebound in 2021. Another decline in transportation emissions is projected for 2022, followed by a relatively static trend through 2042.
- GHG emissions from the electricity generation sector are expected to continue to decrease through 2031 with the tentative retirement of the North Valmy Generating Station in Nevada (currently projected for 2025 based on the 2021 IRP) and the increased RPS established by SB358 (2019). Additional reductions are expected from the conversion of TS Power (a coal-fired power plant owned and operated by Nevada Gold Mines LLC) from a strictly coal-fired facility to a dual-fuel, coal- and natural gas-fired facility. Due to the extension of depreciation dates for several generating facilities, emissions from this sector become static between 2030 and 2043;
- Emissions from the residential and commercial and waste sectors are expected to continue to increase, driven by population and economic growth;
- Industrial process sub-sector emissions are also expected to continue to increase, despite U.S. EPA's HFC phasedown rule which was not finalized until October 2021 and therefore is not considered in this report;
- Upward trends in the transportation, industrial, residential and commercial, and waste sectors offset emissions reduction in the electricity generation sector; and
- Emissions from agriculture and land use, land use change, and forestry sectors largely remain static throughout the complete time series.

Summary of Changes from 2022 Report

Key changes from the previous 2022 report include:

- New estimates for all major economic sectors;
- Updated discussion of COVID-19 impacts on GHG emissions, alongside new 2021 reported emissions that depict Nevada's economic recovery following the 2020 shutdown;
- Updates to the 2023 version of EPA's SIT provide historical emissions estimates for the waste, agriculture, and land use, land use change, and forestry sectors up to 2020; and
- Updates to the 2023 versions of State Energy Data System and Annual Energy Outlook provide historical emissions estimates for the transportation, electricity generation, industry, and residential and commercial sectors up to 2021.

Conclusions

Going forward, Nevada's pathway to reducing GHG emissions and mitigating the impacts of climate change statewide can be achieved through a variety of budget and policy mechanisms informed by input from this report, the *State Climate Strategy*, and other relevant input from state and local agencies, stakeholder groups, university and scientific experts, and the general public.

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 2021 and projected emissions from each of these sectors from 2022 through 2030. 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 Nevada's reduction goals of 28% by 2025 and 45% by 2030 are measured. Reductions in GHG emissions from 2005 through 2020 come primarily from the electricity generation sector. Projections indicate that current policies will achieve reductions in the electricity generation sector primarily due to the recently increased RPS, but unless more aggressive policies are adopted at the state and federal level, these reductions may be offset by increase in emissions in the other sectors, primarily industry and residential and commercial.

Table ES-1 directly compares 2025 and 2030 GHG emissions projections against the NRS 445B.380 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 the relative contribution of gross GHG emissions from each sector for select years (the 2005 benchmark year, 2021 most recent inventory, 2025, and 2030).

Reported gross and net statewide emissions increased by approximately 3 MMTCO2e between 2020 and 2021, driven by the gradual return to normal operations following the COVID-19 pandemic shutdowns and subsequent increase in economic activity. Increases in emissions are primarily seen in the transportation sector.

The transportation sector has been the leading sector of GHG emissions in Nevada since 2015, even considering the reported and projected impacts of the COVID-19 pandemic. The electricity generation sector's contribution is predicted to continue to decrease from 30% in 2021, to 28% in 2025, down to 24% by 2030.

Figure ES-1: Nevada Historical and Projected Net GHG Emissions and Sinks by Sector, 2005-2030, with Projections Beginning in 2022 and Comparisons to Nevada's Emission Reduction Goals for 2025 and 2030

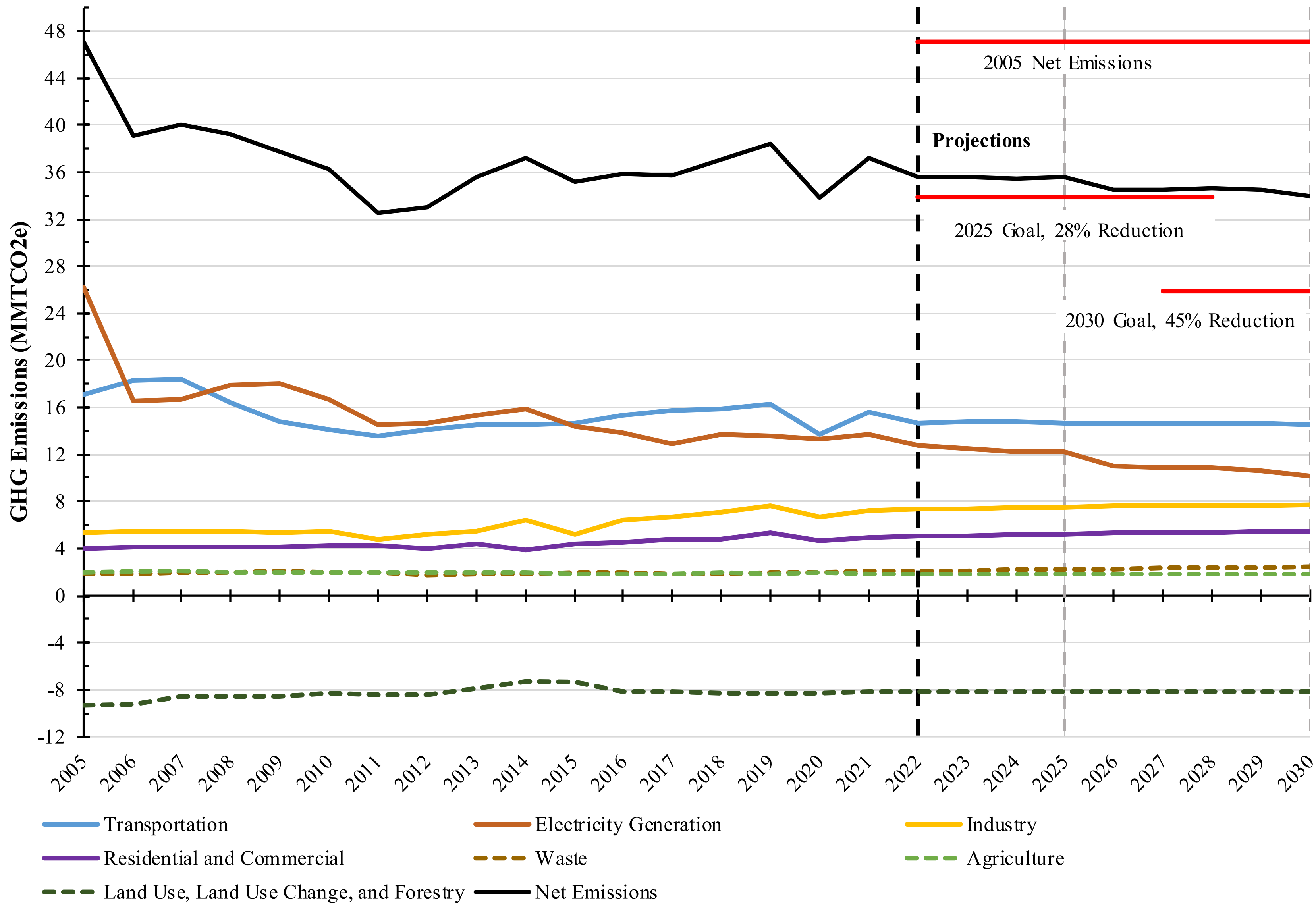
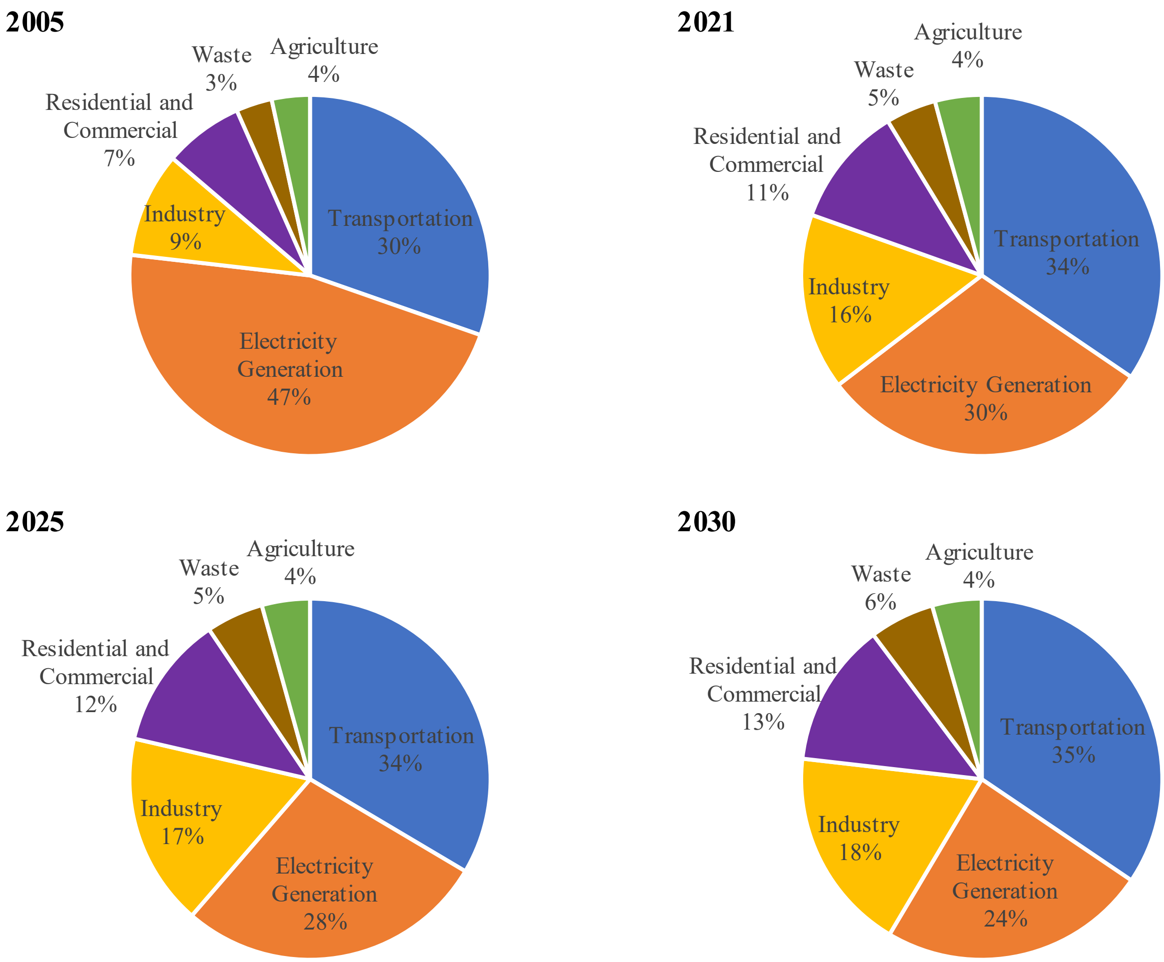


Table ES-1: Nevada Net GHG Emissions Comparison with Nevada's Emission Reduction Goals (MMTCO2e and Percent)

	2005	2025	2030
Net Emissions	47.078	35.559	33.996
Projected Emissions Reduction	-	11.519	13.082
Projected Percent Reduction	**-**	**24.5%**	**27.8%**
Nevada GHG Emissions Goals	-	33.896	25.893
GHG Emissions Reductions	-	13.182	21.185
Percent Reduction	-	28%	45%
Percent Deficit		3.5%	17.2%
Estimated Additional Emissions Reductions Required	**-**	**1.663**	**8.103**

Figure ES-2: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2021, 2025, and 2030



Introduction

1.1 Overview

The *Nevada Greenhouse Gas Emissions Inventory and Projections, 1990-2043* is an inventory of greenhouse gas (GHG) emissions in Nevada starting in 1990 and projected through 2043. In accordance with Nevada Revised Statutes (NRS) 445B.380, this report includes:

- Sources and quantities of GHG emissions in Nevada from transportation (Section 3), electricity generation (Section 4), industry (Section 5), residential and commercial (Section 6), waste (Section 7), agriculture (Section 8), and land use, land use change, and forestry sectors (Section 9);
- A quantification of GHG emissions reductions required to achieve the 2025 and 2030 reduction goals;
- A statement of policies that could achieve reductions in projected GHG emissions, including:
  - 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;
  - 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; and
  - A qualitative assessment of whether identified policies support long-term reductions of GHG emissions to zero or near-zero levels by the year 2050.

The GHGs considered by this report are those listed in 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. Unless the emissions are quantified using apportioned national emissions (which is the case for fluorinated gases), this report uses the GWPs from the Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report.[6, 7, 8]

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[6] GHG emissions quantified using this method generally depend on IPCC Fifth Assessment Report GWPs and are noted as such throughout the report.
[7] Previous inventories have utilized GWPs from previous IPCC assessments.
[8] 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.

Table 1-1: The GHGs and 100-year GWPs without Climate Carbon Feedbacks[9] for the GHGs Considered in this Report[10]

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
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 provides updated emissions from the following sectors:

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

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 updated historical and projected GHG emissions estimates.

For all sectors considered in this report, 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 emitted from each sector.

[9] Climate Carbon Feedback refers to the effect that emissions of CO_2 have on climate change, which impacts the carbon cycle, which impacts atmospheric CO_2, which in turn further changes the climate. GWPs calculated without Climate Carbon Feedback utilize metrics that account for such feedback for CO_2, but do not for all the other species of GHGs. While IPCC recognizes this as a limitation, it also acknowledges that more research is required to define GWPs with Climate Carbon Feedback. See for instance Gasser et al. (2017) *Accounting for the climate-carbon feedback in emission metrics. Earth Syst. Dynam., 8, 235-253*

[10] IPCC (2013) Appendix 8

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 (LULUCF)	CO_2, CH_4, and N_2O

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 2023 release of the United States Energy Information Administration's (EIA's) *State Energy Data System* (SEDS)[11], the 2023 release of the EIA's *Annual Energy Outlook* (AEO)[12], the 2023 release of the EPA's State Inventory Tool[13], recommendations developed by the IPCC, and additional federal, state, and local data sources that were used to increase the accuracy of this report. Along with the primary sources of data previously listed, other major sources of information used by NDEP to prepare the emissions inventory and projections are provided in Table 1-3. 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.

Historical and projected GHG emissions in this report are based on data made publicly available in 2023 or earlier. The most recent inventory year available and presented using these datasets is 2021.

A list of the major sources of information is included 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[14]	U.S. population data
	Nevada State Demographer[15]	Nevada population data
Transportation	EIA	Historical fossil fuel consumption data AEO projections
Electricity Generation	EIA[16]	Historical fossil fuel consumption data Electricity Generation data

[11] State Energy Data System (SEDS): 1960-2021 (complete). US Energy Information Administration. [released 2023 June 23]. https://www.eia.gov/state/seds/seds-data-complete.php?sid=US
[12] Annual Energy Outlook 2023: with projections to 2050. US Energy Information Administration. [released 2023 March 16]. https://www.eia.gov/outlooks/aeo/
[13] State Inventory and Projection Tool. US Environmental Protection Agency; 2023 June 01. [accessed 2023 July 20]. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[14] 2017 National Population Projections Datasets. US Census Bureau. [updated 2018 Sep 6; accessed 2020 Sep 29]. https://www.census.gov/data/datasets/2017/demo/popproj/2017-popproj.html
[15] Lawton M. Nevada County Population Projections 2022 to 2040. Nevada Department of Taxation, Nevada State Demographer; 2022 Oct 1. https://tax.nv.gov/Publications/Population_Statistics_and_Reports/
[16] U.S. Energy Information Administration Electricity Generation Data. [released 2023 Jun 23; accessed 2023 Sep 30]. https://www.eia.gov/state/seds/

Sector	Source/Resource	Information Utilized
	EPA Emissions & Generation Resource Integrated Database (eGRID)[17]	Electric generating unit (EGU) data
	EPA Greenhouse Gas Reporting Program (GHGRP)[18]	EGU data
	Public Utilities Commission of Nevada (PUCN)[19]	Utility regulatory filings
Industry	EIA[20]	Historical fossil fuel consumption data AEO projections Oil and natural gas production data
	United States Geological Survey Minerals Yearbook[21]	Annual production and consumption for different minerals
	EPA's 2019 report, Global Non-CO_2 Greenhouse Gas Emission Projections and Mitigation: 2015-2050[22]	U.S. HFC emissions projections
	United Nations Framework Convention on Climate Change GHG Data Interface[23]	U.S. historical fluorinated gas emissions data
	U.S. Department of Transportation Pipeline and Hazardous Material Safety Administration[24]	Natural gas transmission and distribution data
Residential and Commercial	EIA	Historical fossil fuel consumption data AEO projections
Waste	NDEP Bureau of Sustainable Materials Management[25]	Annual solid waste emplacement data
	EPA Landfill Methane Outreach Program (LMOP)[26]	Waste in place data In-place and planned landfill gas recovery technology information
Agriculture	United States Department of Agriculture (USDA) National Agricultural Statistics Service[27]	Livestock population and crop production data

[17] Emissions and Generation Resource Integrated Database. U.S. Environmental Protection Agency. [updated 2023 Nov 8; accessed 2023 Nov 9]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[18] Greenhouse Gas Reporting Program. U.S. Environmental Protection Agency [accessed 2022 Mar 2]. https://www.epa.gov/ghgreporting
[19] State of Nevada Public Utilities Commission. [accessed 2023 Oct 1]. http://puc.nv.gov/
[20] U.S. Energy Information Administration State Energy Data System. [accessed 2023 Sept 3]. https://www.eia.gov/state/seds/
[21] National Minerals Information Center. U.S. Geological Survey. [accessed 2020 Oct 1]. https://www.usgs.gov/centers/nmic
[22] U.S. Environmental Protection Agency. Global Non-CO_2 Greenhouse Gas Emission Projections and Mitigation: 2015-2050. U.S. Environmental Protection Agency Office of Atmospheric Programs; released 2019 Oct. Washington D.C. EPA 430-R-19-010. [accessed 2022 Nov 18]. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-greenhouse-gas-emission-projections
[23] GHG Data Interface. United Nations Framework Convention on Climate Change. [accessed 2021 Oct 12]. https://di.unfccc.int/
[24] Pipeline and Hazardous Materials Safety Administration. U.S. Department of Transportation. [accessed 2021 Oct 7]. https://www.phmsa.dot.gov/
[25] Solid Waste Facility Management and Recycling Reports. Nevada Division of Environmental Protection, Bureau of Sustainable Materials Management. https://nvwastemanagementreports.ndep.nv.gov/
[26] 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
[27] Quick Stats (Searchable Database). US Department of Agriculture, National Agricultural Statistics Service. [accessed 2023 Oct]. https://quickstats.nass.usda.gov/

Sector	Source/Resource	Information Utilized
Land Use, Land Use Change, and Forestry	USDA Forest Service Forest Inventory and Analysis[28]	Forest productivity
	National Interagency Fire Center (NIFC)[29]	Nevada wildland fire acreage

1.2.1 EIA's State Energy Data System

The State Energy Data System (SEDS) is an annual report prepared by the EIA that provides estimates of U.S. energy data from 1960 through the most recent year of the report's release. SEDS aggregates estimates of production, consumption, prices, and expenditures by source and sector for the U.S., all 50 states, and many of the U.S. territories. Fuel consumption estimates provided by SEDS are used to estimate the historical fossil fuel emissions from transportation, electricity generation, industry, and the residential and commercial sectors. The use of the SEDS allows for the reporting of inventory emissions in more recent years. In this 2023 report, actual emissions are reported through 2021.

1.2.2 EIA's Annual Energy Outlook

The Annual Energy Outlook (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 economic growth. Potential future prices of fossil fuels such as oil and gas as well as renewables are considered. For all cases, current laws and regulations as of November 2022 and current views on economic and demographic trends, and technology improvements remain unchanged.[30] The potential impacts of proposed legislation, regulations, and standards are not considered in the AEO. Of the AEO's multiple cases, the Reference case is utilized by NDEP in its energy consumption projections. That is, the AEO and its Reference case assumptions are used in part to project future GHG from the combustion of fossil fuels from the transportation, industry, and the residential and commercial sectors.[31]

1.2.3 EPA's State Inventory Tool

The State Inventory Tool (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 2050 and is developed in part with the data used to prepare the EPA's national GHG emissions inventory.[32] While the SIT's default input data were used as the primary resource for GHG emissions not associated with the combustion of fossil fuels — specifically industrial process emissions for this report — when more accurate data or methods were available, they were utilized.

1.3 GHG Emissions in Nevada and the Effects of COVID-19

Projected GHG emissions in this report are based on data made publicly available in 2023 or earlier. Due to the availability and time required to process historical fuel consumption data, changes in emissions due to the COVID-19 pandemic are reported as actual emissions up to 2021 and projections for 2022 and later. State emissions show a decline of approximately 12% in 2020 from 2019, driven by a decline in the transportation sector emissions of approximately 16% for 2020. Annual consumption of aviation fuel decreased by 44% compared to 2019.

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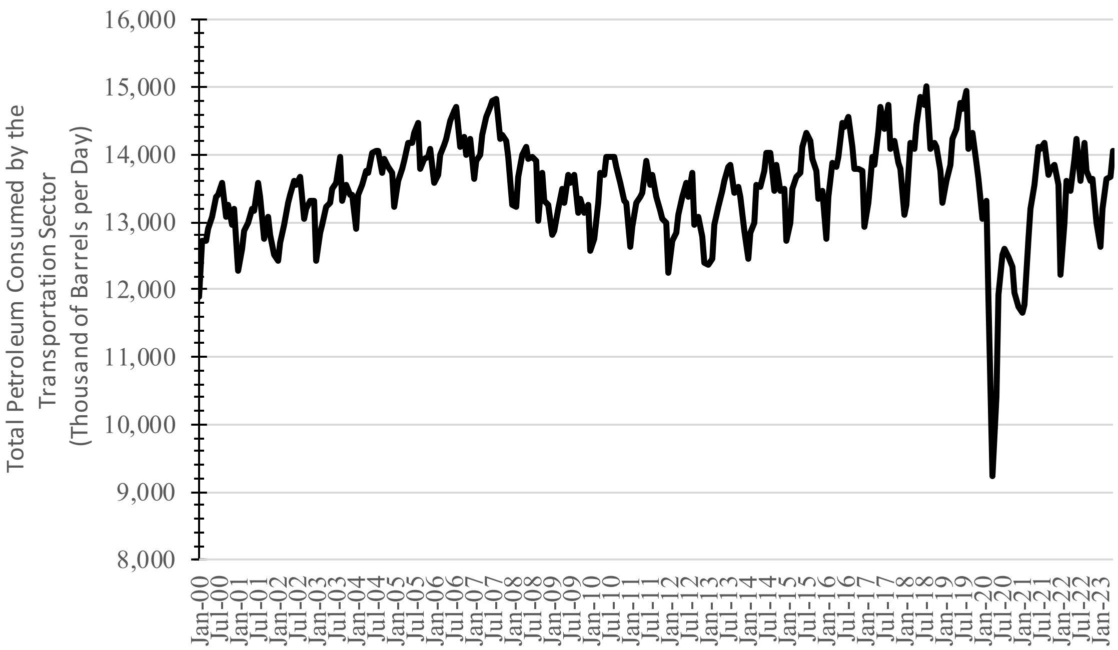
[28] Forest Inventory and Analysis. US Forest Service. [accessed 2023 Oct]. https://www.fia.fs.fed.us/
[29] National Interagency Fire Center. [accessed 2023 Oct]. https://www.nifc.gov/
[30] Assumptions to AEO2023. US Energy Information Administration. [released 2023 March 16]. https://www.eia.gov/outlooks/aeo/assumptions/ .
[31] 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.
[32] The 2023 release of the State Inventory Tool included data to inventory historical emissions from 1990 through 2020 and methods to project emissions from 2021 through 2050.

As projected in NDEP's previous report, an economic recovery from COVID-19 impacts is seen in actual 2021 GHG emissions from 2020, where state net emissions increased by 10%, driven by an increase in transportation emissions of roughly 15%, including a steep rebound of aviation fuel consumption up by 60% compared to the previous year.

In addition, available data for monthly total U.S. consumption of petroleum by the transportation sector may provide a more up-to-date picture of what the recovery in Nevada could look like.[33] Figure 1-1 shows monthly petroleum consumption by the transportation sector in the U.S. from January of 2000 through June of 2022. The sharp decline in January of 2020 (down approximately 70% from January of 2019) is followed by a somewhat rapid W-shaped recovery through July of 2021, followed by a more stabilized trend in 2022 and 2023 that remains about 1,000 thousand barrels per day less than comparable months prior to the COVID-19 pandemic.

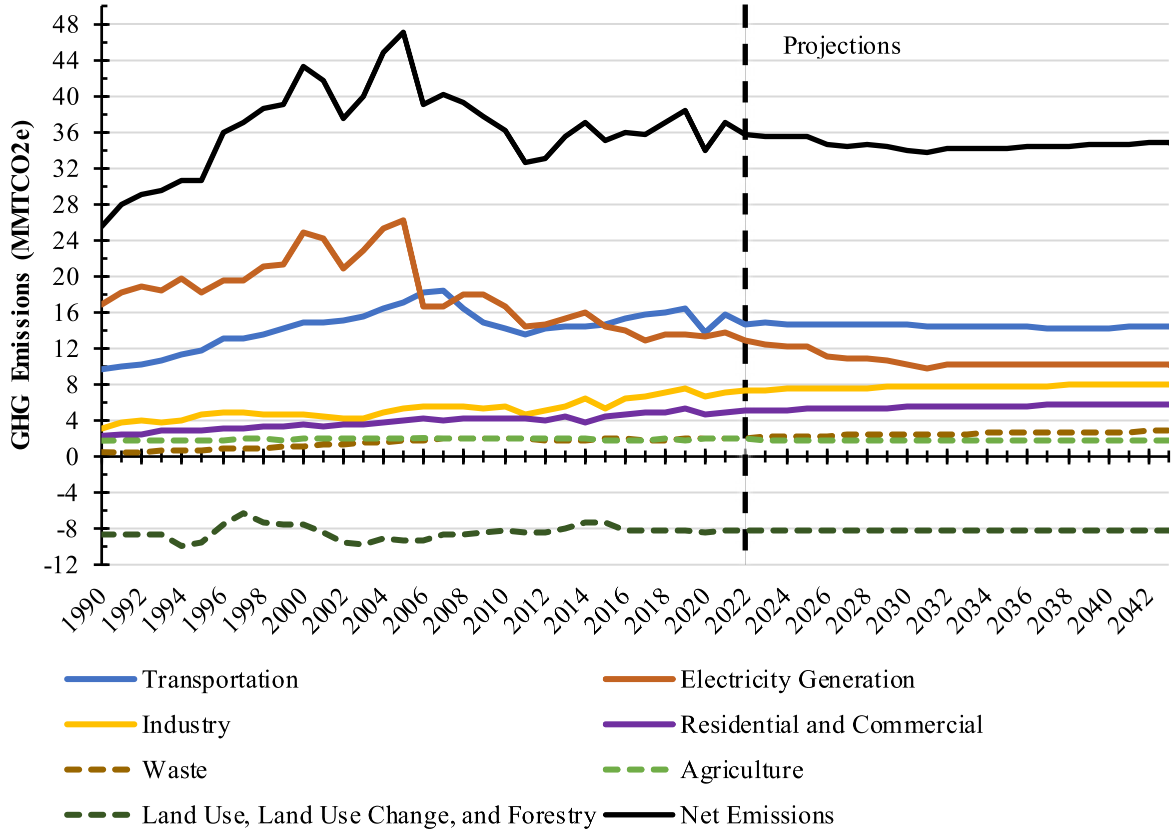
Figure 1-1: Monthly Total U.S. Transportation Sector Petroleum Consumption



[33] Data from EIA, Total Energy – Monthly Energy Review – Petroleum, Table 3.7c Transportation and electric power sectors. https://www.eia.gov/totalenergy/data/browser/index.php?tbl=T03.07C#/?f=M&start=200001

State of Nevada Greenhouse Gas Emissions

Figure 2-1: Nevada Historical and Projected Total GHG Emissions and Sinks by Sector, 1990-2043, with Updated Projections Beginning in 2022



2.1 GHG Emissions, 1990-2021

GHG emissions in Nevada peaked in 2005, when net GHG emissions totaled 47.078 MMTCO2e.[34] Overall, net GHG emissions in 2021 were 21.1% below 2005 levels. Since 2005, significant reductions in Nevada's 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 in the electricity generation sector rather than any significant change in the transportation sector. For 2021, Nevada's net GHG emissions totaled 37.163 MMTCO2e, with transportation accounting for 34.5% of gross emissions.[35]

[34] This report does not include the GHG emissions associated with wildland fires when illustrating statewide emissions.

[35] In this report, gross emissions describe the sum of all sectors acting as sources of GHG emissions while net, or total, emissions are 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.[36] It is, however, important to recognize that GHG emissions are not always spatially associated with their related activities. For instance, the generation (source of emissions) and consumption of electricity (the related activities) can take place in different states. For example, 14.5% of 2021's electricity generation sector GHG emissions (1.976 MMTCO2e) are associated with electricity consumed out-of-state; since that electricity is generated in-state, the related GHG emissions are included in this report.

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 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 report.

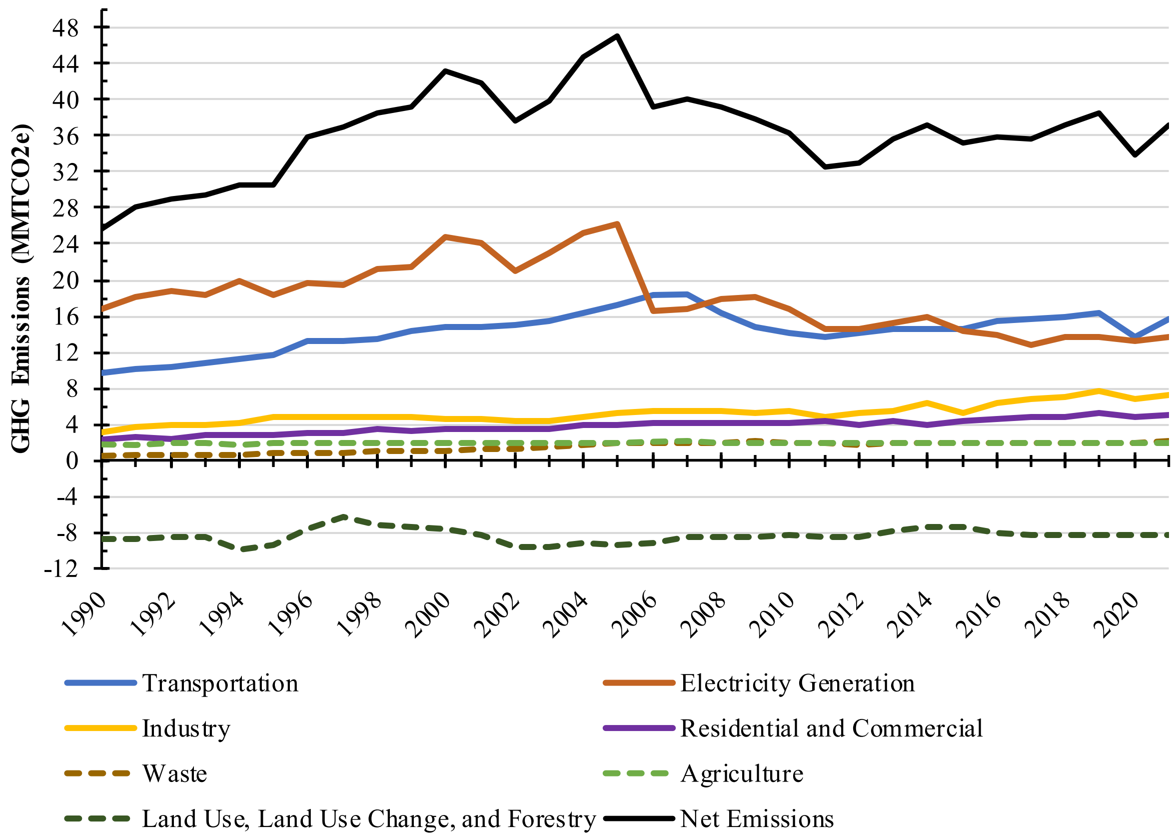
Table 2-1 lists Nevada's GHG emissions and sinks by sector for select years. Figure 2-2 illustrates updated GHG emissions from the transportation, electricity generation, industry, residential and commercial, agriculture, waste, and LULUCF sectors from 1990 through 2021.

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

Sector	1990	1995	2000	2005	2010	2015	2019	2020	2021
Transportation	9.684	11.765	14.865	17.123	14.157	14.614	16.326	13.661	15.657
Electricity Generation	16.849	18.263	24.768	26.211	16.746	14.415	13.571	13.256	13.666
Industry	3.101	4.698	4.623	5.308	5.505	5.271	7.658	6.753	7.186
Residential and Commercial	2.295	2.783	3.512	4.015	4.223	4.402	5.353	4.693	4.924
Waste	0.488	0.742	1.105	1.820	1.940	1.913	1.900	1.914	2.052
Agriculture	1.762	1.846	1.919	1.929	1.956	1.859	1.877	1.898	1.896
LULUCF	-8.626	-9.463	-7.588	-9.329	-8.315	-7.326	-8.242	-8.321	-8.218
Gross Emissions	**34.179**	**40.097**	**50.792**	**56.406**	**44.527**	**42.473**	**46.686**	**42.174**	**45.381**
Net Emissions	**25.552**	**30.635**	**43.204**	**47.078**	**36.212**	**35.147**	**38.444**	**33.853**	**37.163**

[36] The only exception to this being the accounting of certain industrial process emissions. Refer to Industry Section of Appendix A for more details.

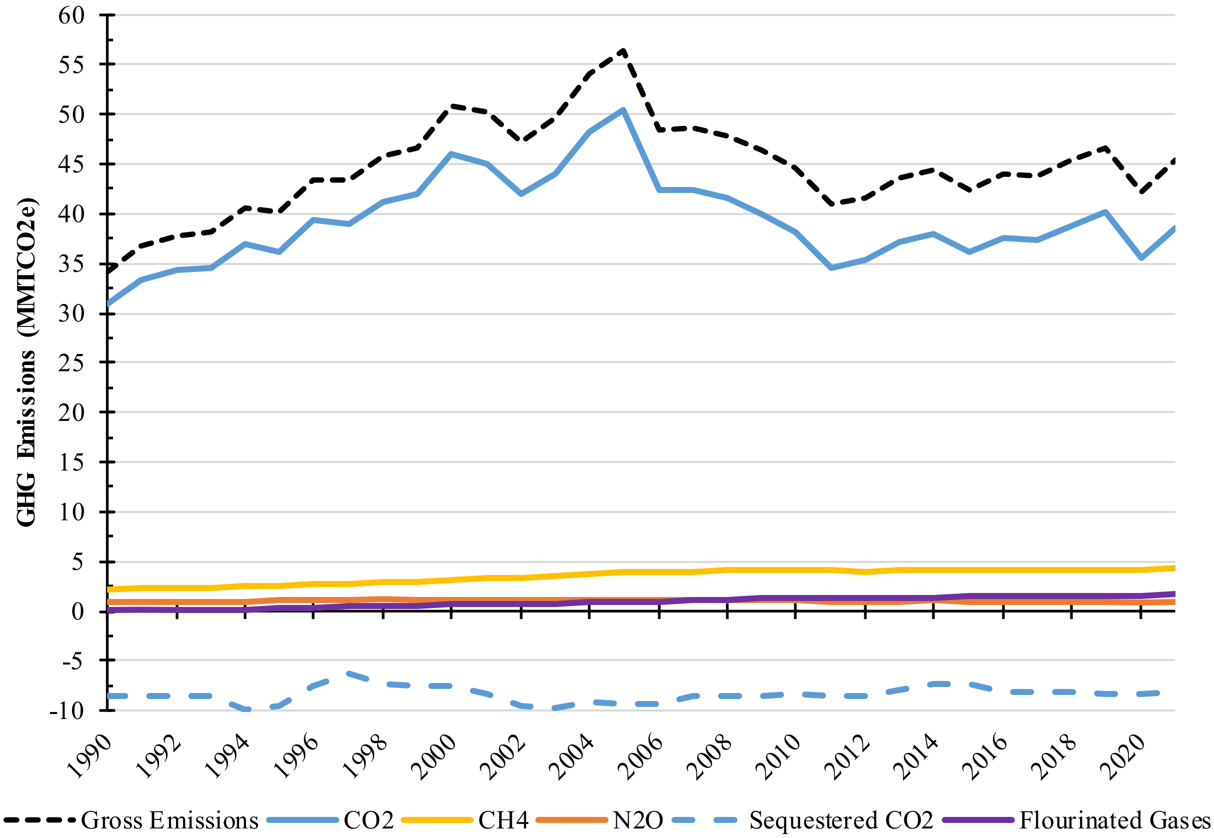
Figure 2-2: Nevada Total GHG Emissions and Emissions from Individual Sectors, 1990-2021



The primary GHG in Nevada is CO_2, which accounted for 85% of gross GHG emissions in 2021. Figure 2-3 illustrates Nevada's total GHG emissions and GHG emissions by individual GHGs for 1990 through 2021. Apart from some industrial processes and the application of minerals to agricultural soils as fertilizers, CO_2 emissions are the result of fossil fuel combustion.[37] CH_4 emissions are the result of the decay of organic matter,the production, transmission, and distribution of natural gas and oil, and fossil fuel combustion byproducts. N_2O emissions are the result of agricultural activities relating to livestock and fertilizers and fossil fuel combustion byproducts. Emissions of HFCs, PFCs, and SF_6 in Nevada are the result of ozone depleting substance (ODS) substitute usage (which are used in air conditioners, aerosols, foams, fire extinguishers, refrigerators, and solvents), HFC, semiconductor manufacturing (PFC), and electric power transmission and distribution (SF_6).

[37] The land use, land use change, and forestry (LULUCF) sector sequesters CO_2 emissions.

Figure 2-3: Nevada Gross GHG Emissions and GHG Emissions by Individual GHG, 1990-2021



GHG emissions in Nevada are generally tied to the State's population and economy. With a growing population, there is an associated increase in various activities including travel, electricity consumption, heating and cooling demands for homes and businesses, and the overall amount of waste generated. Economic expansion/contraction can also lead to changes in GHG emissions. Table 2-2 lists the annual changes in GHG emissions in Nevada by sector for 2016 through 2021.

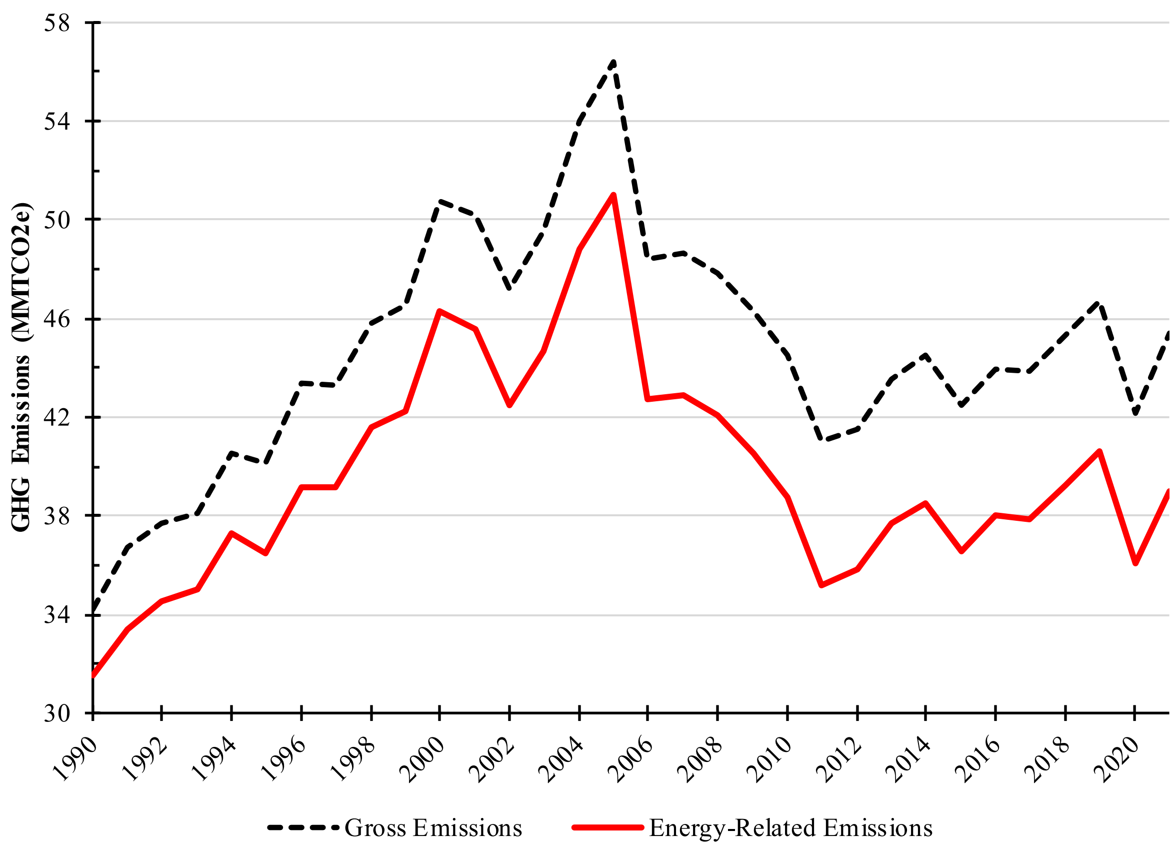
Table 2-2: Annual Changes in Nevada GHG Emissions by Sector, 2016-2021 (MMTCO2e and Percent)

Sector	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Transportation	0.382	2.49%	0.184	1.17%	0.388	2.44%	-2.665	-16.32%	1.996	14.61%
Electricity Generation	-1.028	-7.40%	0.791	6.15%	-0.079	-0.58%	-0.315	-2.32%	0.410	3.09%
Industry	0.374	5.88%	0.338	5.03%	0.591	8.36%	-0.906	-11.83%	0.433	6.42%
Residential and Commercial	0.200	4.37%	0.080	1.68%	0.489	10.06%	-0.661	-12.34%	0.231	4.93%
Waste	-0.096	-4.94%	0.017	0.90%	0.037	1.97%	0.014	0.72%	0.138	7.21%
Agriculture	0.060	3.26%	0.088	4.67%	-0.100	-5.07%	0.020	1.08%	-0.002	-0.09%
LULUCF	-0.082	1.01%	-0.046	0.56%	-0.010	0.12%	-0.079	0.95%	0.103	-1.24%
Gross Emissions	**-0.108**	**-0.25%**	**1.499**	**3.42%**	**1.326**	**2.92%**	**-4.513**	**-9.67%**	**3.207**	**7.60%**
Net Emissions	**-0.190**	**-0.53%**	**1.452**	**4.07%**	**1.316**	**3.55%**	**-4.591**	**-11.94%**	**3.310**	**9.78%**

2.1.1 Fossil Fuel Combustion and Carbon Dioxide Emissions

This report presents historical and projected GHG emissions in Nevada by economic sector. While Nevada's GHG emissions are overwhelmingly associated with the combustion of fossil fuels, the interrelatedness of these sectors and their shared dependence on fossil fuels is not always clear. The transportation, energy generation, stationary combustion and natural gas and oil industry sub-sectors, and the residential and commercial sectors are all sources of energy-related GHG emissions. Combined, these sectors accounted for 51.013 MMTCO2e emissions in 2005 and 39.026 MMTCO2e emissions in 2021, or, 90.4% and 86.0% of Nevada's gross GHG emissions, respectively. Figure 2-4 illustrates both Nevada's gross GHG emissions and energy-related emissions from 1990 through 2021. The decline in energy-related emissions as a percentage of gross GHG emissions is due to Nevada's less carbon-intense electricity generation sector (that is, less coal and more natural gas and renewables) and an increase of non-energy related emissions from industrial processes and emissions from the waste sector.

Figure 2-4: Nevada Gross GHG Emissions and Energy-Related Emissions, 1990-2021



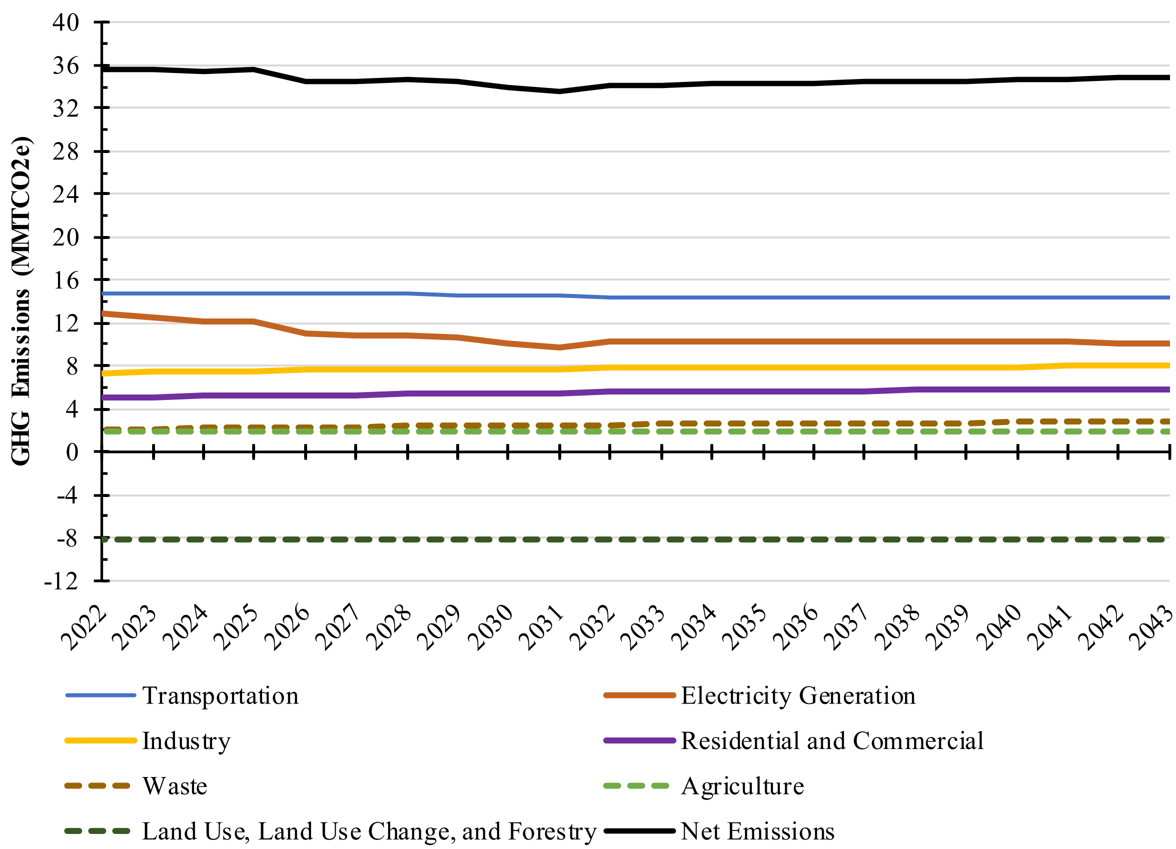
2.2 Emissions Projections, 2022-2043

Projected GHG emissions in this report are based on data made publicly available in 2023 or earlier. Due to the time required to process historical fuel consumption data, 2022 emissions are not reported in the inventory, but are projected. Changes in emissions due to the COVID-19 pandemic are considered in these projections starting with 2022. Under the policies considered in this report, GHG emissions in Nevada are projected to remain relatively unchanged through 2043, with slight decreases in total emissions in 2026 and again in 2031 that are driven by the depreciation-based retirement dates of facilities within the electricity generation sector (Section 4.3). Net GHG emissions in 2025 are projected to be 35.559 MMTCO2e, 24.5% below 2005 levels, net GHG emissions in 2030 are projected to be

33.996 MMTCO2e, 27.8% below 2005 levels, and net GHG emissions in 2043 are projected to increase back up to 34.855 MMTCO2e, or 26.0% below 2005 levels. Since previous depreciation dates for several power generating facilities have been pushed back, emissions are expected to increase in later years, largely driven by rising population and economic activity. The sectors whose emissions are projected to increase through 2043 are industry (additional 0.826 MMTCO2e), residential and commercial (additional 0.194 MMTCO2e), and waste (additional 0.755 MMTCO2e).

While transportation sector emissions increased by 1.996 MMTCO2e between 2020 and 2021, this was due to the economic rebound following the events of the COVID-19 pandemic and shutdowns. Beginning in 2022, emissions in the transportation sector are expected to largely remain static through 2043. This is due to increased emissions driven by population and vehicle demand, counterbalanced by decreased emissions driven by improvements in average fuel economy and increased market share of electric vehicles. Figure 2-5 illustrates Nevada's projected total GHG emissions and the emissions from individual sectors from 2022 through 2043.

Figure 2-5: Projected Nevada Net GHG Emissions and Emissions from Individual Sectors, 2022-2043



Some of the state- and federal-level policies affecting Nevada's GHG emissions that were 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. The federal regulations that have changed since the release of the SIT and the completion of this report have been noted as such in Table 2-3.

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

Sector	Policy	Current Status
Transportation	Part Two of the Safer Affordable Fuel-Efficient (SAFE) Vehicle Rule	In April 2021, EPA and NHTSA formally announced that they are reconsidering this action and soliciting public comments on a more stringent path forward. A new rule was finalized in late December 2021, but it is not considered in this report.
	Clean Cars Nevada	Clean Cars Nevada is effective starting January 1, 2022, and applies to all new model year 2025 light-duty vehicles. The California Air Resources Board approved new regulations for light-duty vehicles (collectively, Advanced Clean Cars II) starting with model year 2026 and later light-duty vehicles. Nevada has not adopted this next set of regulations, and therefore Clean Cars Nevada will be effective for new vehicle model year 2025 only. However, emissions projections presented in this report assume Clean Cars Nevada remains in place beyond model year 2025.
	Greenhouse Gas Emissions Standards for Heavy-duty Vehicles – Phase 3	On April 27, 2023, the U.S. Environmental Protection Agency published a proposed rule in the Federal Register that would set new GHG emissions standards for heavy-duty vehicles in model years 2028-2032 and revise certain standards for model year 2027. A final rule has not been promulgated, so the impacts of the proposed rule were not included in the projections and is provided for informational purposes.
	Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles	On May 5, 2023, the U.S. Environmental Protection Agency published a proposed rule in the Federal Register, which would set new emissions standards for GHGs and other air pollutants for light- and medium-duty vehicles. The proposed standards would phase in starting in model year 2027 through model year 2032. A final rule has not been promulgated, so the impacts of the rule were not included in the projections and is only provided for informational purposes.
Electricity Generation	The updated Renewable Portfolio Standard (RPS) in NRS 704.7821	No changes to the RPS are currently expected.
	The voluntary retirement of the North Valmy Generating Station in 2025.	Since the retirements are voluntary, it remains unknown whether they will occur according to the provided timeline. NV Energy recently submitted a fifth amendment to the 2021 IRP for approval by the PUCN that includes plans to continue operations at the North Valmy Generating Station indefinitely and convert the facility from coal-fired to natural gas-fired.

Sector	Policy	Current Status
	The 2021 Integrated Resource Plan (IRP) approved retirement dates and depreciation-based retirement dates of NV Energy's natural gas-fired electricity generating resources.	On November 30, 2022, NV Energy submitted a fourth amendment to the 2021 IRP. The proposed changes were approved by the Public Utilities Commission of Nevada on May 12, 2023. The new retirement dates have been incorporated into this year's report.
Industry	The EPA's finalized rollback of the 2012 and 2016 new source performance standards (NSPSs) for the oil and natural gas industry on August 13, 2020.	EPA proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Source for the oil and natural gas industry on November 15, 2021. A supplemental proposal designed to update, strengthen, and expand the previous proposal was released on November 11, 2022.
	Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act	NDEP was not able to assess the specific effects of this rulemaking on anticipated fluorinated gas use projections in Nevada. However, EPA announced the rule would phase down the production and consumption of HFCs in the United States by 85% over the next 15 years.[38]

2.3 Nevada's Emission Reduction Goals, the State of Nevada Climate Initiative and Climate Strategy

In 2019, the Nevada Legislature passed multiple climate-related bills including SB 358 to increase the statewide RPS to 50% by 2030. The adoption of SB 254 followed, requiring NDEP to develop an annual, rather than quadrennial, GHG emissions inventory for all major sectors of Nevada's economy, including electricity generation, transportation, and other key sectors. SB 254 also set economy-wide GHG emissions-reduction targets for the State: 28% by 2025, 45% by 2030, and net-zero by 2050 (compared to a 2005 GHG emissions baseline). NDEP's 2021 GHG emissions inventory shows that under the policies considered in this report, Nevada will fall 3.5% short of the 2025 goal and 17.2% short of the 2030 goal if no additional policies or actions are implemented by state and local governments.

Since 2006, the average annual change in total reported emissions is close to zero, and so is the average annual change projected through 2043. In general, the emission reduction trend observed and projected for the electricity generation sector is offset by the upward trends in the industrial and residential and commercial sectors which are all mainly driven by increase in population.

Table 2-4 lists Nevada's net GHG emissions by sector for 2005, 2021, 2025, and 2030 and Figure 2-6 illustrates relative contributions of GHG emissions from the various sectors for 2005, 2021, 2025, and 2030. Figure 2-7 illustrates Nevada's net GHG emissions by sector from 2005 through 2030 with statutory (NRS 445B.380) 2025 and 2030 emission reduction goals included for comparison. Finally, Table 2-5 compares 2005 net GHG emissions against 2025, 2030, and statutory (NRS 445B.380) emission reduction goals for 2025 and 2030.

[38] Final Rule - Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act. U.S. Environmental Protection Agency. [accessed 2022 Nov 18]. https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation

Table 2-5 provides a quantification of reductions in GHG emissions necessary to achieve the GHG emissions reductions goals for 2025 and 2030. Based on current projections, Nevada is short 1.663 MMTCO2e (or 3.5%) of the 2025 goal. Nevada may still be able to meet the 2025 goal if strategic, near-term investments and policies are adopted. Nevada is also currently projected to fall well short of its 2030 goal for GHG emission reductions unless more aggressive investment and policies are adopted in both the near and medium term. Based on Nevada policies considered in this report, it is estimated that Nevada will fall 17.2% short of achieving the 2030 goal of a net GHG emissions reduction of 45% (21.185 MMTCO2e) below 2005 levels.

On March 21, 2023, Governor Lombardo signed Executive Order 2023-07[3]. The Executive Order outlines Nevada's energy policy objectives aimed at:

- Achieving 50% renewable energy portfolio standard by 2030, as established by SB358 in 2019;
- Developing and maintaining a diverse energy supply portfolio and a balanced approach to affordability and reliability for consumers; and
- Developing sufficient in-state electric generation resources to ensure the needs of all Nevadans are met and ensuring that Nevada has sufficient electric generation resources to mitigate risks during peak usage periods.

In addition, Executive Order 2023-07 directs the review and revision of Nevada's 2020 Climate Strategy through a broad-based stakeholder effort.

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

Sector	2005	2021	2025	2030
Transportation	17.123	15.657	14.673	14.548
Electricity Generation	26.211	13.666	12.188	10.159
Industry	5.308	7.186	7.551	7.719
Residential and Commercial	4.015	4.924	5.231	5.458
Waste	1.820	2.052	2.248	2.457
Agriculture	1.929	1.896	1.885	1.871
LULUCF	-9.329	-8.218	-8.218	-8.218
Net Emissions	**47.078**	**37.163**	**35.559**	**33.996**

Table 2-5: Nevada Net GHG Emissions Comparison with NRS 445B.380 Goals (MMTCO2e and Percent)

	2005	2025	2030
Net Emissions	47.078	35.559	33.996
Projected Emissions Reduction	-	11.519	13.082
Projected Percent Reduction	-	24.5%	27.8%
Nevada GHG Emissions Goals	-	33.896	25.893
GHG Emissions Reductions	-	13.182	21.185
Percent Reduction	-	28%	45%
Percent Deficit		3.5%	17.2%
Estimated Additional Emissions Reductions Required	-	**1.663**	**8.103**

Figure 2-6: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2021, 2025, and 2030

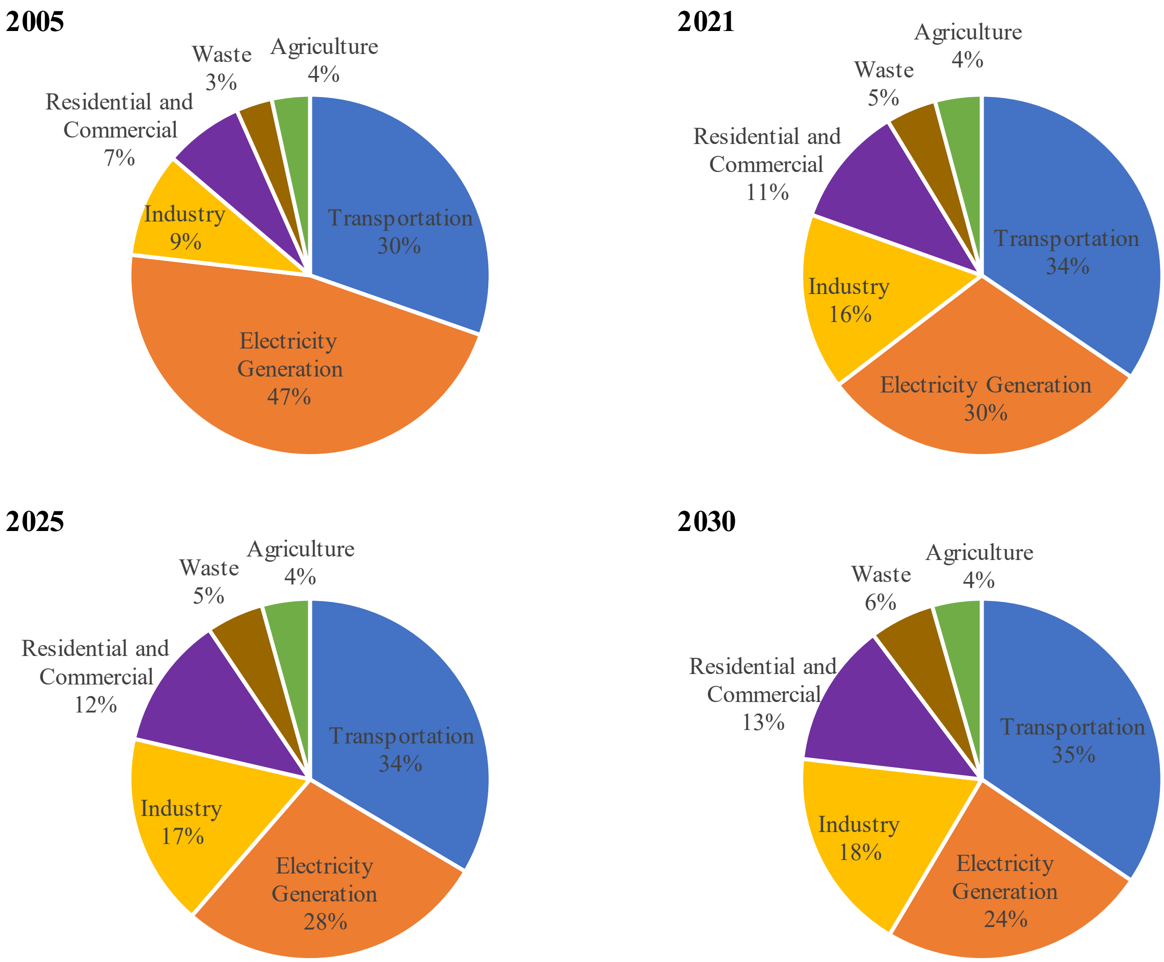
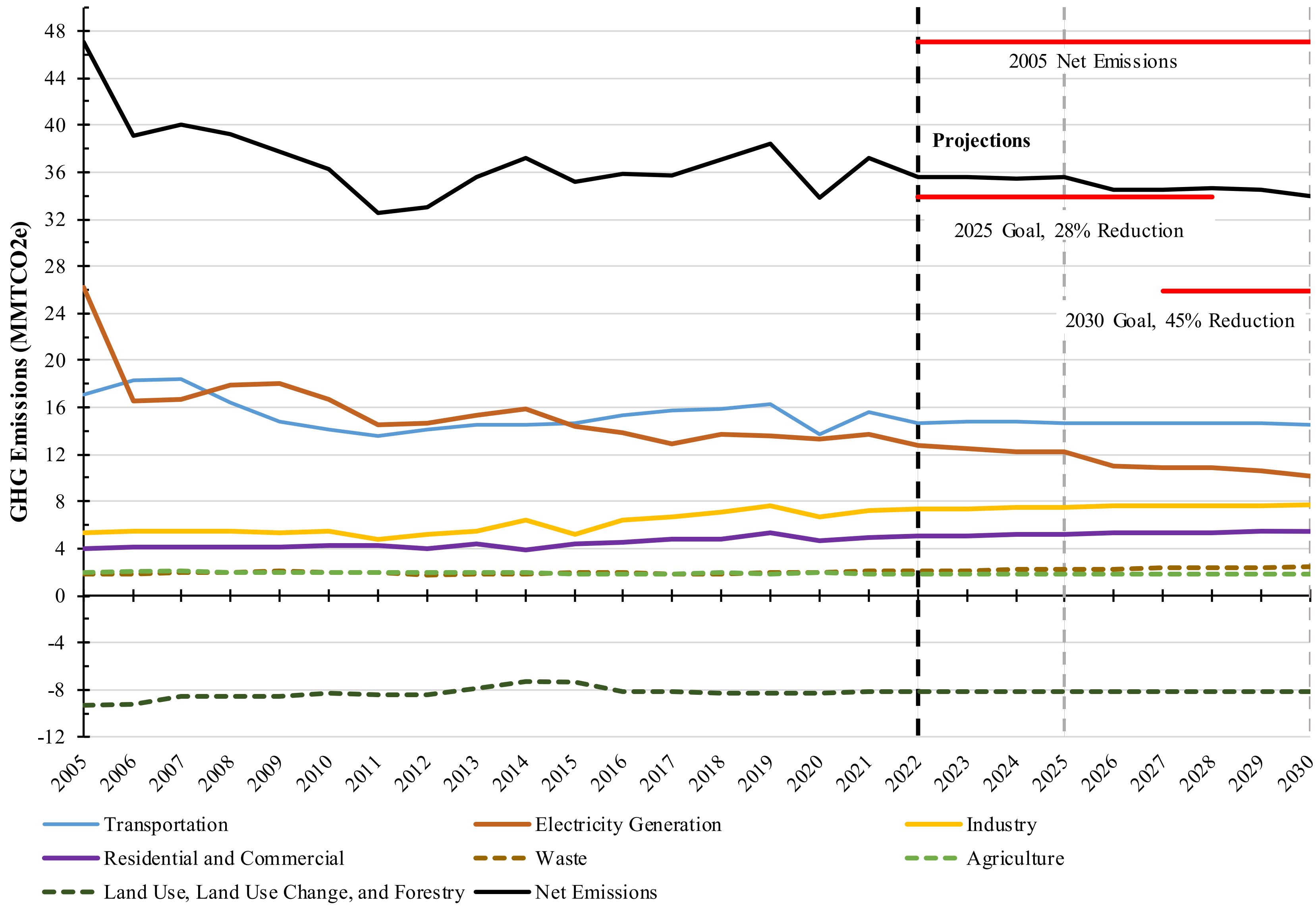


Figure 2-7: Nevada Historical and Projected Net GHG Emissions and Emissions by Sector, 2005-2030, with Updated Projections Beginning in 2022 and Comparison to NRS 445B.380's 2025 and 2030 Goals



Transportation

Figure 3-1: Nevada Net GHG Emissions with Transportation Sector Emissions Emphasized and Updated Projections Beginning in 2022, 1990–2043

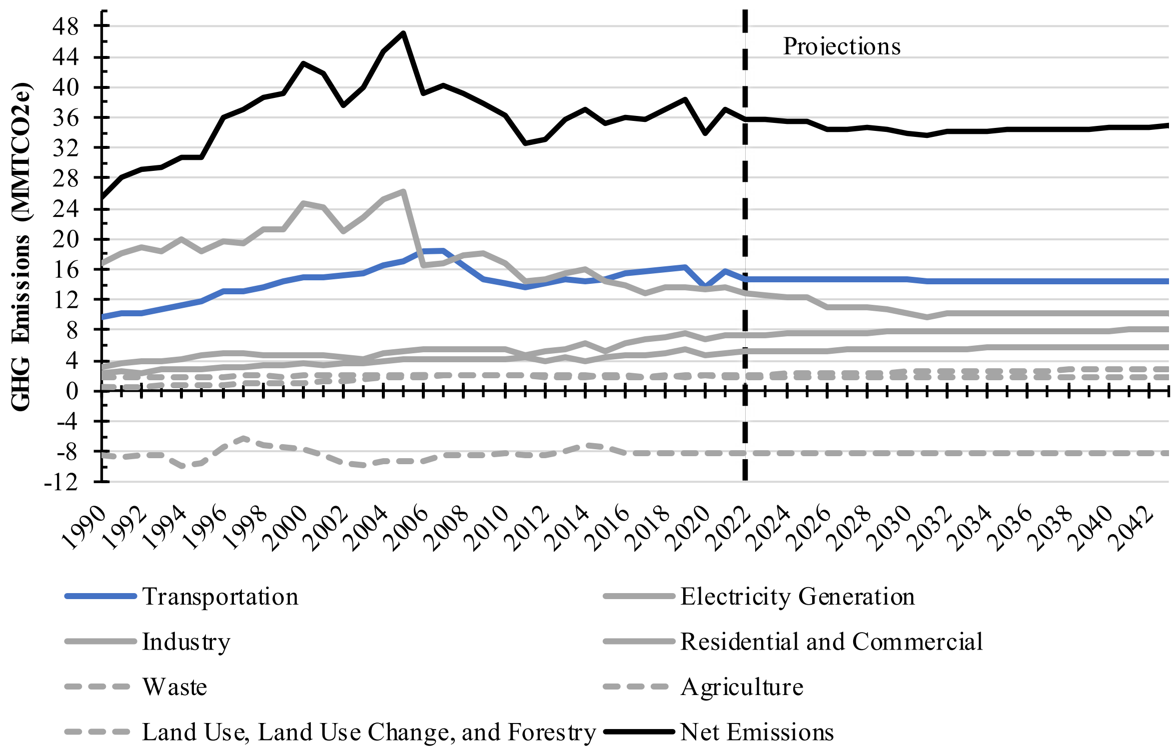
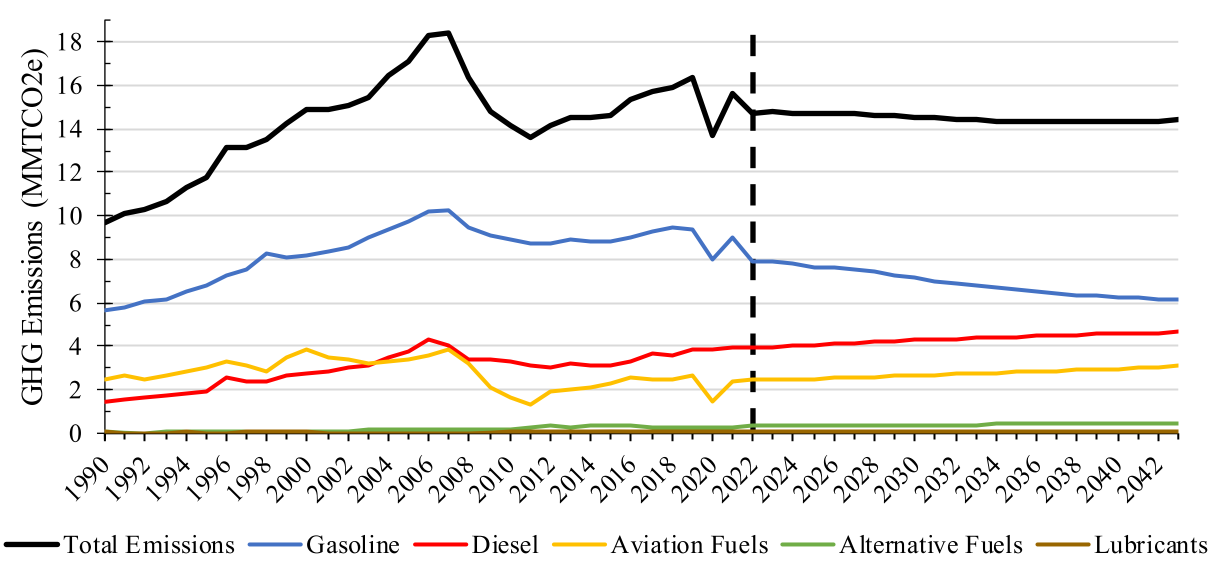


Figure 3-2: Transportation Sector GHG Emissions and Emissions by Fuel Type with Projections Beginning in 2022, 1990–2043



3.1 Overview

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 vary 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.

Transportation sector emissions peaked in 2007 and exceeded the electricity generation sector in 2015 becoming the largest sector of GHG emissions in Nevada. The transportation sector is projected to remain the largest sector of GHG emissions, displaying a slight downward trend in Nevada through 2043. The types of GHGs emitted from this sector are CO_2, CH_4, and N_2O, although the overwhelming majority is attributed to CO_2 emissions. Total transportation sector emissions and emissions for individual fuel types for 1990 through 2043 are illustrated in Figure 3-2.

3.2 GHG Emissions, 1990-2021

The transportation sector exceeded electricity generation in 2015 becoming the largest sector of GHG emissions in Nevada. In 2021, there were 15.657 MMTCO2e emissions attributed to transportation in Nevada, nearly 35% of the State's total GHG emissions. The types of GHGs emitted from this sector are CO_2, CH_4, and N_2O. CH_4 and N_2O account 1.2% of transportation's 2021's GHG emissions. Total transportation sector emissions and emissions for individual fuel types for 1990 through 2043 are illustrated in Figure 3-2.

Transportation sector emissions peaked in 2007 at 18.406 MMTCO2e. The reduced emissions in the years following the 2007 peak were likely due to the Great Recession which caused a reduction in transportation activity across the country. Another sharp reduction is observed in 2020, as the result of the COVID-19 global shutdown. Sector emissions are estimated to be 17.123 MMTCO2e for 2005. Figure 3-3 illustrates transportation sector GHG emissions in Nevada from 1990 through 2021 by fuel type and Table 3-1 lists transportation sector GHG emissions in Nevada for select years. For Figure 3-3 and Table 3-1, note that aviation fuels represent the combined emissions of kerosene, naphtha, and aviation gasoline, while alternative fuels represent the combined emissions from compressed natural gas (CNG), liquefied natural gas (LNG), and other hydrocarbon gas liquids (such as liquefied petroleum gas).

Figure 3-3: Transportation Sector GHG Emissions and Emissions by Fuel Type, 1990–2021

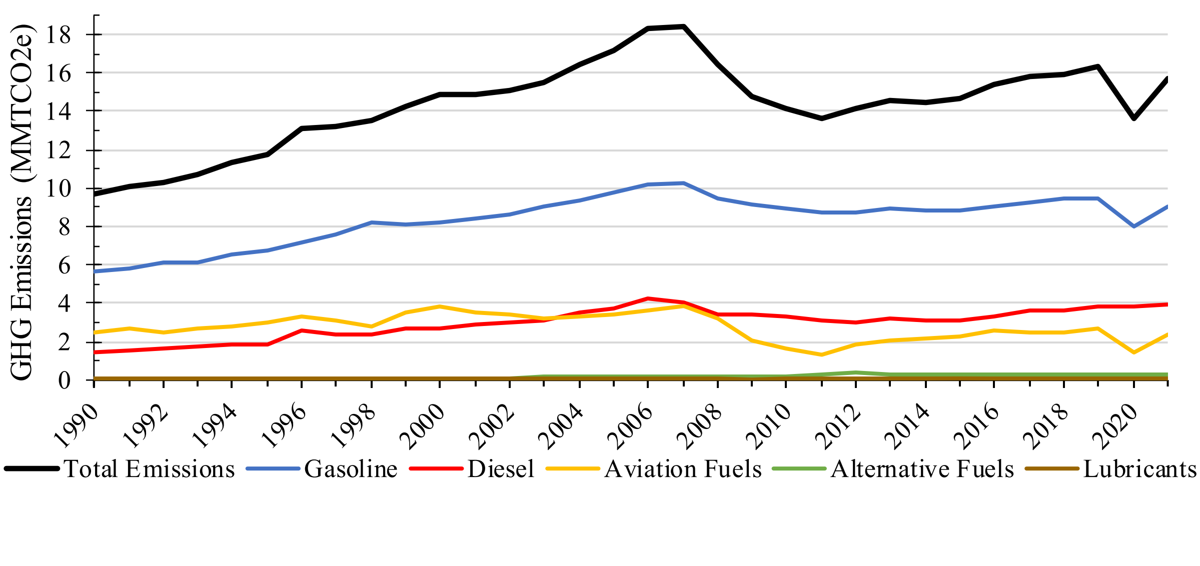


Table 3-1: Transportation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2015	2019	2020	2021
Gasoline	5.654	6.780	8.211	9.744	8.937	8.832	9.403	7.989	9.029
Diesel	1.447	1.883	2.729	3.755	3.308	3.120	3.867	3.852	3.942
Aviation Fuels	2.496	3.014	3.815	3.420	1.613	2.254	2.668	1.474	2.358
Alternative Fuels	0.049	0.051	0.071	0.171	0.213	0.321	0.311	0.278	0.256
Lubricants	0.038	0.037	0.039	0.033	0.087	0.087	0.077	0.069	0.072
Total Emissions	**9.684**	**11.765**	**14.865**	**17.123**	**14.157**	**14.614**	**16.326**	**13.661**	**15.657**

The Transportation sector GHG emissions show an overall positive trend from 1990 to 2021, with sharp declines occurring only during the Great Recession and the COVID-19 shutdown. This increase has been driven largely by aircraft (aviation fuels) and highway vehicles[39]. 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 2016 through 2021 are listed in Table 3-2.

Table 3-2: Annual Change in Transportation Sector GHG Emissions in Nevada by Fuel Type, 2016-2021 (MMTCO2e and Percent)

Fuel Type	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Gasoline	0.215	2.38%	0.210	2.27%	-0.069	-0.73%	-1.415	-15.05%	1.041	13.03%
Diesel	0.312	9.42%	-0.007	-0.20%	0.247	6.82%	-0.015	-0.39%	0.090	2.35%
Aviation Fuels	-0.098	-3.78%	-0.023	-0.92%	0.194	7.84%	-1.194	-44.75%	0.884	59.97%
Alternative Fuels	-0.045	-13.56%	0.008	2.76%	0.018	6.08%	-0.032	-10.41%	-0.022	-8.05%
Lubricants	-0.003	-3.22%	-0.004	-4.49%	-0.002	-1.98%	-0.009	-11.23%	0.003	5.08%
All Fuel Types	0.382	2.49%	0.184	1.17%	0.388	2.44%	-2.665	-16.32%	1.996	14.61%

3.2.1 Highway Vehicle Emissions

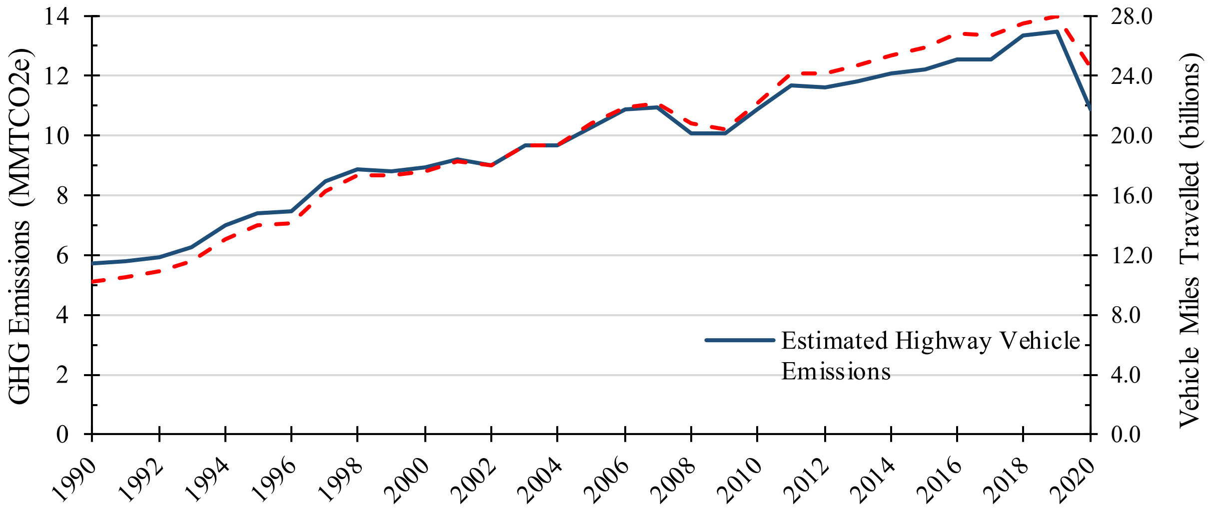
Highway vehicle GHG emissions are the result of passenger cars, light-duty trucks, and medium- and heavy-duty vehicles operating on Nevada's roads and highways. These vehicles are registered by Nevada's and other out-of-state Departments of Motor Vehicles to operate on Nevada's highways. Highway vehicle 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. California is the only state in the nation with the authority to set their own, more stringent vehicle emission standards. For states to do so, they must first seek and receive a waiver from the EPA.

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 (PM) and oxides of nitrogen (NOx) which are both criteria pollutants. These efforts have been generally successful at reducing criteria pollutant emissions from vehicles, but GHG emissions have not been as successfully managed. Since 2009 (both the recent low for highway vehicle GHG emissions and the end of the Great Recession), it is estimated that total vehicle miles traveled (VMT) in Nevada in 2019 had increased by 36.9% (that's more than 7.5 billion additional

[39] While SEDS does not report fossil fuel consumption specifically from highway vehicles — emissions are listed by fuel type, not vehicle type — the SIT's *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.

miles travelled annually compared to 2009) while emissions have increased by 33.9%. In 2020, those figures dropped drastically, comparatively, due to the COVID-19 pandemic. Figure 3-4 illustrates the relationship between estimated highway vehicle GHG emissions and total VMT from 1990 through 2020 in Nevada.

Figure 3-4: Estimated Highway Vehicle GHG Emissions in Nevada and Total VMT, 1990-2020



3.2.2 Jet Fuel Emissions

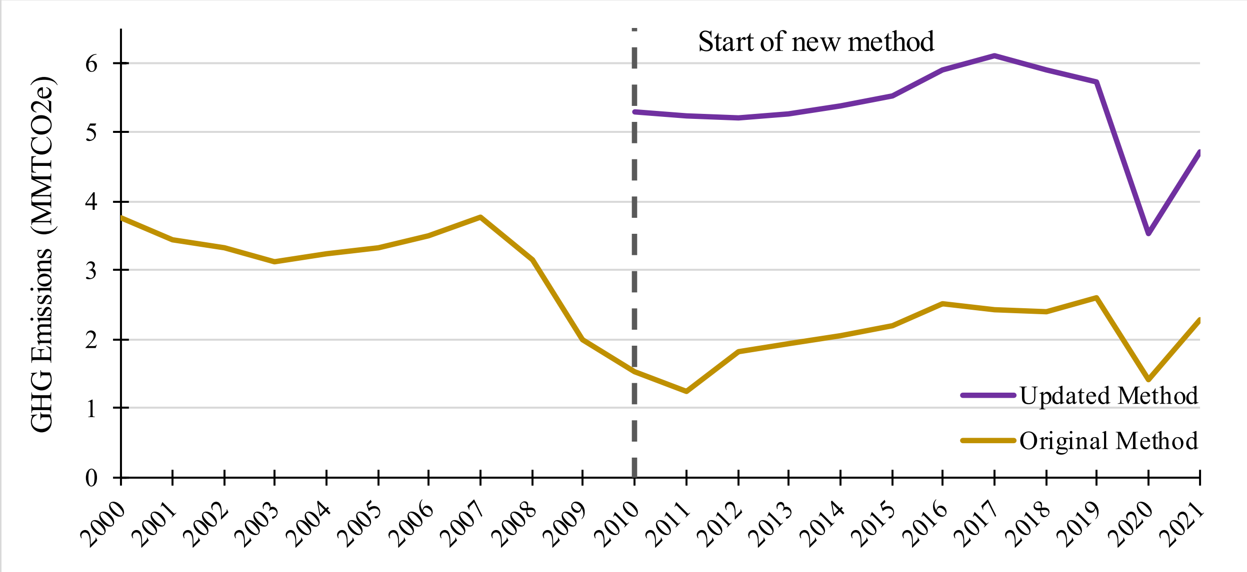
The 2021 release of SEDS includes a new method for allocating commercial aviation jet fuel consumption to states for 2010-2019. Previously, and what's presented throughout this report, jet fuel consumption was associated with the state where the jet fuel was purchased (as reported in the EIA publication *Petroleum Supply Annual*). However, not all commercial aircraft refuel between landing at one airport and departing to another, so the jet fuel sold at an airport in one state to refuel an aircraft might be used for the next several flights of that aircraft. The new method of allocating consumption is based on total ton-miles traveled. From page 56 of the 2021 SEDS technical notes:[40]

> For commercial aviation, SEDS takes annual jet fuel volume data for about 75 to 92 U.S. airports collected by A4A [Airlines4America, the North American airline industry trade group]. Using BTS's [U.S. Department of Transportation Bureau of Transportation Statistics] "Air Carrier Statistics (Form 41 Traffic)—All Carriers" database, "T-100 Segment (All Carriers)" table, SEDS calculates the "total ton-miles" (equal to the product of the estimated total weight of the aircraft, passengers, and cargo multiplied by flight distances) for each origin airport. SEDS first uses the total ton-miles (TTM) data to fill in earlier missing A4A data assuming the growth rates of the airport-level jet fuel volume and TTM are the same. Then, for each year, SEDS calculates a simple ratio of jet fuel volume and TTM for the airports covered in the A4A dataset and applies it to the TTM of all the other U.S. airports to estimate their jet fuel use for commercial aviation. SEDS aggregates the estimates at the airport level to the state level.

The effect of the new method is a different allocation of jet fuel consumption and related GHG emissions across states. For Nevada, jet fuel emissions almost double using the new method. Figure 3-5 illustrates estimated jet fuel emissions in Nevada using both methods.

[40] State Energy Consumption Estimates, 1960 Through 2019. U.S. Department of Energy, Energy Information Administration. [accessed 2021 Oct 18] [Technical Notes p56]. https://www.eia.gov/state/seds/archive/seds2019.pdf

Figure 3-5: Estimated Jet Fuel Emissions in Nevada Using Two EIA Methods of Attribution, 2000-2021



Using the new method, jet fuel emissions are annually an average of 3 MMTCO2e emissions higher in Nevada for the period 2010-2019. Because of the significant difference in approach between the two methods and the fact the SEDS does not provide estimates for the 2005 baseline (making any emissions reduction analysis impossible), NDEP is continuing to use the previous SEDS jet fuel allocation method until it has been determined how best to incorporate the updated method into Nevada's pre-2010 jet fuel consumption data with a focus on the 2005 baseline year Nevada has set for our GHG reduction goals.

3.3 Emissions Projections, 2022-2043

There is some degree of uncertainty with projected transportation sector emissions. In the near-term, this is largely attributed to the impact of the COVID-19 pandemic on emissions in 2022 and beyond (see Section 1.3), as well as shifts in the prevalence of teleworking and hybrid work schedules for many Nevadans. If made permanent, these changes to how some people work will result in a permanent reduction in VMT and therefore transportation sector emissions. In the long-term, there have been several transportation sector regulations announced or finalized and others still that have been vacated by the courts since the assumptions in the 2023 release of the AEO were finalized.

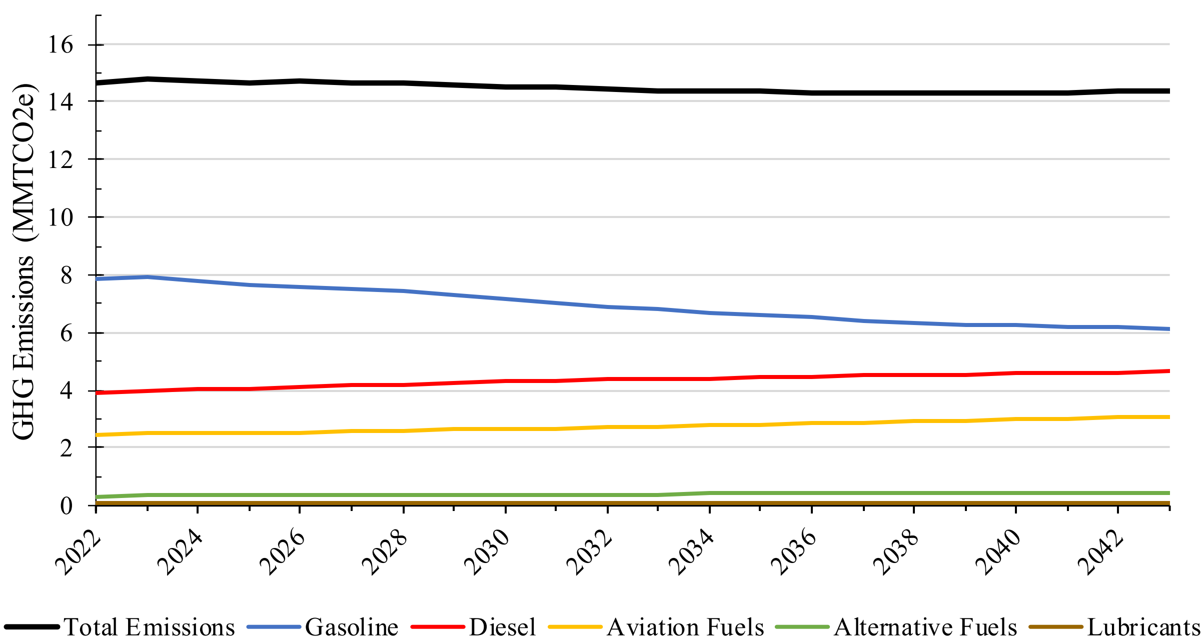
The 2023 AEO Reference case used to prepare these projections assumes current laws and regulations as of November 2022 remain unchanged. This includes regulations such as the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part Two, which rolls back the Tier 3 passenger car and light-duty truck fuel economy standards for vehicle model years 2021 through 2026;[41] as well as the Phase 2 GHG standards for medium- and heavy-duty vehicles, requiring more fuel-efficient vehicles through model year 2027 for medium- and heavy-duty vehicles. Certain impacts, like increased battery-electric vehicle and/or plug-in hybrid electric vehicle adoption, as a result of Inflation Reduction Act (IRA) clean vehicle credits were also considered in the 2023 AEO. It should be noted that not all IRA incentives and credits, and their impacts on GHG emissions, were considered in emissions projections due to the uncertainty around implementation and ultimate influence on domestic markets.

[41] U.S. 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

In September 2020, Nevada adopted regulations known as Clean Cars Nevada. These regulations incorporate California's Low and Zero Emission Vehicle (LEV and ZEV, respectively) programs requiring light-duty vehicle manufacturers to adhere to stricter fleetwide GHG emission standards beginning with model year 2025 vehicles and making more zero emission vehicles available for sale in the State. The adoption of Clean Cars Nevada is considered in these projections, however, while CARB adopted California's new light-duty vehicle standards for model year 2026 and later, Nevada has not. Because of this, Nevada will revert back to federal LEV and ZEV standards starting with vehicle model years 2026. This report's assumptions are not updated to revert to the federal LEV and ZEV standards, and the report still uses the outdated assumption that Clean Cars Nevada will be effective for model year 2026 and later. The potential impacts of these changes on emissions in the transportation sector have yet to be determined. Of relevance is the ongoing electrification of Nevada's transportation sector driven by federal standards and policies as well as market dynamics. Additionally, this report does not account for the U.S. Court of Appeals for the District of Columbia decision on November 12, 2021 which vacated all parts of the Phase 2 GHG standards pertaining to trailers. The consequence of this decision is an anticipated rise in emissions which is not addressed in this report.

Based on the assumptions considered by the AEO, which include the impact of COVID-19, and projected avoided emissions associated with Clean Cars Nevada, transportation sector GHG emissions are estimated to fall to 14.661 MMTCO2e in 2022 and will slightly decrease, but largely remain static, through 2043, reaching an estimated 14.673 MMTCO2e in 2025, 14.548 MMTCO2e in 2030, and 14.401 MMTCO2e emissions in 2043. Figure 3-6 illustrates transportation sector GHG emissions projections in Nevada by fuel type for 2022 through 2043. It is estimated that gains in emission reductions due to new federal and State regulations will be offset by population and economic growth.

Figure 3-6: Transportation Sector Projected GHG Emissions and Emissions by Fuel Type, 2022–2043



Electricity Generation

Figure 4-1: Nevada Net GHG Emissions with Electricity Generation Sector Emissions Emphasized and Updated Projections Beginning in 2022, 1990–2043

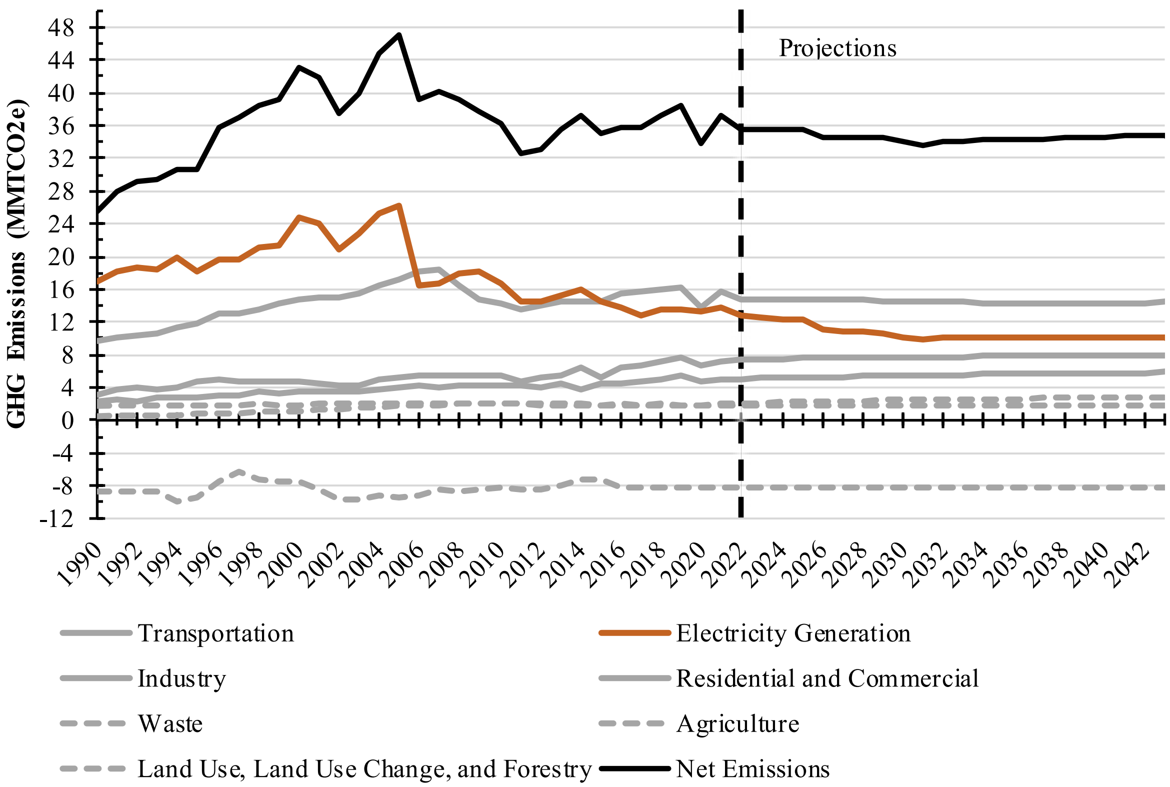
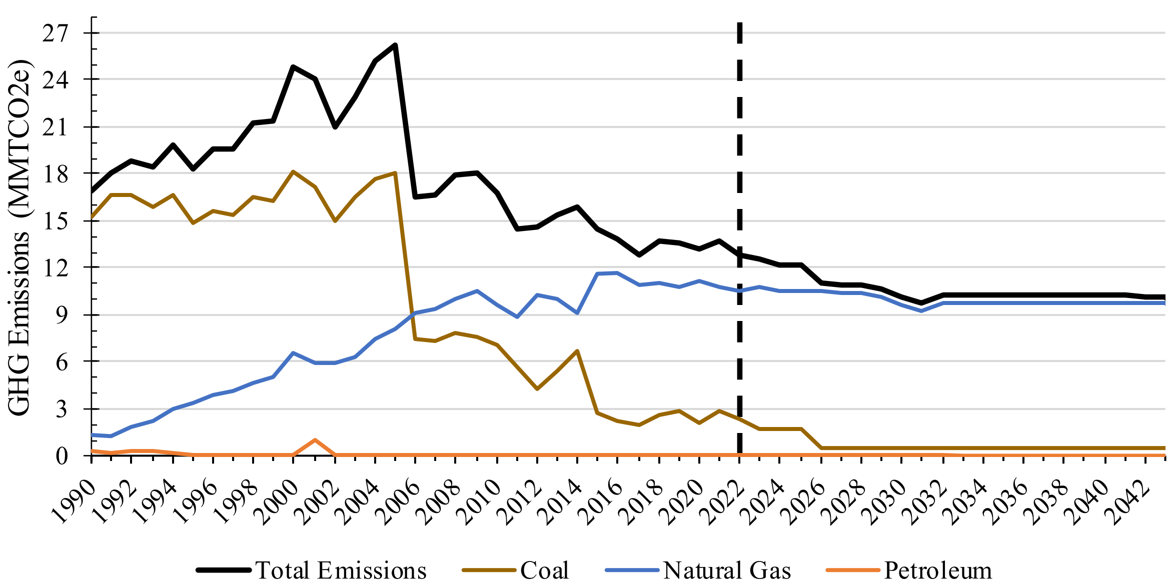


Figure 4-2: Electricity Generation Sector GHG Emissions and Emissions by Fuel Type with Projections Beginning in 2022, 1990–2043



4.1 Overview

This report estimates emissions for all fossil fuel-fired 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 a more accurate accounting of the actual GHG emissions for the State, as emissions are estimated through reported fuel usage at the generating unit level. In 2021, there were an estimated 1.976 MMTCO2e emissions associated with electricity transmitted out-of-state.

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 along with 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.

It is projected that, by 2043, emissions from electricity generation will be 10.179 MMTCO2e emissions, or 24% of the State's gross GHG emissions. Reductions in emissions and the electricity generation sector's continued decline through the projection period are largely associated with the assumed retirement of the North Valmy Generating Station (one of Nevada's two remaining coal-fired power plants) and the announced plan to convert TS Power (Nevada's other remaining coal-fired power plant) to a dual-fuel facility that can operate on both coal and natural gas.

Total electricity generation sector emissions by fuel type for 1990 through 2043 are illustrated in Figure 4-2. Electricity generation sector emissions were 26.211 MMTCO2e in 2005 and are projected to be 12.118 MMTCO2e and 10.159 MMTCO2e in 2025 and 2030, respectively.

On May 12, 2023, the Public Utilities Commission of Nevada (PUCN) approved the Fourth Amendment to the 2021 Joint Integrated Resource Plan filed by Nevada Power Company and Sierra Pacific Power. The Amendment extended the retirement dates based on depreciation for multiple power generating units, with most receiving a 10-year extension. A comparison of the retirement dates assumed in this year's report versus previous year's reports as it pertains to the Fourth Amendment is included in Table 4-1.

Table 4-1: Updated Retirement Dates for Select Power Generating Facilities from the Fourth Amendment to the 2021 Joint IRP

Facility	Units	Pre-Amendment Retirement (used in previous year's reports)	Post-Amendment Retirement (used in this year's report)
Clark Generating Station	4	2030	2035
	5, 6, and 10	2034	2044
	7, 8, and 9	2033, 2038, 2040	2043
	11-22 (peakers)	2038	2049
Harry Allen	3 and 4	2036	2046
	CC	2046	2049
Chuck Lenzie	Facility	2041	2049
Silverhawk	Facility	2039	2049
Higgins	Facility	2039	2049
Las Vegas Gen Station	Facility	2039	2049
Sun Peak Gen Station	Facility	2031	2041
Clark Mountain	Facility	2034	2044

On August 22, 2023, Nevada Power Company and Sierra Pacific Power Company filed a joint application with the Public Utilities Commission of Nevada (PUCN) for approval of the Fifth Amendment to the 2021 Joint Integrated Resource Plan[42]. The Amendment introduces uncertainty into the closure of the North Valmy Generating Station and, subsequently, the reported emission projections. The impact of the submitted Amendment on future emissions will be considered after approval by the Public Utilities Commission and will likely be included in the next year's annual report.

4.2 GHG Emissions, 1990-2021

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 79.2% of 2021 emissions, 10.830 MMTCO2e), and an ever-increasing reliance on renewable electricity (hydroelectric, solar thermal and photovoltaic, wind, and geothermal resources). In 2021, it is estimated that 13.666 MMTCO2e emissions attributed to electricity generation were emitted in Nevada, that's roughly 30% of the State's gross GHG emissions.

Figure 4-3 shows electricity generation sector GHG emissions in Nevada from 1990 through 2021 by fuel type and Table 4-2 lists electricity generation sector GHG emissions in Nevada for select years.

Figure 4-3: Electricity Generation Sector GHG Emissions by Fuel Type, 1990–2021

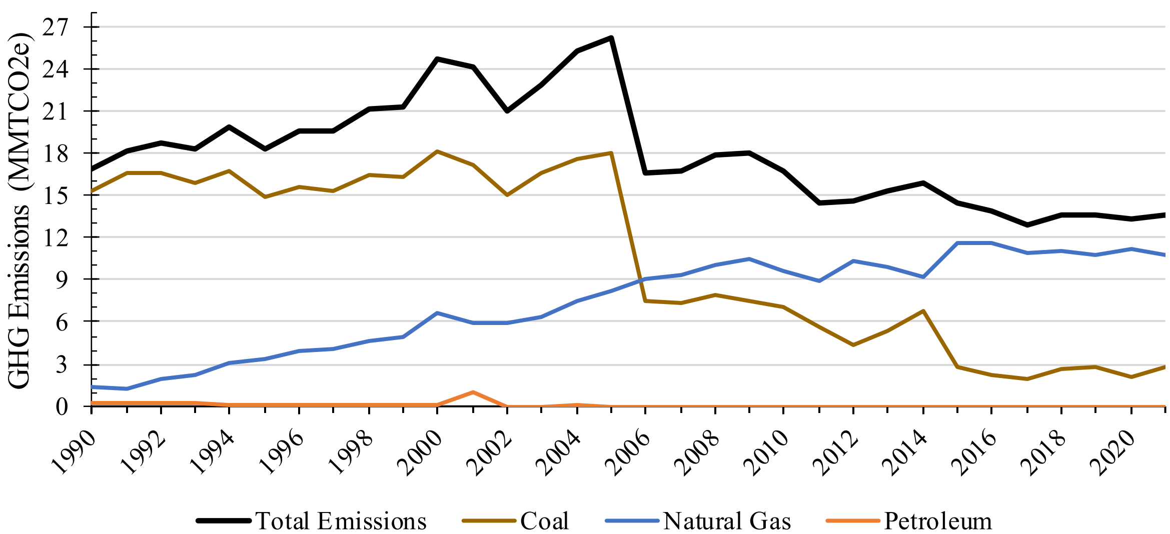


Table 4-2: Electricity Generation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2015	2019	2020	2021
Natural Gas	1.333	3.380	6.581	8.133	9.627	11.614	10.710	11.205	10.830
Coal	15.266	14.858	18.132	18.059	7.108	2.787	2.851	2.045	2.829
Petroleum	0.250	0.024	0.055	0.019	0.011	0.013	0.011	0.006	0.007
Total Emissions	**16.849**	**18.263**	**24.768**	**26.211**	**16.746**	**14.415**	**13.571**	**13.256**	**13.666**

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

[42] Public Utilities Commission Docket No. 23-08015. [accessed 2023 Nov 09]. https://pucweb1.state.nv.us/puc2/Dktinfo.aspx?Util=Electric

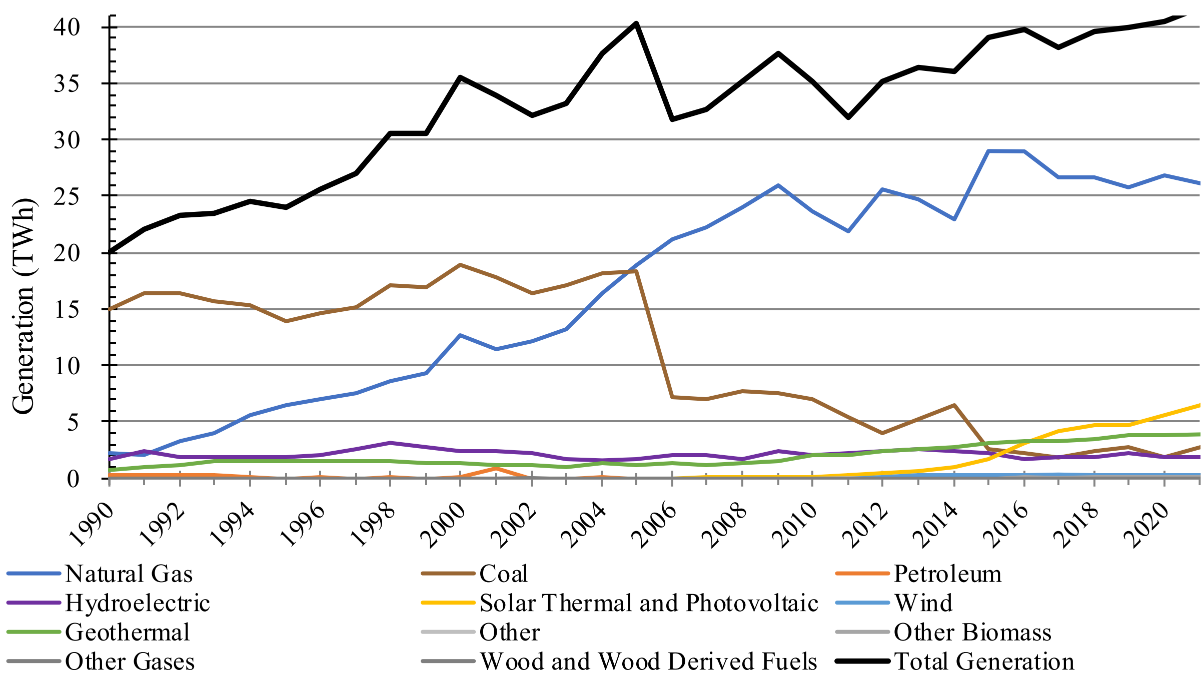
shutting down). Smaller inter-annual variability is likely associated with factors such as weather variability and the economy. An especially hot summer could mean higher demand for air conditioning, which would not be otherwise utilized in cooler conditions, resulting in an increase in emissions. Annual changes in electricity generation sector GHG emissions by fuel from 2016 through 2021 are listed in Table 4-3.

Table 4-3: Annual Change in Electricity Generation Sector GHG Emissions in Nevada by Fuel Type, 2016-2021 (MMTCO2e and Percent)

Fuel Type	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Natural Gas	-0.763	-6.57%	0.168	1.55%	-0.300	-2.72%	0.495	4.63%	-0.376	-3.35%
Coal	-0.264	-11.62%	0.622	30.96%	0.220	8.34%	-0.806	-28.26%	0.784	38.33%
Petroleum	-0.001	-12.90%	0.001	13.89%	0.001	15.45%	-0.005	-47.18%	0.001	22.67%
All Fuel Types	**-1.028**	**-7.40%**	**0.791**	**6.15%**	**-0.079**	**-0.58%**	**-0.315**	**-2.32%**	**0.410**	**3.09%**

Using EIA data, Figure 4-4 shows, in terawatt-hours (TWh)[43], the amount of electricity generated in Nevada from 1990 through 2021 by source.[44] Table 4-4 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 nearly 31% of the electricity generated in Nevada in 2021; 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, 1990-2021, TWh



[43] For reference, 1 TWh is the same as 1,000,000 megawatts-hours (MWh).
[44] U.S. Energy Information Administration Electricity Generation Data. [released 2023 Jun 23; accessed 2023 Oct]. https://www.eia.gov/state/seds/

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

Source	2005	2010	2015	2016	2017	2018	2019	2020	2021
Natural Gas	18.836	23.688	29.000	28.922	26.626	26.689	25.775	26.801	26.130
Coal	18.384	6.997	2.657	2.167	1.866	2.485	2.735	1.953	2.752
Petroleum	0.021	0.011	0.016	0.011	0.009	0.010	0.012	0.006	0.008
Hydroelectric	1.702	2.157	2.264	1.789	1.813	1.881	2.242	1.923	1.944
Solar Thermal and Photovoltaic	0.000	0.217	1.657	3.124	4.146	4.719	4.811	5.535	6.585
Wind	0.000	0.000	0.310	0.344	0.361	0.312	0.329	0.325	0.340
Geothermal	1.263	2.070	3.111	3.353	3.292	3.462	3.909	3.801	3.917
Other	0.000	0.000	0.001	0.021	0.032	0.029	0.022	0.026	0.027
Other Biomass	0.000	0.000	0.026	0.055	0.058	0.053	0.054	0.054	0.050
Other Gases	0.008	0.006	0.006	0.001	0.000	0.000	0.000	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	0.000
Total Generation	**40.214**	**35.146**	**39.047**	**39.787**	**38.201**	**39.640**	**39.890**	**40.425**	**41.755**

4.3 Projected Emissions, 2022-2043

In 2023, 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 generated electricity out-of-state. Table 4-5 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 4-5: Information for Power Plants Operating in Nevada in 2023

Power Plant Name	County Located	Destination for Electricity	Combined Facility Nameplate Capacity (MW)	Projected Closure
Coal-Fired Power Plants				
North Valmy Generating Station[45]	Humboldt	Nevada and Idaho	567	2025
TS Power[46]	Eureka	Nevada	242	2048
Natural Gas-Fired Power Plants				
Apex Generating Station	Clark	California	600	2043
Chuck Lenzie Generating Station	Clark	Nevada	1,465	2049
CityCenter Central Plant Cogen Units	Clark	Nevada	8.6	
Clark Mountain Combustion Turbines	Storey	Nevada	170	2044
Desert Star Energy Center	Clark	California	536	2040
Edward W. Clark Generating Station	Clark	Nevada	1,375	2035-2049
Fort Churchill Generating Station[47]	Lyon	Nevada	230	2028

[45] There is a pending application from NV Energy to re-power both Valmy units with natural gas and to extend their lives through 2049. See open PUCN Docket No. 23-08015, Vol. 1, pg. 25 of 256, item 2.a. These potential changes were not incorporated into this report's projections.
[46] Nevada Gold Mines is currently converting the TS Power plant to have dual fuel (natural gas and coal) capability.
[47] Fort Churchill's currently approved retirement date is 2038. See PUCN Docket No. 22-06015, Vol. 1, Lescenski direct, exhibit 2, pg. 63 of 315. This report's projections assume a retirement date in 2028 for this source.

Power Plant Name	County Located	Destination for Electricity	Combined Facility Nameplate Capacity (MW)	Projected Closure
Frank A. Tracy Generating Station[48]	Storey	Nevada	863	2028-2043
Harry Allen Generating Station	Clark	Nevada	745	2046-2049
Las Vegas Generating Station	Clark	Nevada	359	2049
Nevada Cogeneration Associates #1 and #2	Clark	Nevada	191	2023
Saguaro Power Plant	Clark	Nevada	127	2031
Silverhawk Generating Station[49]	Clark	Nevada	664	2049
Sun Peak Generating Station	Clark	Nevada	222	2041
Walter M. Higgins Generating Station	Clark	Nevada	688	2049
Western 102 Power Plant	Storey	Nevada	117	2045

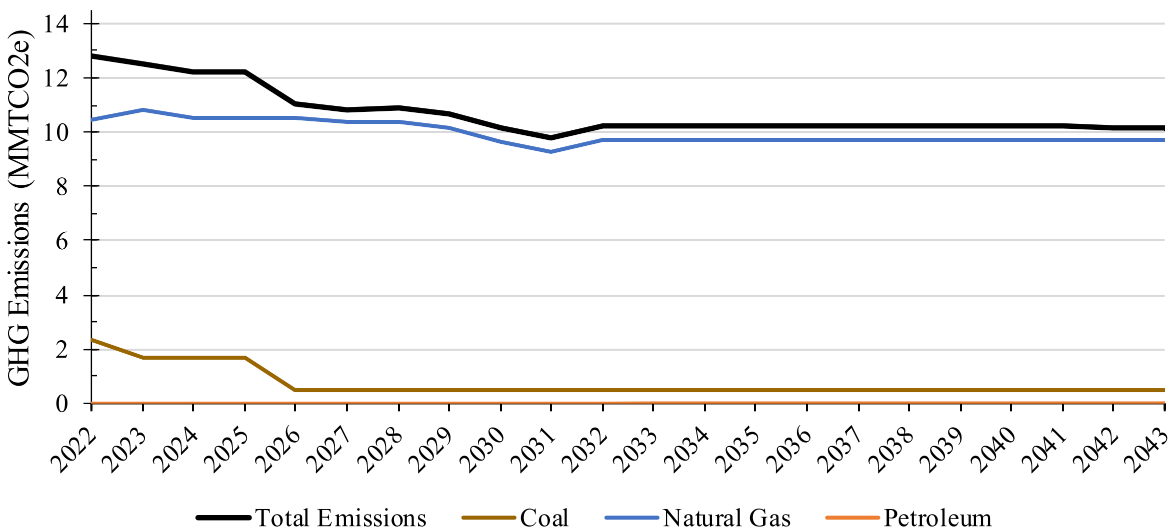
Without any additional changes to Nevada's RPS, electricity generation sector GHG emissions are expected to drop to 10.179 MMTCO2e by 2043 with emissions in 2025 projected to be 12.188 MMTCO2e, and emissions in 2030 projected to be 10.159 MMTCO2e. Before 2030, emissions reductions are largely associated with the expected retirement of the North Valmy Generating Station — there is a high level of uncertainty regarding whether the facility will retire on its current schedule, which for Unit 1 is a delay of its previously expected shutdown at the end of 2021 (this report assumes that both units will retire in 2025). By 2043, expected emission reductions are nearly half of what has been estimated in previous reports due to the extension of retirement dates for several units, many of which now have anticipated retirement dates beyond 2043.

Figure 4-5 shows electricity generation sector GHG emissions in Nevada by fuel type projected for 2022 through 2043. The method of projecting these emissions (explained in Appendix A) assumes the closure of these facilities and that wholesale electricity will be purchased to meet any demand not met by renewables or other forms of in-state generation.

[48] Tracy station consists of T3, T4/5, and T8/9/10. T3 retirement date is 2038. See Docket No. 22-06015, Vol. 1, Lescenski direct, exhibit 2, pg. 63 of 315. T4/5 retirement date is currently 2031. (see same exhibit 2). There is currently a pending application from NV Energy to install SCR and extend the retire date thru 2049. See open Docket No. 23-08015, Vol. 1, pg. 26 of 256, item 2.c. T8/9/10 has a retirement date of 2049. See Docket No. 22-06014, Order dated 2/16/23, pg. 66 of 315.

[49] NV Energy is constructing 444 MW of new gas turbines that will be restricted to summer months only running that will have a retirement date of 2054. See PUCN Docket No. 22-11032, Phase 1 Order, Paragraph 80. These new gas turbines are not incorporated into this report's projections.

Figure 4-5: Electricity Generation Sector Projected GHG Emissions and Emissions by Fuel Type, 2022–2043



These are conservative projections that may slightly overestimate projected emissions. They consider the recently updated RPS and the retirement dates 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, 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.

Industry

Figure 5-1: Nevada Net GHG Emissions with Industry Emissions Emphasized and Updated Projections Beginning in 2022, 1990–2043

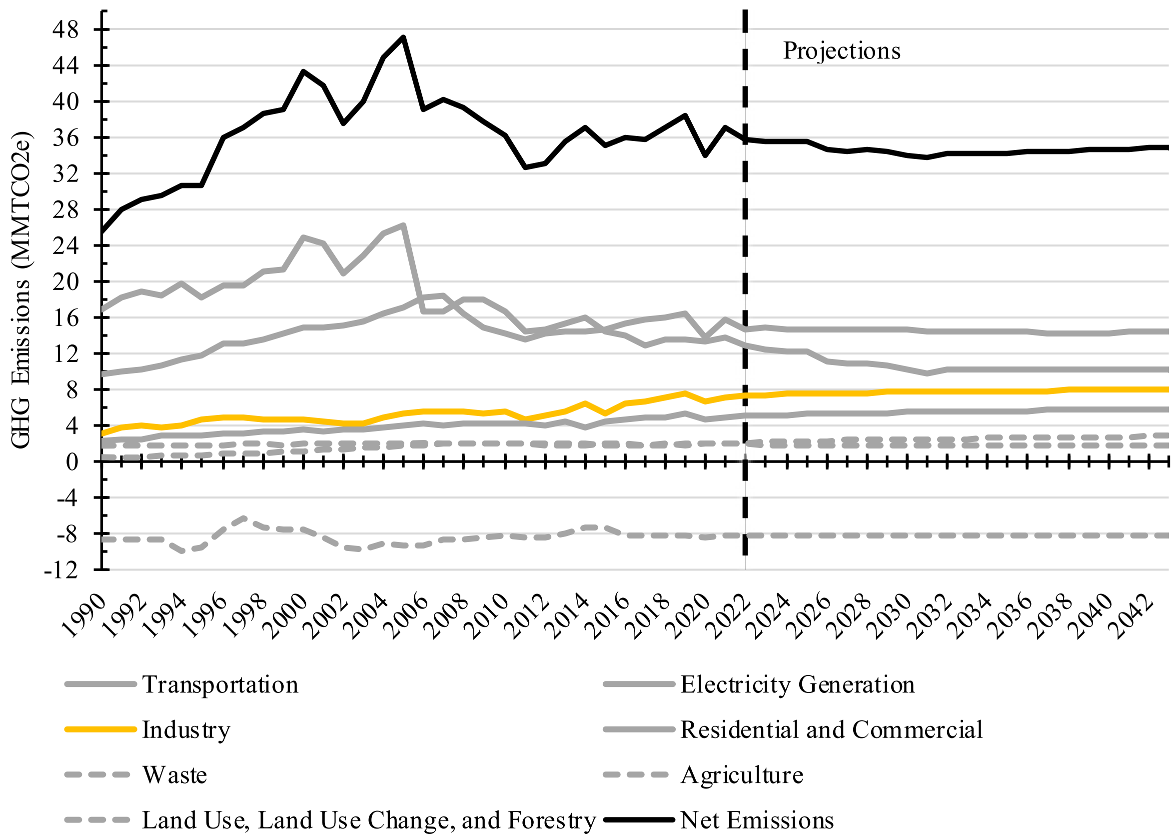
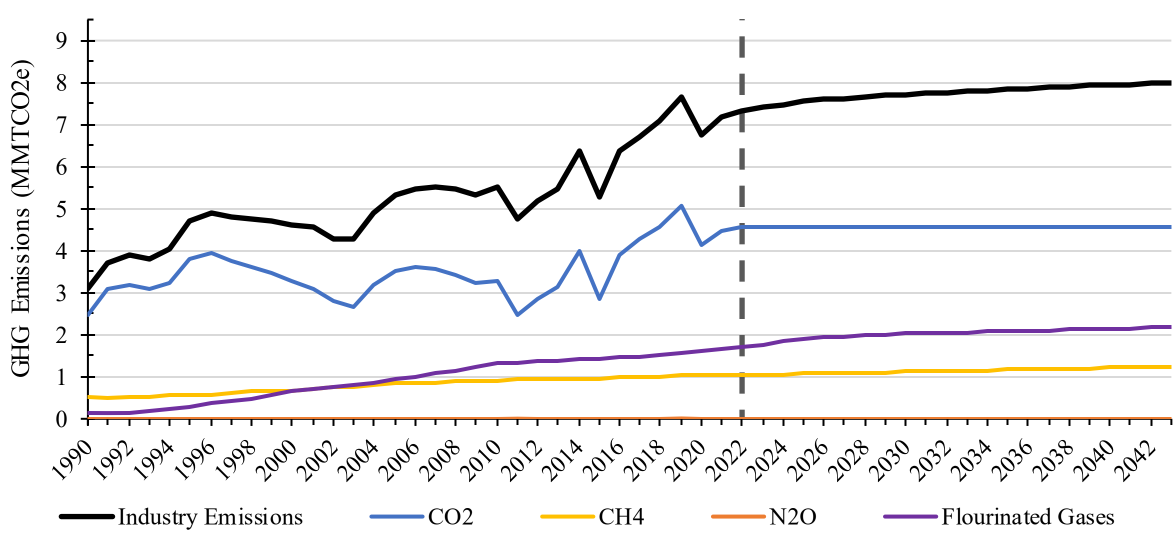


Figure 5-2: Industry GHG Emissions and Emissions by GHG with Projections Beginning in 2022, 1990–2043

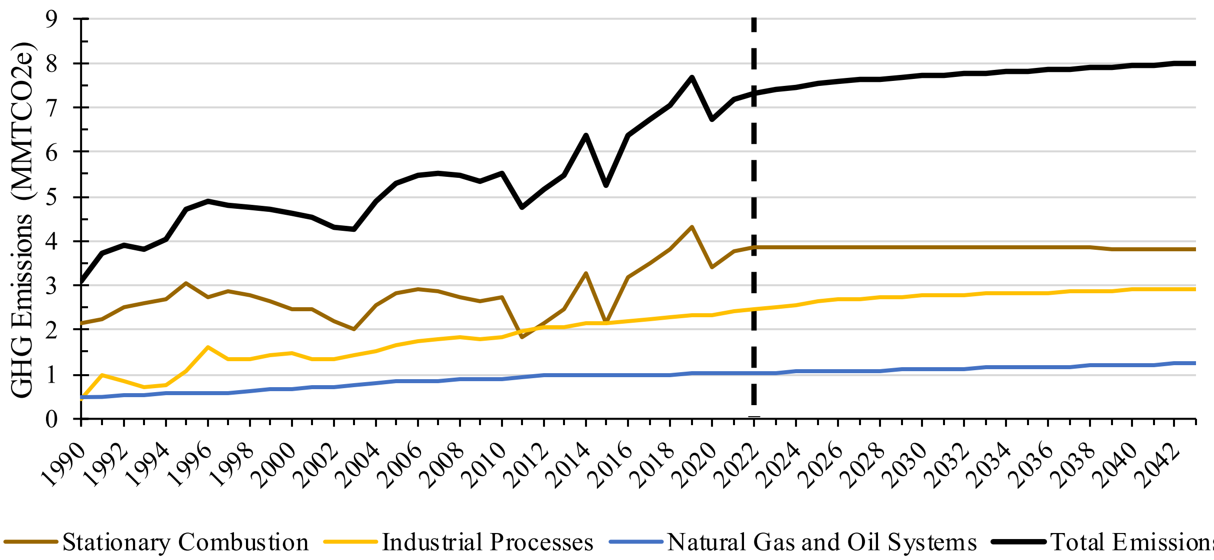


5.1 Overview

Industrial sector GHG emissions for 2021 are estimated to be 7.186 MMTCO2e and account for 15.8% 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, such as ozone depleting substances or ODS substitutes) (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, and fluorinated gases (fluorinated gases includes HFCs, PFCs, and SF_6).[50]

Total industry emissions are illustrated by GHG for 1990 through 2043 in Figure 5-2. Figure 5-3 shows the annual contributions of the three sub-sectors on total industry GHG emissions for 1990 through 2043. Stationary combustion was still the largest sub-sector of industry emissions in 2021 and is projected to remain that way through 2043. Emissions from industry were 5.308 MMTCO2e in 2005 and are projected to be 7.551 MMTCO2e in 2025 and 7.719 MMTCO2e in 2030. As a whole, industry will account for nearly 19% of the gross GHG emissions in Nevada in 2043.

Figure 5-3: Industry GHG Emissions and Emissions by Sub-Sector with Projections Beginning in 2022, 1990-2043



Emissions from the stationary combustion of fossil fuels by industry includes the combustion of natural gas, coal, petroleum products, and wood. There were 3.748 MMTCO2e emissions attributable to this sub-sector in 2021. Emissions from this sub-sector also include 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 subtracted from the sub-sector total). Table 5-1 lists the fossil fuels consumed by this sub-sector and considered by SEDS.

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

Table 5-1: Industrial Stationary Combustion Sub-Sector Fuels Consumed[51]

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

Industrial process emissions are 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.[52] Emissions from the industrial process sub-sector accounted for 2.407 MMTCO2e emissions in 2021. The sources of emissions from individual industrial processes are listed in Table 5-2.

Table 5-2: Industrial Process Emissions Sources Detailed[53]

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.
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

[51] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Stationary Combustion Module. U.S. Environmental Protection Agency; 2019 Dec. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

[52] 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.

[53] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Industrial Processes Module. U.S. Environmental Protection Agency; 2020 Dec. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

Process	Source of Emissions
	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 are classes of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) 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.[54] 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.[55] Natural gas and oil systems in Nevada accounted for 1.032 MMTCO2e emissions in 2021.

5.2 GHG Emissions, 1990-2021

As industry sector emissions are tied to production and consumption/usage, emissions are driven by increases in population, unless GHG intensive replacements are introduced and widely adopted. Sector emissions are estimated to be 5.308 MMTCO2e for 2005 and 7.186 MMTCO2e for 2021. Figure 5-4 shows industry emissions in Nevada by GHG from 1990 through 2021 and Table 5-3 lists industry GHG emissions in Nevada for select years.

[54] 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.
[55] ICF International. State Greenhouse Gas Inventory Tool User's Guide for the Natural Gas and Oil Module. U.S. Environmental Protection Agency; 2020 Dec. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

Figure 5-4: Industry GHG Emissions in Nevada by GHG, 1990-2021

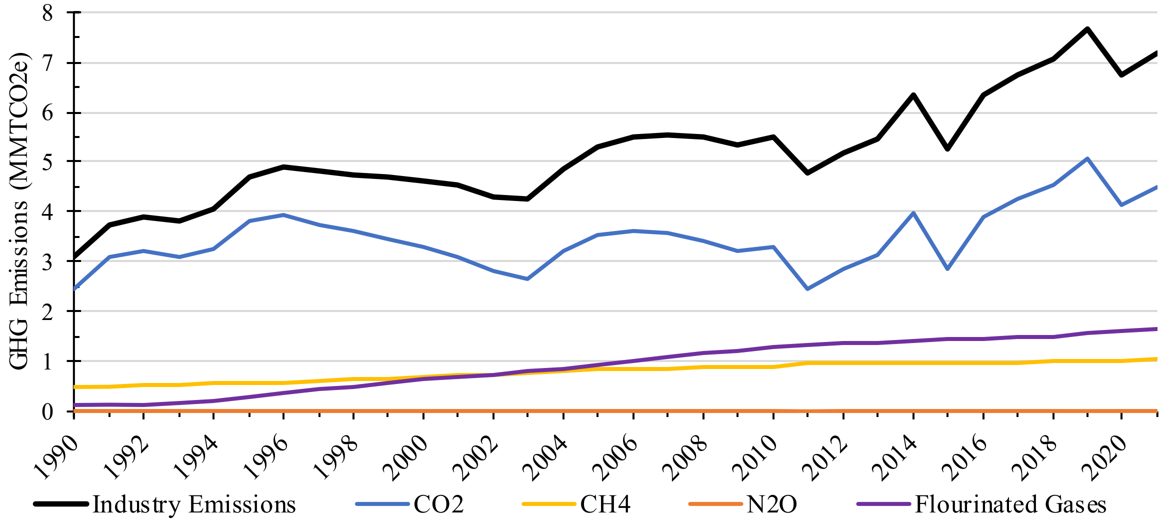


Table 5-3: Industry GHG Emissions in Nevada by GHG, Select Years (MMTCO2e)

GHG	1990	1995	2000	2005	2010	2015	2019	2020	2021
CO_2	2.455	3.822	3.298	3.524	3.294	2.856	5.068	4.123	4.484
CH_4	0.500	0.570	0.678	0.853	0.899	0.971	1.019	1.027	1.036
N_2O	0.005	0.007	0.005	0.006	0.006	0.004	0.009	0.007	0.007
Fluorinated Gases	0.141	0.299	0.642	0.926	1.306	1.440	1.562	1.595	1.658
Total Emissions	**3.101**	**4.698**	**4.623**	**5.308**	**5.505**	**5.271**	**7.658**	**6.753**	**7.186**

5.2.1 Industry Emissions from Stationary Combustion

The stationary combustion of fossil fuels is the largest sub-sector of industry emissions. 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. The combustion of petroleum products is both the largest contributor of sub-sector emissions and 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 2016 through 2021.

Figure 5-5: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 1990-2021 (MMTCO2e)

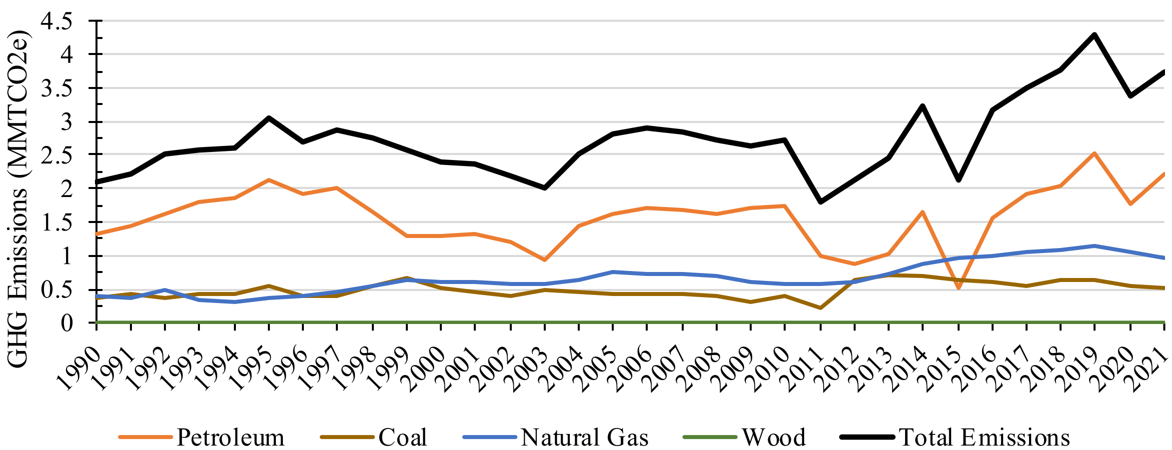


Table 5-4: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2015	2019	2020	2021
Natural Gas	0.403	0.377	0.605	0.747	0.578	0.959	1.144	1.062	0.966
Coal	0.365	0.549	0.502	0.429	0.391	0.637	0.624	0.551	0.527
Petroleum	1.336	2.120	1.298	1.629	1.753	0.529	2.524	1.771	2.229
Wood	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Emissions	**2.105**	**3.046**	**2.405**	**2.805**	**2.723**	**2.125**	**4.292**	**3.383**	**3.722**

Table 5-5: Annual Change in Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 2016-2021 (MMTCO2e and Percent)

Fuel Type	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Natural Gas	0.050	5.05%	0.046	4.37%	0.054	4.98%	-0.082	-7.19%	-0.095	-8.98%
Coal	-0.060	-9.98%	0.098	18.03%	-0.016	-2.48%	-0.073	-11.67%	-0.024	-4.34%
Petroleum	0.359	23.02%	0.133	6.92%	0.472	23.02%	-0.753	-29.85%	0.458	25.86%
Wood	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Totals	**0.349**	**11.07%**	**0.276**	**7.88%**	**0.511**	**13.51%**	**-0.908**	**-21.17%**	**0.339**	**10.01%**

5.2.2 Industry Emissions from Industrial Processes

Industrial process sub-sector GHG emissions were estimated to be 2.407 MMTCO2e in 2021. Figure 5-6 illustrates individual industrial process sub-sector GHG emissions in Nevada for 1990 through 2021 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. While the HFC phasedown rule will likely lead to emissions reductions, there is no immediate substitute for many of the final products — cement, and lime — of these industrial processes nor for the ways in which these materials are processed/produced.

Figure 5-6: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, 1990-2021 (MMTCO2e)

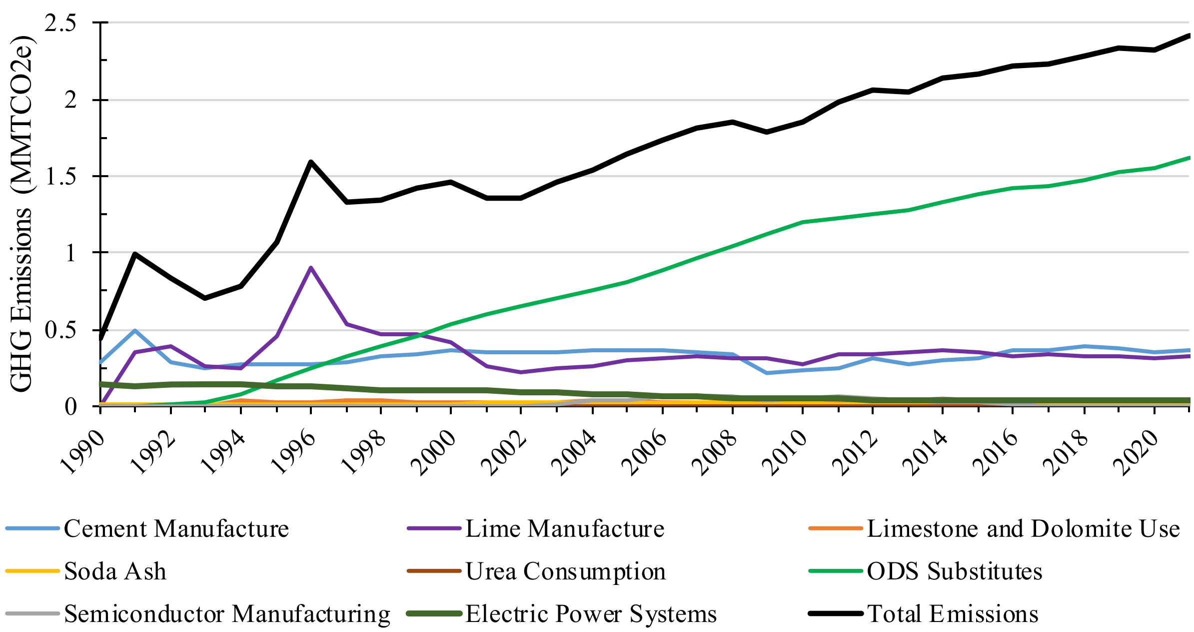


Table 5-6: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, Select Years (MMTCO2e)

Process	1990	1995	2000	2005	2010	2015	2019	2020	2021
Cement Manufacture	0.288	0.270	0.359	0.362	0.229	0.316	0.372	0.352	0.360
Lime Manufacture	0.000	0.451	0.414	0.295	0.276	0.350	0.330	0.314	0.329
Limestone and Dolomite Use	0.000	0.026	0.030	0.040	0.026	0.042	0.045	0.041	0.040
Soda Ash	0.013	0.016	0.019	0.021	0.019	0.018	0.018	0.018	0.018
Urea Consumption	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ODS Substitutes	0.001	0.171	0.538	0.808	1.204	1.383	1.521	1.556	1.619
Aerosols	*0.000*	*0.048*	*0.076*	*0.063*	*0.108*	*0.137*	*0.112*	*0.114*	*0.117*
Fire Extinguishers	*0.000*	*0.000*	*0.001*	*0.002*	*0.004*	*0.007*	*0.009*	*0.009*	*0.010*
Foams	*0.000*	*0.000*	*0.001*	*0.011*	*0.039*	*0.058*	*0.064*	*0.063*	*0.033*
Refrigerators and Air Conditioners	*0.000*	*0.113*	*0.426*	*0.674*	*0.969*	*1.060*	*1.184*	*1.220*	*1.306*
*Solvents**	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Other Applications	*0.001*	*0.010*	*0.034*	*0.058*	*0.084*	*0.121*	*0.151*	*0.149*	*0.153*
Semiconductor Manufacturing	0.000	0.000	0.001	0.044	0.051	0.021	0.001	0.001	0.000
Electric Power Transmission and Distribution Systems	0.140	0.128	0.103	0.074	0.051	0.036	0.041	0.039	0.039
Total Emissions	**0.442**	**1.062**	**1.464**	**1.644**	**1.856**	**2.166**	**2.327**	**2.321**	**2.407**

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, 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. Although not harmful to the ozone layer, they are potent GHGs with GWPs sometimes several orders of magnitude larger than CO_2 (refer to Table 1-1). Table 5-7 lists the lists the annual change of individual industrial process sub-sector GHG emissions in Nevada from 2016 through 2021.

Table 5-7: Annual Change in Industrial Process Sub-Sector GHG Emissions in Nevada by Process, 2016-2021 (MMTCO2e and Percent)

Process	2016 to 2017		2017 to 2018		2018 to 2019		2019 to 2020		2020-2021	
Cement Manufacture	-0.005	-1.44%	0.029	8.05%	-0.019	-4.89%	-0.020	-5.29%	0.008	2.24%
Lime Manufacture	0.011	3.41%	-0.009	-2.73%	0.005	1.55%	-0.016	-4.74%	0.015	4.77%
Limestone and Dolomite Use	0.001	1.73%	-0.007	-17.74%	0.011	31.80%	-0.004	-8.05%	-0.001	-1.46%
Soda Ash	-0.001	-2.95%	0.000	0.32%	0.000	-1.39%	-0.001	-4.76%	0.001	5.39%
Urea Consumption	0.000	8.06%	0.000	0.34%	0.000	0.34%	0.000	0.33%	0.000	-2.89%
ODS Substitutes	0.021	1.50%	0.031	2.16%	0.053	3.59%	0.035	2.32%	0.063	4.05%
Aerosols	*-0.009*	*-6.86%*	*-0.010*	*-8.20%*	*0.003*	*2.83%*	*0.002*	*1.69%*	*0.002*	*2.11%*
Fire Extinguishers	*0.001*	*8.01%*	*0.001*	*7.52%*	*0.001*	*7.09%*	*0.000*	*4.74%*	*0.000*	*4.49%*
Foams	*0.000*	*0.78%*	*0.002*	*3.14%*	*0.001*	*1.34%*	*-0.001*	*-1.95%*	*-0.029*	*-46.82%*
Refrigerators and Air Conditioners	*0.018*	*1.61%*	*0.032*	*2.92%*	*0.046*	*4.01%*	*0.036*	*3.03%*	*0.085*	*7.01%*
*Solvents**	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*
Other Applications	*0.011*	*8.70%*	*0.006*	*4.23%*	*0.002*	*1.66%*	*-0.002*	*-1.15%*	*0.004*	*2.71%*
Semiconductor Manufacturing	-0.010	-94.88%	0.000	3.60%	0.000	-7.58%	0.000	-0.56%	-0.001	-100.00%

Process	2016 to 2017		2017 to 2018		2018 to 2019		2019 to 2020		2020-2021	
Electric Power Transmission and Distribution Systems	0.002	4.80%	-0.003	-8.10%	0.003	9.22%	-0.002	-4.99%	0.000	0.76%
Totals	**0.019**	**0.86%**	**0.040**	**1.81%**	**0.053**	**2.31%**	**-0.007**	**-0.28%**	**0.086**	**3.70%**

*ODS substitute emissions from the use of solvents is reported as part of "Other Applications" emissions.

5.2.3 Industry Emissions from Natural Gas and Oil Systems

Natural gas and oil systems sub-sector GHG emissions were estimated to be 1.032 MMTCO2e in 2021. 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 lists natural gas and oil systems sub-sector GHG emissions in Nevada by fuel type for select years and Table 5-9 lists the annual change in natural gas and oil systems GHG emissions by fuel type from 2016 through 2021.

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	2015	2019	2020	2021
Natural Gas	0.414	0.538	0.661	0.839	0.887	0.964	1.011	1.021	1.029
Production	*0.000*	*0.000*	*0.001*	*0.001*	*0.001*	*0.001*	*0.016*	*0.017*	*0.017*
Transmission	*0.237*	*0.296*	*0.326*	*0.414*	*0.385*	*0.445*	*0.446*	*0.446*	*0.446*
Distribution	*0.177*	*0.241*	*0.333*	*0.424*	*0.501*	*0.517*	*0.549*	*0.559*	*0.567*
Oil	0.083	0.028	0.014	0.010	0.009	0.004	0.003	0.002	0.002
Total Emissions	**0.497**	**0.566**	**0.675**	**0.849**	**0.896**	**0.968**	**1.014**	**1.023**	**1.032**

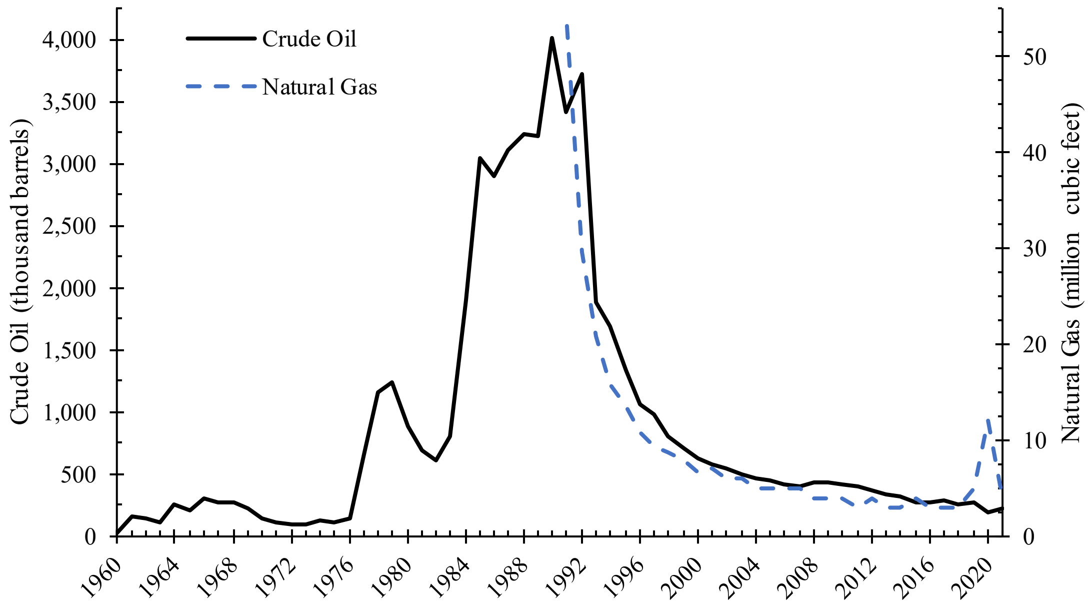
Table 5-9: Annual Change in Natural Gas and Oil Systems Sub-Sector GHG Emissions in Nevada by Fuel Type, 2016-2021 (MMTCO2e and Percent)

Fuel Type	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Natural Gas	0.006	0.58%	0.023	2.35%	0.014	1.44%	0.010	0.97%	0.008	0.82%
Production	*0.000*	*0.00%*	*0.014*	*940.00%*	*0.001*	*5.77%*	*0.000*	*1.82%*	*0.000*	*0.00%*
Transmission	*0.000*	*-0.09%*	*0.000*	*0.03%*	*0.000*	*-0.02%*	*0.000*	*0.00%*	*0.000*	*0.00%*
Distribution	*0.006*	*1.17%*	*0.009*	*1.66%*	*0.014*	*2.54%*	*0.010*	*1.74%*	*0.008*	*1.50%*
Oil	0.000	-1.72%	-0.001	-27.81%	0.000	-1.92%	-0.001	-20.34%	0.000	11.51%
Totals	**0.006**	**0.58%**	**0.022**	**2.22%**	**0.014**	**1.43%**	**0.009**	**0.92%**	**0.009**	**0.85%**

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 2005 through 2019 production in the industry has been relatively stagnant with natural gas production averaging roughly 4 million cubic feet per year and oil production averaging roughly 350,000 barrels per year. Natural Gas production shows an uptick in 2020, with 12 million cubic feet produced. However, new data indicates that production was back to nearly 5 million cubic feet in 2021. Figure 5-9 shows EIA historical production estimates of natural gas and oil in Nevada from 1960 through 2021.[56]

[56] U.S. Energy Information Administration State Energy Data System [accessed 2023 Oct 20]. https://www.eia.gov/state/seds/

Figure 5-7: EIA Historical Natural Gas and Oil Production Estimates for Nevada, 1960-2021



5.3 Projected Emissions, 2022-2043

Industry GHG emissions in Nevada are projected to continue to increase through 2043 with emissions in 2025 projected to be 7.551 MMTCO2e, emissions in 2030 projected to be 7.719 MMTCO2e, and emissions in 2043 projected to reach 8.012 MMTCO2e. Figure 5-10 illustrates industry GHG emissions projections in Nevada by GHG from 2022 through 2043. Figure 5-11 illustrates industry emissions projections by sub-sector and shows that future increases in sector emissions will be the result of minor, but steady increases in stationary combustion and industrial process emissions. It is also worth noting that these projections do not account for the phasedown of production and consumption of ODS substitutes included in the second federal coronavirus relief bill, the Consolidated Appropriations Act, 2021.

Figure 5-8: Industry GHG Emissions Projections in Nevada by GHG, 2022-2043

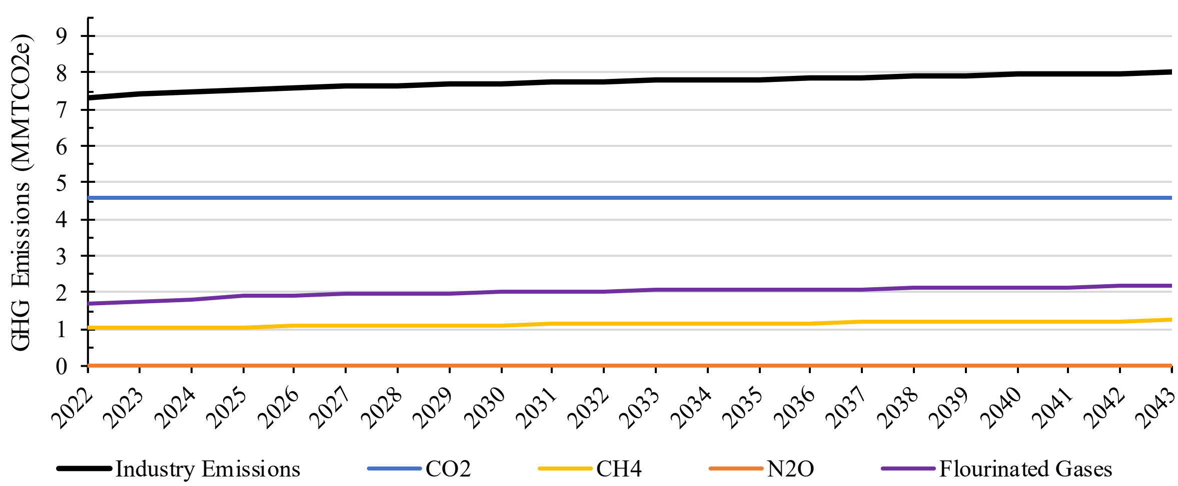
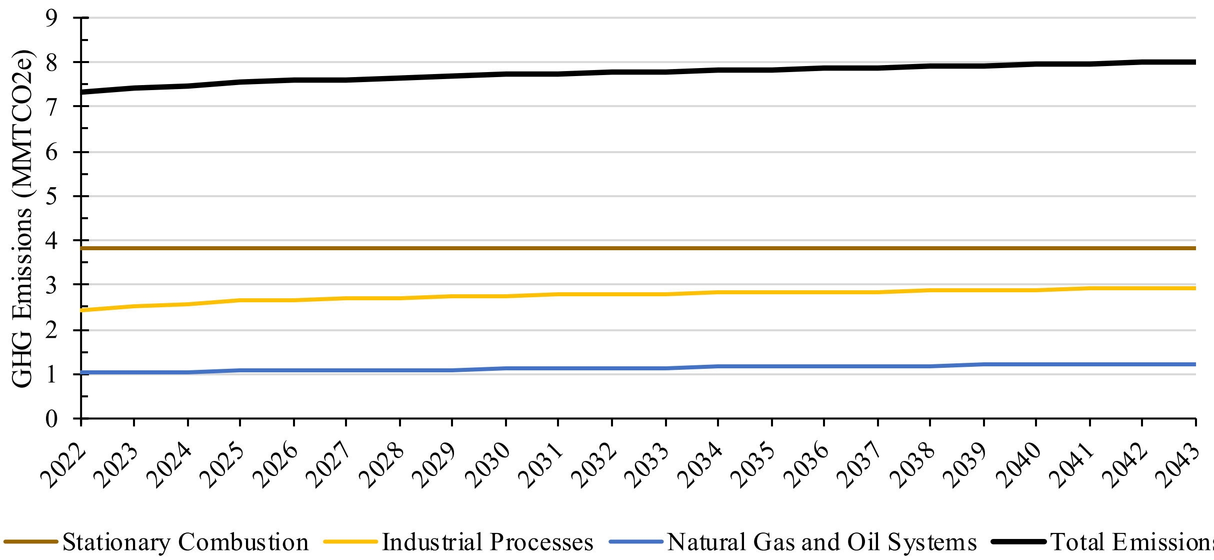


Figure 5-9: Industry GHG Emissions Projections in Nevada by Sub-Sector, 2022-2043



Residential and Commercial

Figure 6-1: Nevada Net GHG Emissions with Residential and Commercial Emissions Emphasized and Updated Projections Beginning in 2022, 1990–2043

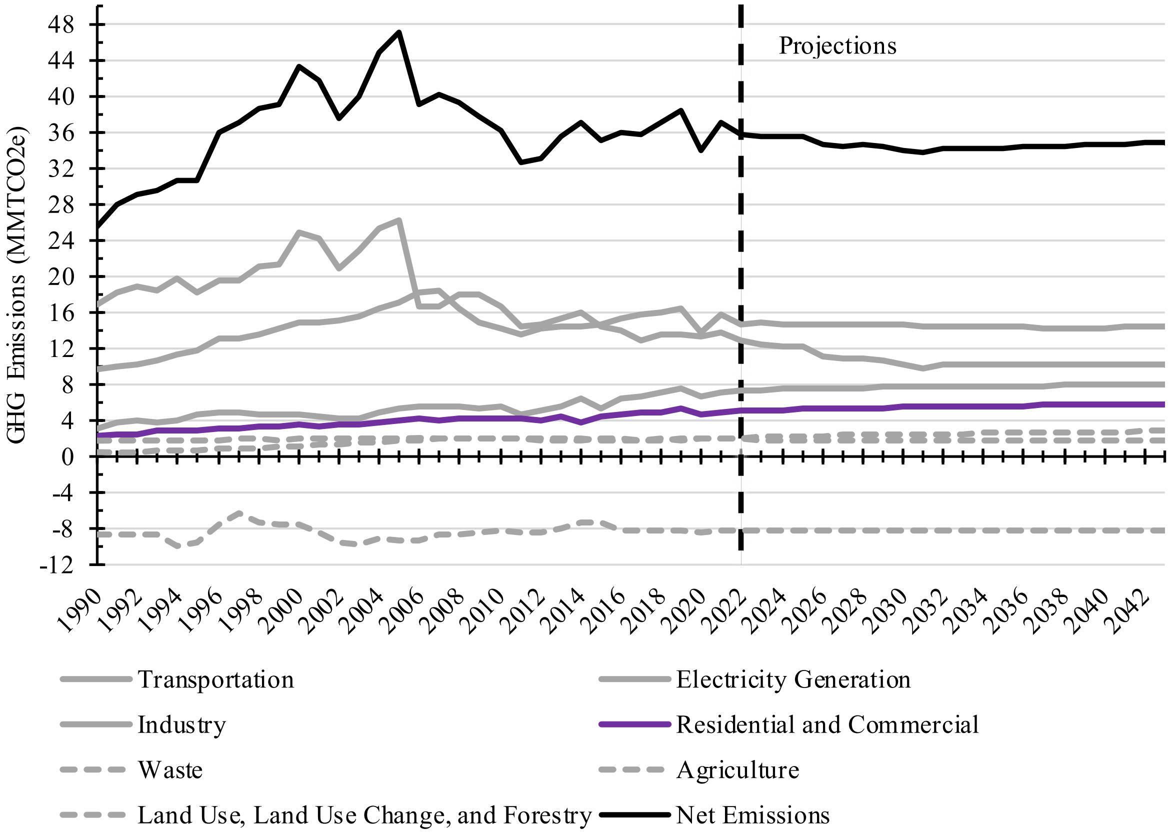


Figure 6-2: Residential and Commercial GHG Emissions and Emissions by Sub-Sector and GHG with Projections Beginning in 2022, 1990-2043

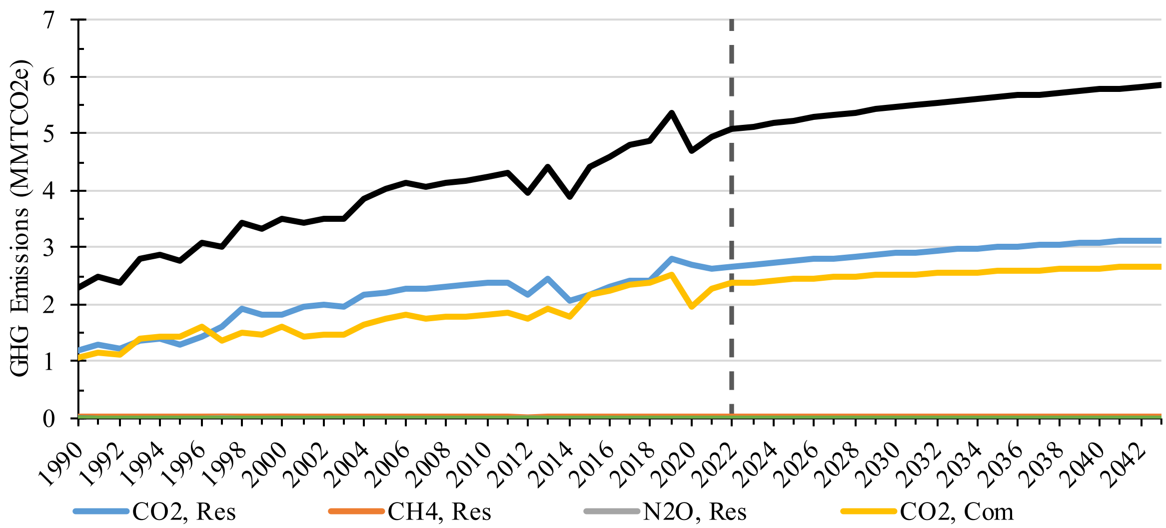
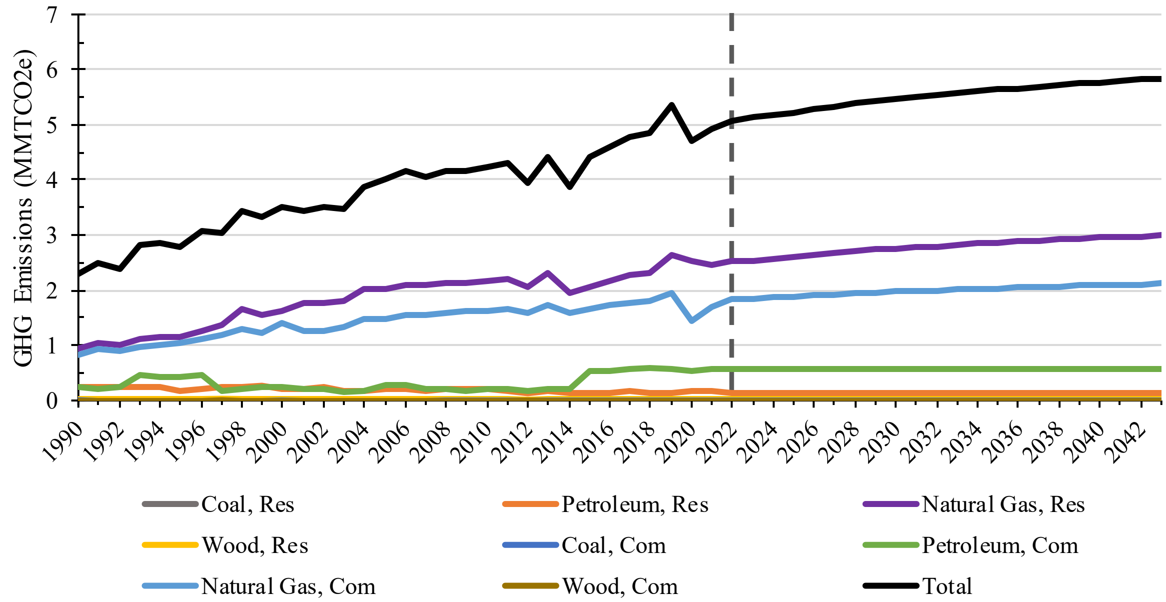


Figure 6-3: Residential and Commercial GHG Emissions and Emissions by Fuel Source and GHG with Projections Beginning in 2022, 1990-2043



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 2021 totaled 4.924 MMTCO2e and accounted for 11% of the State's total GHG emissions. Emissions are projected to be 5.838 MMTCO2e by 2043, an increase of 0.914 MMTCO2e above 2021 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 2021. 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 5.231 MMTCO2e in 2025 and 5.458 MMTCO2e in 2030.

6.2 GHG Emissions, 1990-2021

Residential and commercial sector GHG emissions in 2021 were estimated to be 4.924 MMTCO2e, with residential emissions totaling 2.652 MMTCO2e and commercial emissions totaling 2.272 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 2021. 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 6-4: Residential and Commercial Sector GHG Emissions in Nevada by Fuel Type, 1990-2021

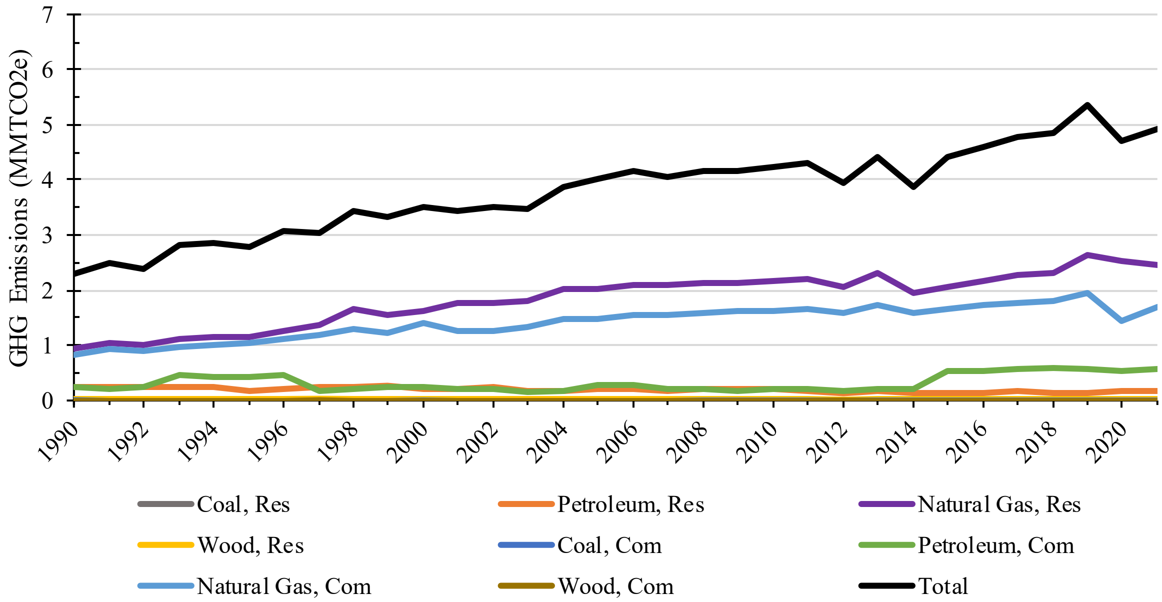


Table 6-1: Residential and Commercial Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2015	2019	2020	2021
Residential Sub-Sector									
Natural Gas	0.941	1.137	1.641	2.021	2.173	2.049	2.656	2.539	2.473
Coal	0.001	0.000	-	-	-	-	-	-	-
Petroleum	0.255	0.178	0.202	0.205	0.199	0.137	0.145	0.165	0.161
Wood	0.023	0.025	0.032	0.017	0.017	0.017	0.017	0.017	0.017
Sub-Total	**1.221**	**1.341**	**1.875**	**2.244**	**2.390**	**2.203**	**2.817**	**2.721**	**2.651**
Commercial Sub-Sector									
Natural Gas	0.827	1.028	1.402	1.474	1.627	1.653	1.950	1.426	1.695
Coal	0.006	0.002	0.000	0.002	-	-	-	-	-
Petroleum	0.239	0.409	0.230	0.292	0.204	0.543	0.575	0.541	0.574
Wood	-	-	-	-	-	-	-	-	-
Sub-Total	**1.072**	**1.439**	**1.632**	**1.768**	**1.831**	**2.196**	**2.525**	**1.967**	**2.269**
Total Emissions	**2.293**	**2.780**	**3.507**	**4.012**	**4.220**	**4.399**	**5.343**	**4.688**	**4.919**

Table 6-2 lists the annual changes in residential and commercial GHG emissions in Nevada by fuel type from 2016 through 2021. 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.

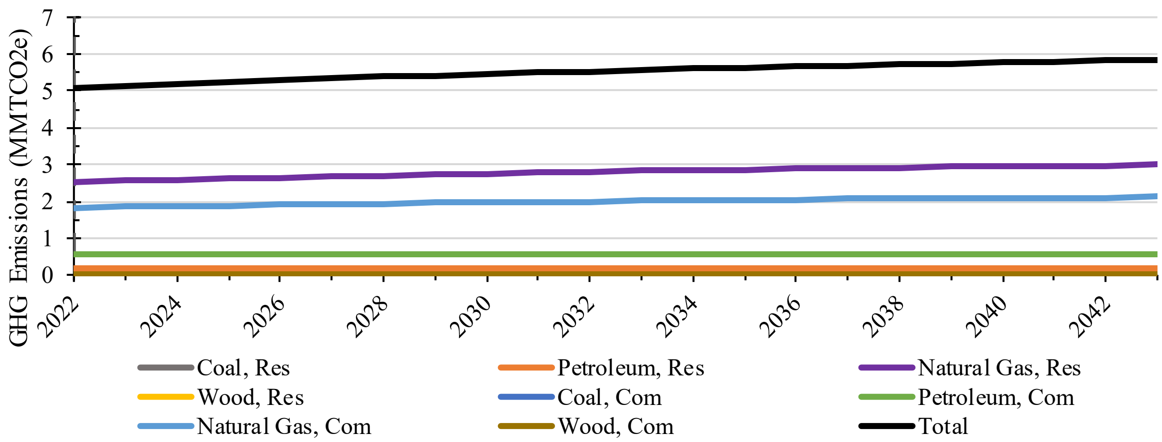
Table 6-2: Annual Change in Residential and Commercial Sector GHG Emissions in Nevada by Fuel Type, 2016-2021 (MMTCO2e and Percent)

Fuel Type	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
Residential Sub-Sector										
Natural Gas	0.099	4.56%	0.044	1.93%	0.349	15.12%	-0.117	-4.40%	-0.066	-2.62%
Coal	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Petroleum	0.012	8.07%	-0.022	-14.46%	0.012	9.36%	0.020	13.89%	-0.004	-2.34%
Wood	0.000	2.95%	0.000	0.11%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Natural Gas	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Sub-Total	**0.111**	**4.77%**	**0.021**	**0.87%**	**0.361**	**14.70%**	**-0.097**	**-3.43%**	**-0.070**	**-2.58%**
Commercial Sub-Sector										
Natural Gas	0.057	3.32%	0.026	1.44%	0.143	7.90%	-0.524	-26.87%	0.269	18.86%
Coal	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Petroleum	0.032	6.06%	0.025	4.40%	-0.014	-2.39%	-0.034	-5.98%	0.033	6.09%
Wood	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Natural Gas	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Sub-Total	**0.089**	**3.96%**	**0.051**	**2.16%**	**0.129**	**5.37%**	**-0.558**	**-22.11%**	**0.302**	**15.35%**
Totals	**0.200**	**4.37%**	**0.072**	**1.50%**	**0.490**	**10.09%**	**-0.655**	**-12.26%**	**0.232**	**4.08%**

6.3 Projected Emissions, 2022-2043

The EIA's AEO Reference case, used by the projection tool, expects building energy consumption to grow gradually through 2050.[57] The Reference case assumes that existing building energy codes and appliance energy efficiency standards will generally offset emissions from new construction related to increases in the population. Emissions are projected to slowly increase through 2043, with emissions in 2025 projected to be 5.231 MMTCO2e, emissions in 2030 projected to be 5.458 MMTCO2e, and 2043 emissions are projected to be 5.838 MMTCO2e. Residential emissions will outpace commercial emissions as 20343 emissions are projected to be 3.162 and 2.676 MMTCO2e, respectively. Figure 6-4 illustrates residential and commercial sector GHG emissions in Nevada by fuel type from 2022 through 2043.

Figure 6-5: Residential and Commercial Sector GHG Emissions Projections in Nevada by Fuel Type, 2022-2043



[57] Annual Energy Outlook 2018, p119.

Waste

Figure 7-1: Nevada Net GHG Emissions with Waste Emissions Emphasized and Updated Projections Beginning in 2021, 1990–2043

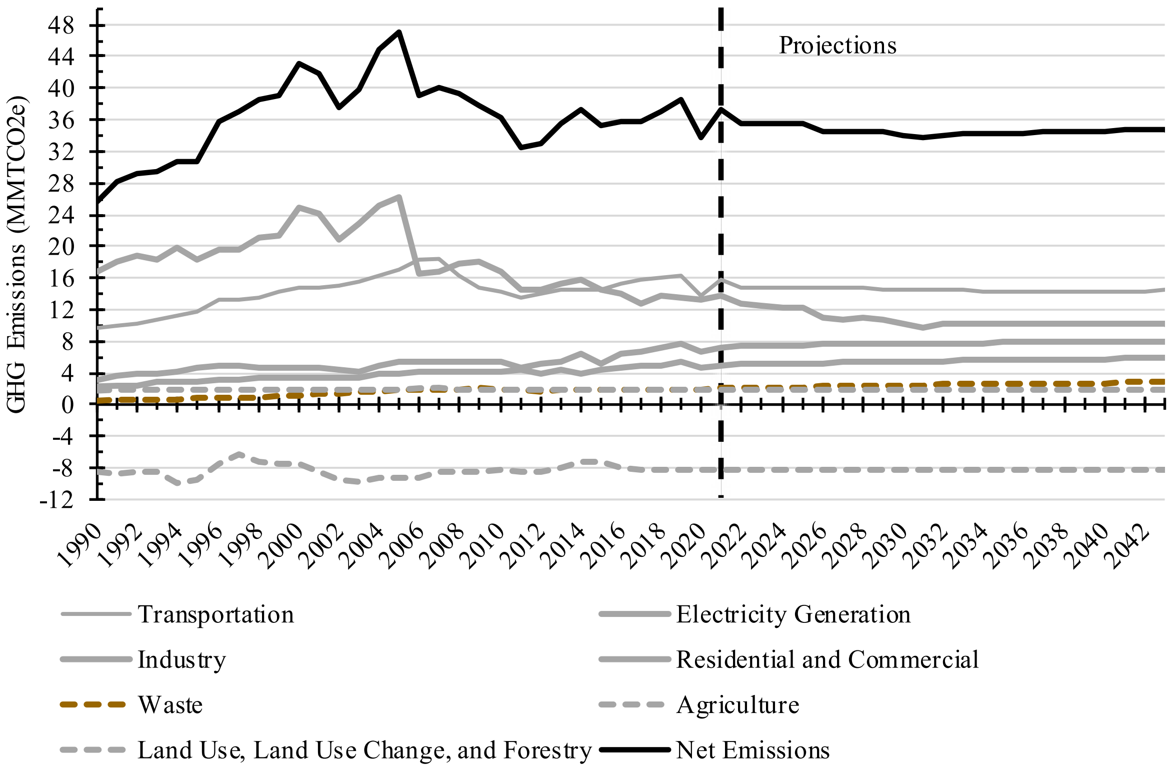
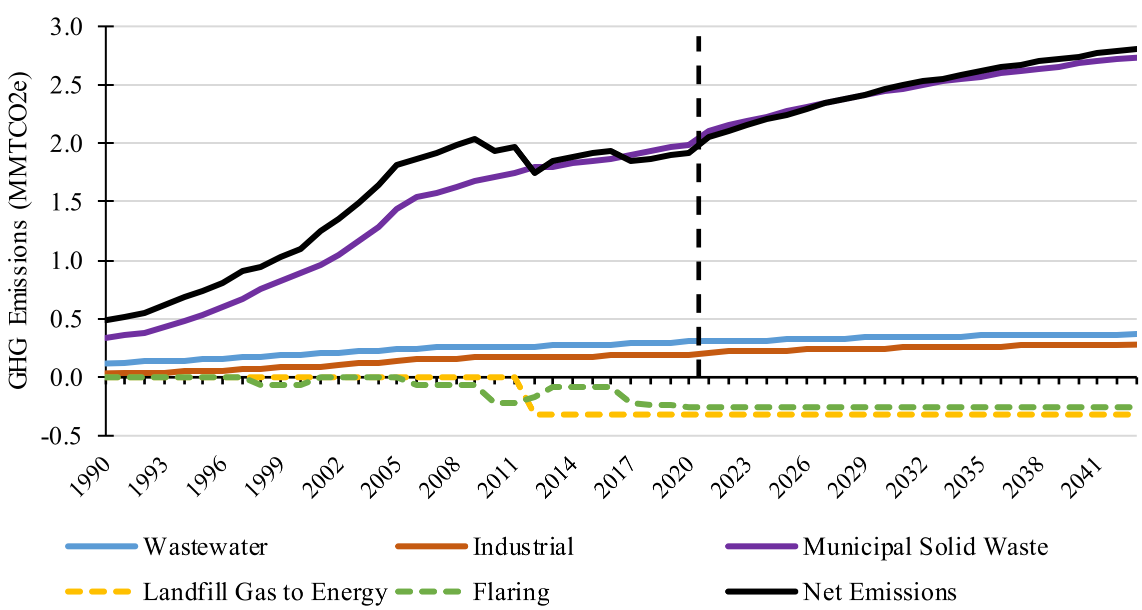


Figure 7-2: Waste GHG Emissions and Emissions by Sub-Sector with Projections Beginning in 2021, 1990-2043



7.1 Overview

GHG emissions from the waste sector totaled 1.914 MMTCO2e for 2020 (after 0.753 MMTCO2e in avoided emissions) and accounted for 4.5% 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.[58] Total waste sector emissions for 1990 through 2043 are illustrated in Figure 7-2.[59] Sector emissions are projected to total 2.248 MMTCO2e, 2.457 MMTCO2e, and 2.806 MMTCO2e in 2025, 2030, and 2043, respectively. Additionally, some landfills collect and flare recovered landfill gas[60] 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 1.820 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 2020, wastewater emissions totaled 1.914 MMTCO2e.

7.2 GHG Emissions, 1990-2021

Nevada's waste emissions in 2005 were 1.820 MMTCO2e. In 2020, emissions were 1.914 MMTCO2e with solid waste and wastewater contributing 1.609 and 0.305 MMTCO2e, respectively. The installation of gas recovery technology, that is, landfill gas flaring in 1998 and LFGTE in 2012, helped avoid 0.575 MMTCO2e, or 30% of sector emissions, in 2021. Figure 7-3 illustrates waste sector GHG emissions in Nevada by source from 1990 through 2020 with avoided emissions from landfill flaring and LFGTE indicated with dashed lines 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 2015 through 2020. Apart from the dip in emissions in 2017, sector emissions increased every year.

[58] 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.
[59] 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.
[60] Landfill gas is also referred to as biogas. This gas is roughly equal parts CO_2 and CH_4.

Figure 7-3: Waste Sector GHG Emissions in Nevada by Sub-Sector, 1990-2020

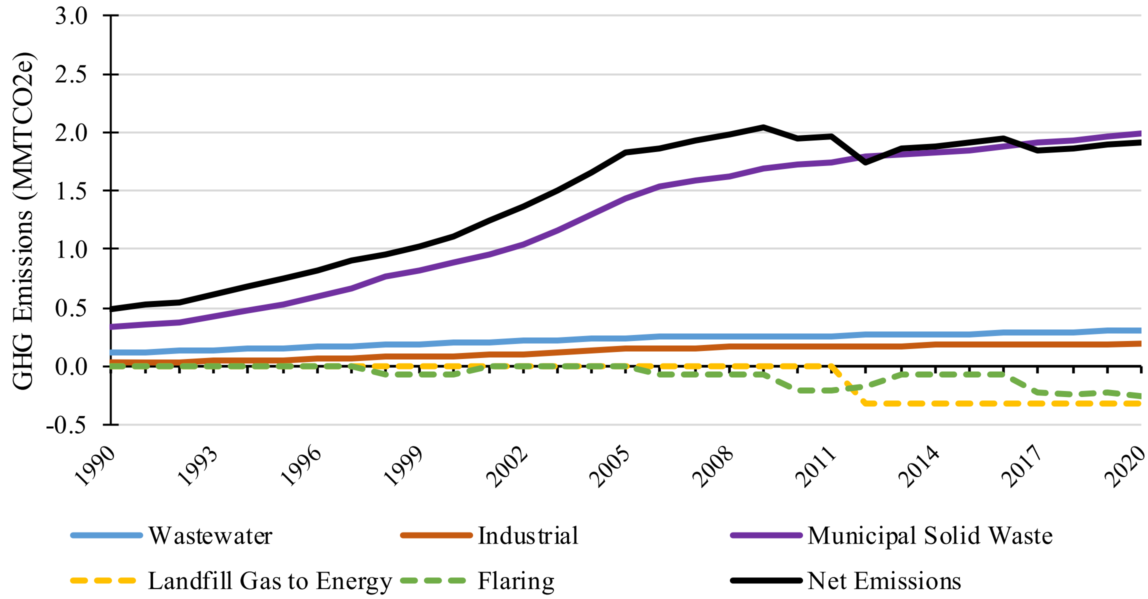


Table 7-1: Waste Sector GHG Emissions in Nevada by Source, Select Years (MMTCO2e)

Sub-Sector	1990	1995	2000	2005	2010	2015	2018	2019	2020
Solid Waste	0.370	0.588	0.907	1.582	1.678	1.634	1.568	1.599	1.609
MSW	0.336	0.535	0.889	1.438	1.720	1.848	1.933	1.960	1.990
Industrial Waste	0.034	0.053	0.088	0.144	0.170	0.181	0.188	0.191	0.193
Flaring	0.000	0.000	-0.070	0.000	-0.212	-0.076	-0.234	-0.233	-0.256
LFGTE	0.000	0.000	0.000	0.000	0.000	-0.319	-0.319	-0.319	-0.319
Wastewater	0.118	0.154	0.197	0.237	0.262	0.279	0.296	0.301	0.305
Total Emissions	**0.488**	**0.742**	**1.105**	**1.820**	**1.940**	**1.913**	**1.863**	**1.900**	**1.914**

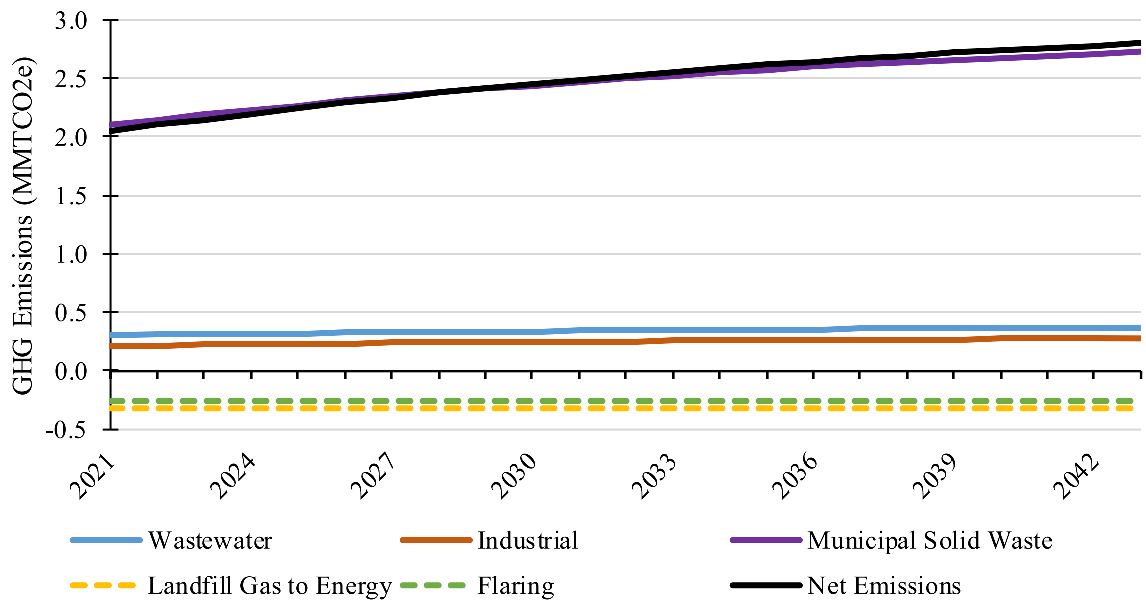
Table 7-2: Annual Change in Waste Sector GHG Emissions in Nevada by Source, 2015-2020 (MMTCO2e and Percent)

Sub-Sector	2015-2016		2016-2017		2017-2018		2018-2019		2019-2020	
Solid Waste	0.025	1.51%	-0.101	-6.11%	0.011	0.68%	0.032	2.03%	0.009	0.57%
Wastewater	0.005	1.87%	0.005	1.92%	0.006	2.09%	0.005	1.66%	0.005	1.54%
Totals	0.030	1.57%	-0.096	-4.94%	0.017	0.90%	0.037	1.97%	0.014	0.72%

7.3 Projected Emissions, 2021-2043

Waste sector GHG emissions in Nevada peaked in 2009 at 2.042 MMTCO2e. The introduction of a gas recovery measure in 2009 slowed down the increase in emissions typically driven by increases in population. This effect was only temporary, and in the absence of any new gas recovery measures, emissions from this sector are projected to slowly increase again. It is projected that the 2009 peak will be surpassed in 2021. Emissions are projected to be 2.248 MMTCO2e in 2025, 2.457 MMTCO2e in 2030, and 2.806 MMTCO2e in 2043. Figure 7-4 illustrates waste sector GHG emissions projections in Nevada by source from 2021 through 2043 with avoided emissions from landfill flaring and LFGTE projects indicated with dashed lines.

Figure 7-4: Waste Sector GHG Emissions Projections in Nevada by Source, 2021-2043 with Striped Regions Indicating Avoided Emissions



Agriculture

Figure 8-1: Nevada Net GHG Emissions with Agriculture Emissions Emphasized and Updated Projections Beginning in 2021, 1990–2043

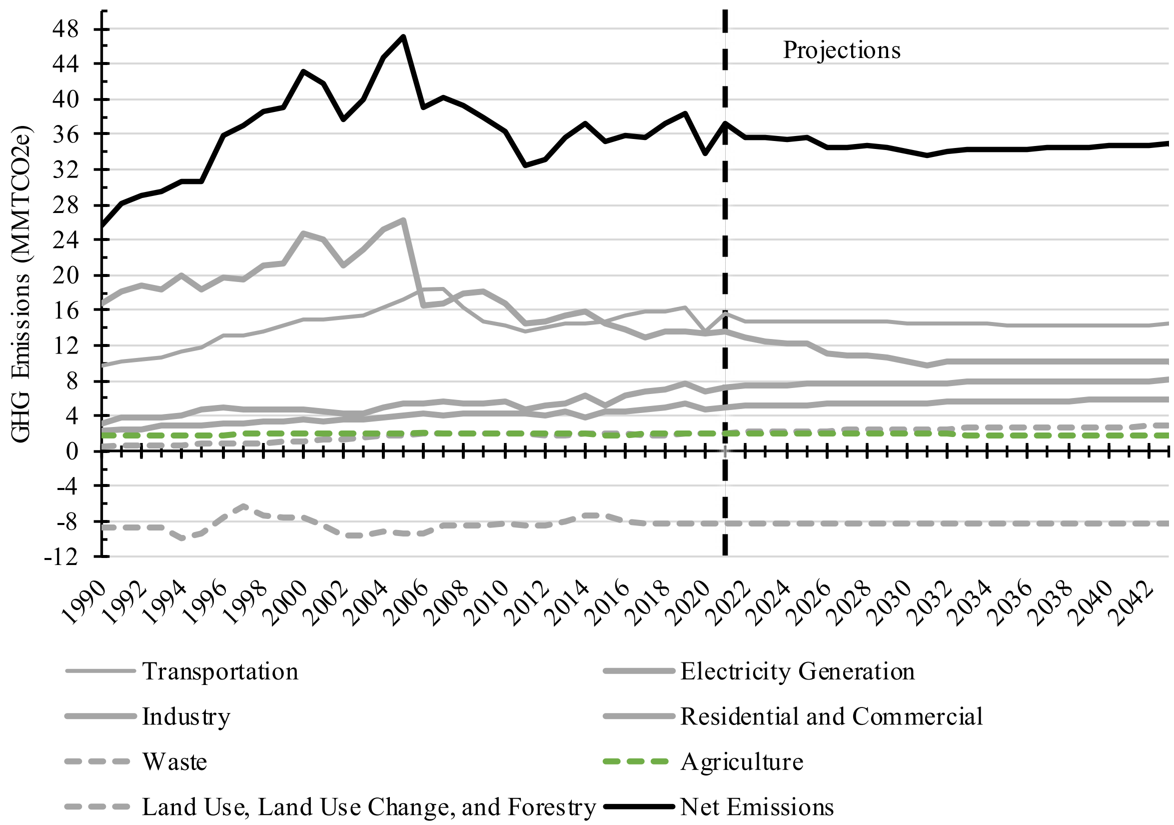
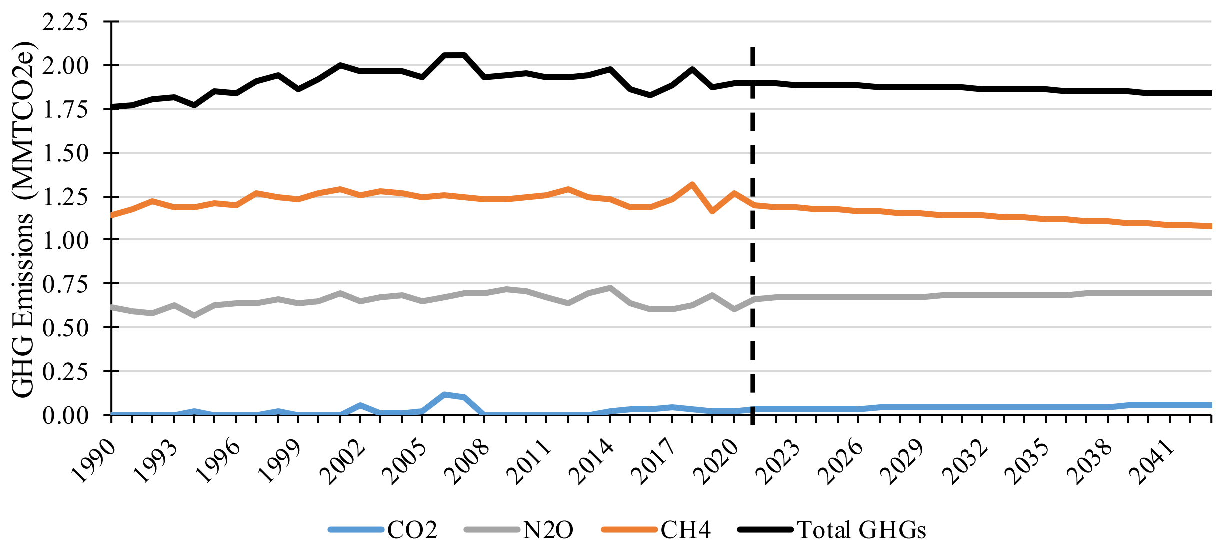


Figure 8-2: Agriculture GHG Emissions by GHG, 1990–2043, with Projections Beginning in 2021



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 1.898 MMTCO2e in 2020 and accounted for 4.5% 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 2043 are illustrated in Figure 8-2. Sector emissions are estimated to be 1.929 MMTCO2e for 2005, and are projected to be 1.885 MMTCO2e in 2025 and 1.871 MMTCO2e in 2030. Sector emissions are projected to remain a minor contributor to GHG emissions in Nevada through 2043. 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[61]

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 GHG Emissions, 1990-2020

GHG emissions from agricultural activities in Nevada totaled 1.929 MMTCO2e in 2005, and 1.898 MMTCO2e in 2020. Figure 8-3 illustrates agricultural activity emissions in Nevada by GHG from 1990 through 2020 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 2020 emissions, with N_2O emissions comprising 32% of 2020 emissions and CO_2 having a negligible impact on sector emissions.

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

Figure 8-3: Agricultural Activity GHG Emissions in Nevada by GHG, 1990-2020

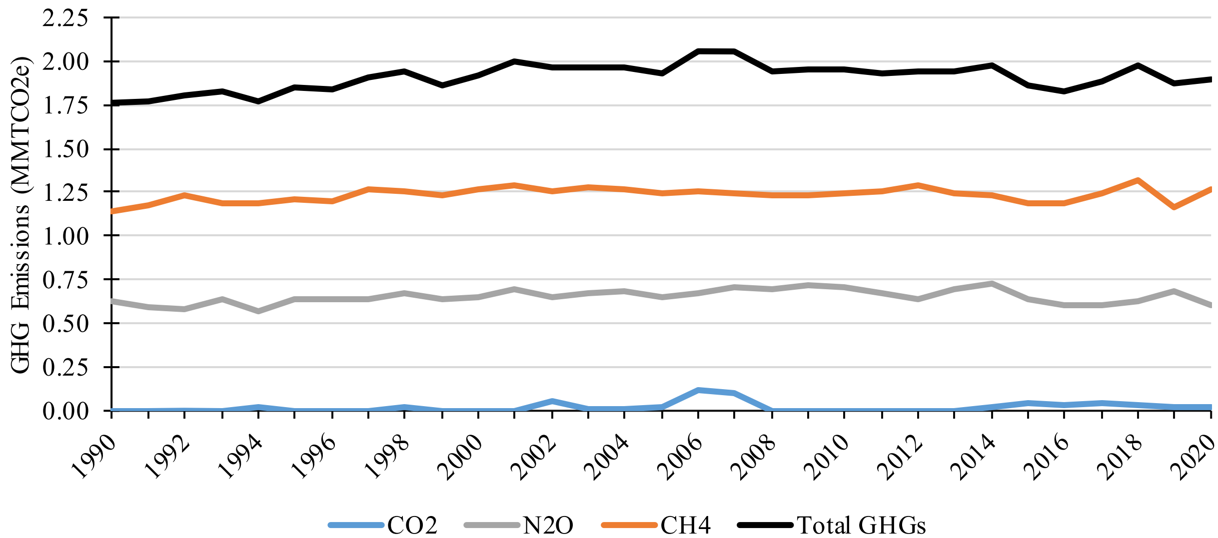


Table 8-2: Agriculture GHG Emissions in Nevada by GHG, Select Years (MMTCO2e)

GHG	1990	1995	2000	2005	2010	2015	2018	2019	2020
CO_2	0.000	0.000	0.001	0.027	0.001	0.038	0.028	0.027	0.027
CH_4	1.141	1.213	1.268	1.249	1.248	1.183	1.319	1.165	1.267
N_2O	0.621	0.633	0.650	0.653	0.706	0.638	0.630	0.686	0.605
Total Emissions	**1.762**	**1.846**	**1.919**	**1.929**	**1.956**	**1.859**	**1.978**	**1.877**	**1.898**

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 2015 through 2020. Annual variability in emissions are likely the result of changing animal/livestock populations.

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

Source	1990	1995	2000	2005	2010	2015	2018	2019	2020
Liming	0.000	0.000	0.000	0.026	0.000	0.037	0.027	0.025	0.025
Urea Fertilization	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Enteric Fermentation	1.016	1.071	1.104	1.085	1.056	0.991	1.096	0.958	1.044
Manure Management	0.146	0.164	0.187	0.184	0.217	0.217	0.252	0.230	0.244
Agricultural Residue Burning	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Agricultural Soils Direct	0.603	0.606	0.616	0.627	0.672	0.598	0.586	0.653	0.574
Agricultural Soils Indirect	0.041	0.049	0.058	0.054	0.060	0.061	0.061	0.060	0.053
Total Emissions	**1.807**	**1.892**	**1.966**	**1.977**	**2.007**	**1.905**	**2.023**	**1.928**	**1.942**

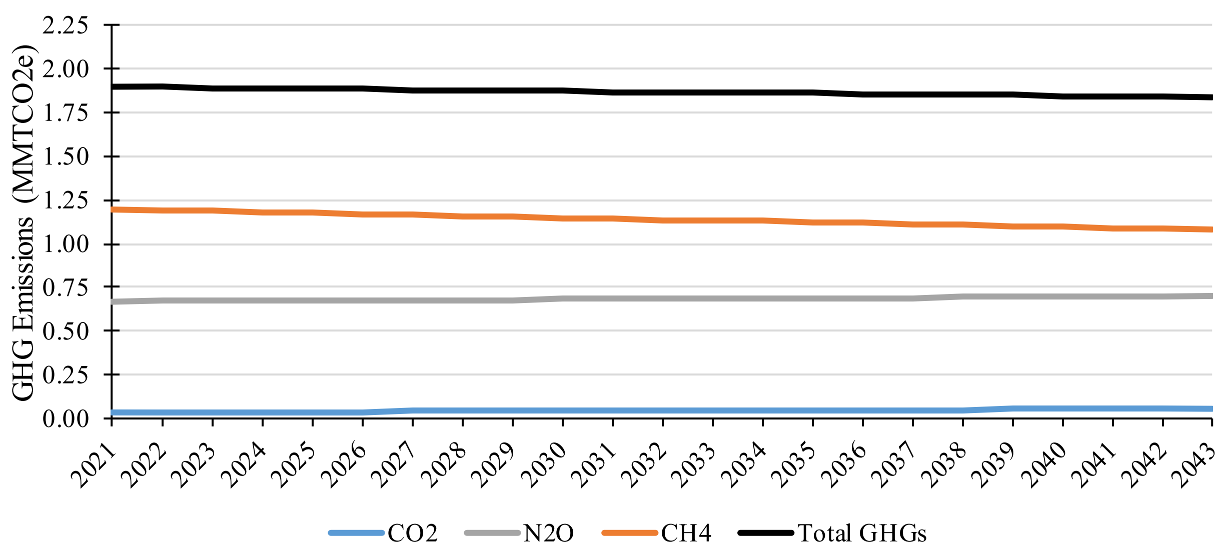
Table 8-4: Annual Change in Agriculture GHG Emissions in Nevada by Source, 2015-2020 (MMTCO2e and Percent)

Source	2015-2016		2016-2017		2017-2018		2018-2019		2019-2020	
Liming	-0.001	-1.69%	0.004	11.56%	-0.013	-33.12%	-0.002	-6.87%	0.000	0.00%
Urea Fertilization	0.000	-1.50%	0.000	8.06%	0.000	0.34%	0.000	0.34%	0.000	0.33%
Enteric Fermentation	0.014	1.44%	0.031	3.07%	0.060	5.82%	-0.138	-12.58%	0.086	9.01%
Manure Management	-0.006	-2.77%	0.018	8.67%	0.022	9.75%	-0.022	-8.82%	0.014	6.16%
Agricultural Residue Burning	0.000	0.15%	0.000	127.34%	0.000	-39.19%	0.000	-100.00%	0.000	-
Agricultural Soils Direct	-0.035	-5.81%	0.007	1.26%	0.015	2.71%	0.067	11.41%	-0.079	-12.07%
Agricultural Soils Indirect	-0.005	-7.76%	-0.001	-1.40%	0.005	9.48%	0.000	-0.30%	-0.007	-12.25%
Totals	**-0.032**	**-1.67%**	**0.060**	**3.21%**	**0.090**	**4.64%**	**-0.096**	**-4.73%**	**0.014**	**0.74%**

8.3 Projected Emissions, 2021-2043

GHG emissions from agricultural activities are projected to decline slightly through 2043, with emissions in 2025 projected to be 1.885 MMTCO2e, emissions in 2030 projected to be 1.871 MMTCO2e, and emissions in 2043 projected to be 1.833 MMTCO2e, a reduction of 0.109 MMTCO2e from 2020 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 2021 through 2043. 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, 2021-2043



Land Use, Land Use Change, and Forestry

Figure 9-1: Nevada Net GHG Emissions with Land Use, Land Use Change, and Forestry Emissions Emphasized and Updated Projections Beginning in 2021, 1990-2043

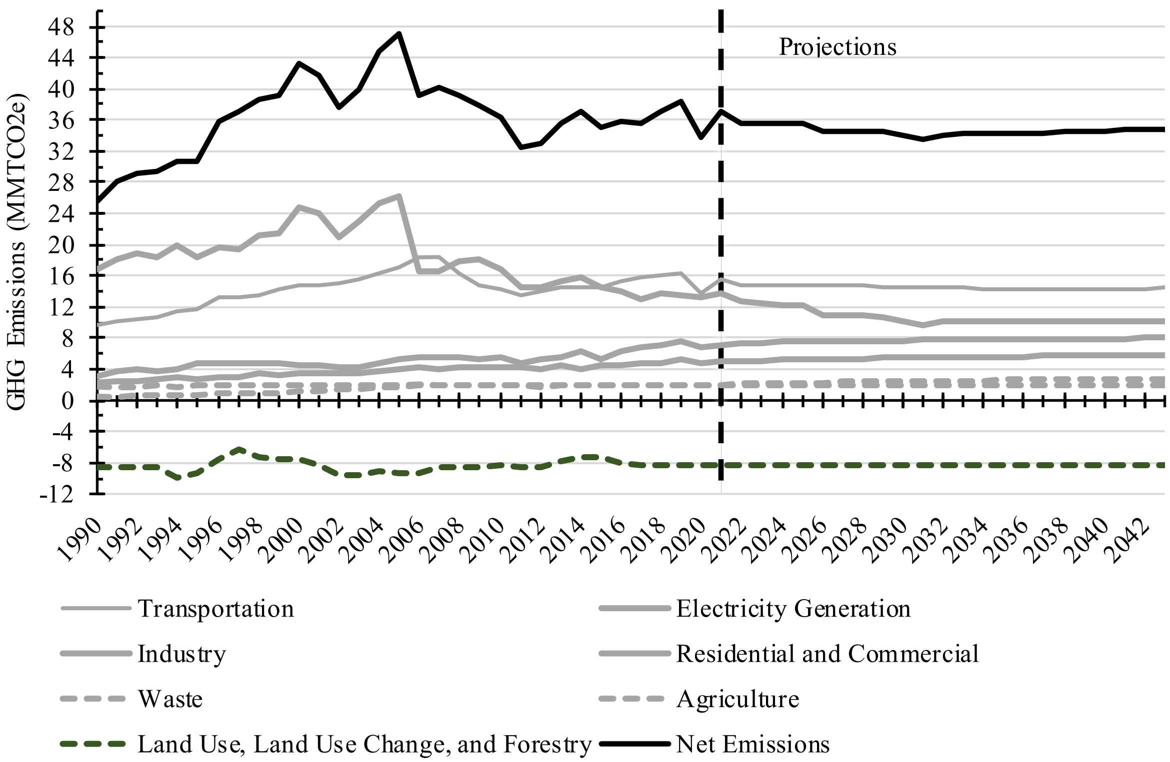
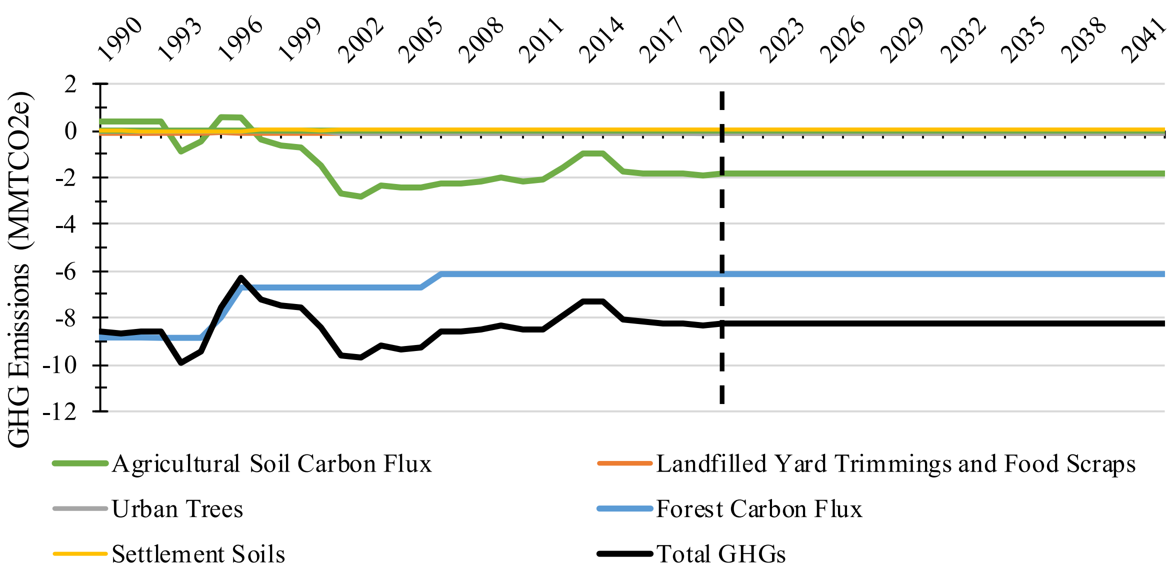


Figure 9-2: Land Use, Land Use Change, and Forestry GHG Emissions by GHG, 1990–2043, with Projections Beginning in 2021



9.1 Overview

The land use, land use change, and forestry sector can act as a net sink of GHGs through carbon sequestration. Nevada's forests, urban trees, and at times, agricultural lands absorb and store carbon from the atmosphere in an amount that can offset the carbon emissions associated with processes such as decomposition and vegetation respiration, commonly referred to as carbon sequestration.[62] GHG emissions from the land use, land use change, and forestry sector are illustrated in Figure 9-2. In 2005, this sector sequestered 9.289 MMTCO2e and in 2020, 8.321 MMTCO2e GHG emissions were sequestered. This sector is projected to sequester 8.218 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 (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 Carbon Sequestration Variability

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). For this reason (discussed in detail below) the report utilizes the 2016 SIT estimates of forest carbon flux for all the years after 2016.

9.2.1 Forest Carbon Flux

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.[63] The FIA research program measures carbon stocks of above- and belowground biomass, deadwood, natural litters, and changes in the soil organic carbon fraction.[64] 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;[65] an increase in carbon stocks indicates that the forest is a sink, that is, it is absorbing carbon from the atmosphere.

A significant uncertainty associated with estimating forest carbon fluxes using this method 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 carbon. While NDEP does not currently have an estimate of the overall uncertainty and

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[62] 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. Section 9.2.2 describes NDEP's recent efforts to better understand the sequestration capacity of these vegetations in Nevada.

[63] Forest Inventory and Analysis. US Forest Service. [accessed 2019 Oct]. https://www.fia.fs.fed.us/

[64] 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.

[65] 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.

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.

In other words, the impact of the inherent uncertainties in the process implies that substantial variations in Nevada's computed forest carbon flux may be associated with the method used in generating the estimates than to actual statewide changes in forest carbon fluxes. This likelihood becomes more apparent when there is substantial chance in forest carbon flux over a very short period of time. Interannual climate variability, such as drought years versus high precipitation years, can affect forest ecosystems. However, significant and persistent changes at the state level affecting all or a significant percentage of Nevada's forests should generally only occur over decades or longer periods. In NDEP's 2012 and 2016 GHG Inventories, the *Land Use, Land Use Change, & Forestry* module from the SIT was 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 presumes this sudden shift from sink to source is not the result of any forest ecosystem change, but rather 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.

9.2.2 Carbon Sequestration Potential of Native Ecosystems of Nevada

In 2023, the Nevada Division of Natural Heritage commissioned the Desert Research Institute to investigate the potential carbon sequestration of native ecosystems in Nevada, including non-forest ecosystems such as sagebrush and desert shrubland[66]. This was accomplished via literature review and studying of existing eddy covariance measurements available in a limited set of sampling stations. The resulting report concludes that non-forest ecosystems in Nevada have the potential to sequester a significant amount of carbon, especially in consideration of the extensive areas covered by these ecosystems. However, such potential sequestration can be reduced and even revert to emissions, depending on interannual variability in environmental factors such as precipitation, temperature, and natural or anthropogenic disturbances (e.g., fire). Another critical finding from this work is the limited research conducted in Nevada, necessitating the use of analog ecosystems from other states to extrapolate the behavior of ecosystems typical of Nevada. These analogs are likely not directly comparable to all areas of the same ecosystem type within Nevada, suggesting that further research is needed to better understand potential and actual carbon sequestration in major ecosystems across the state.

9.2 GHG Emissions, 1990-2020

Apart from wildland fire emissions, the land use, land use change, and forestry sector was a net GHG emissions sink of 8.321 MMTCO2e in 2020. Sequestered emissions in 2020 are 1.008 MMTCO2e less than 2005, when the sector was a net GHG emissions sink of 9.329 MMTCO2e. Figure 9-3 illustrates total land use, land use change, and forestry sector GHG emissions and sinks by source from 1990 through 2020. Table 9-2 lists total land use, land use change, and forestry sector GHG emissions and sinks in Nevada for select years.

[66] CO_2-C sequestration potential of native ecosystems of Nevada: a review of reported values and methodologies for accurate greenhouse gas accounting. Desert Research Institute. https://ndep.nv.gov/air/air-pollutants/greenhouse-gas-emissions

Figure 9-3: Land Use, Land Use Change, and Forestry Sector GHG Emissions and Sinks by Source, 1990-2020

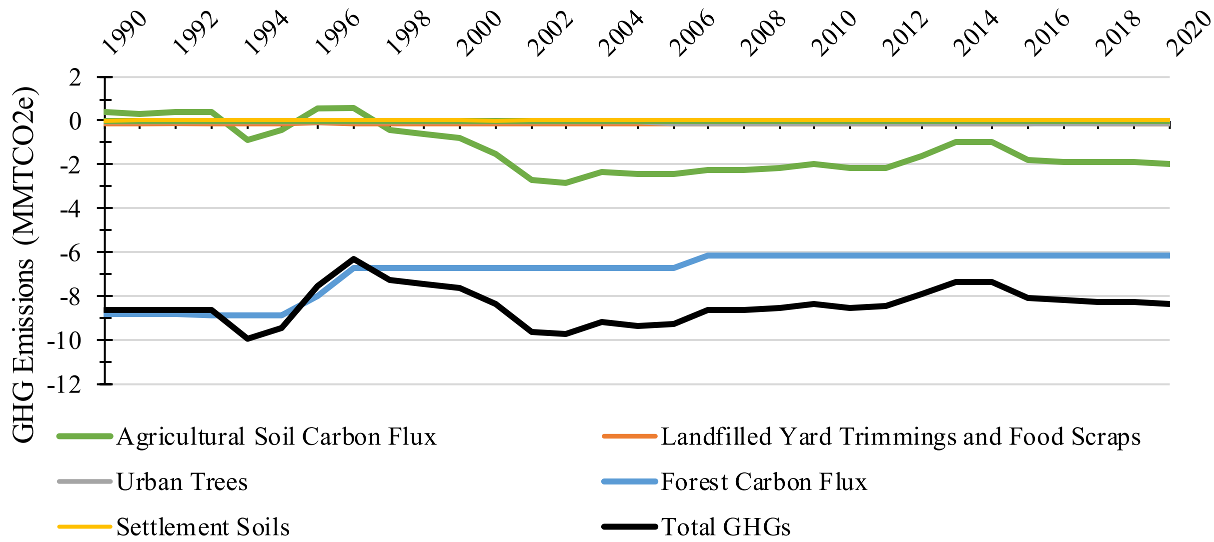

Table 9-1: Land Use, Land Use Change, and Forestry GHG Emissions and Sinks by Source, Select Years (MMTCO2e)

Source	1990	1995	2000	2005	2010	2015	2018	2019	2020
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	-0.123	-0.132	-0.135	-0.138
Landfilled Yard Trimmings and Food Scraps	-0.126	-0.099	-0.101	-0.102	-0.110	-0.102	-0.111	-0.112	-0.114
Agricultural Soil Carbon Flux	0.365	-0.447	-0.733	-2.457	-1.968	-0.973	-1.860	-1.866	-1.940
Settlement Soils	0.001	0.003	0.005	0.004	0.004	0.004	0.004	0.004	0.004
Total	-8.626	-9.463	-7.588	-9.329	-8.315	-7.326	-8.233	-8.242	-8.321

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 2022 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, 1990-2022

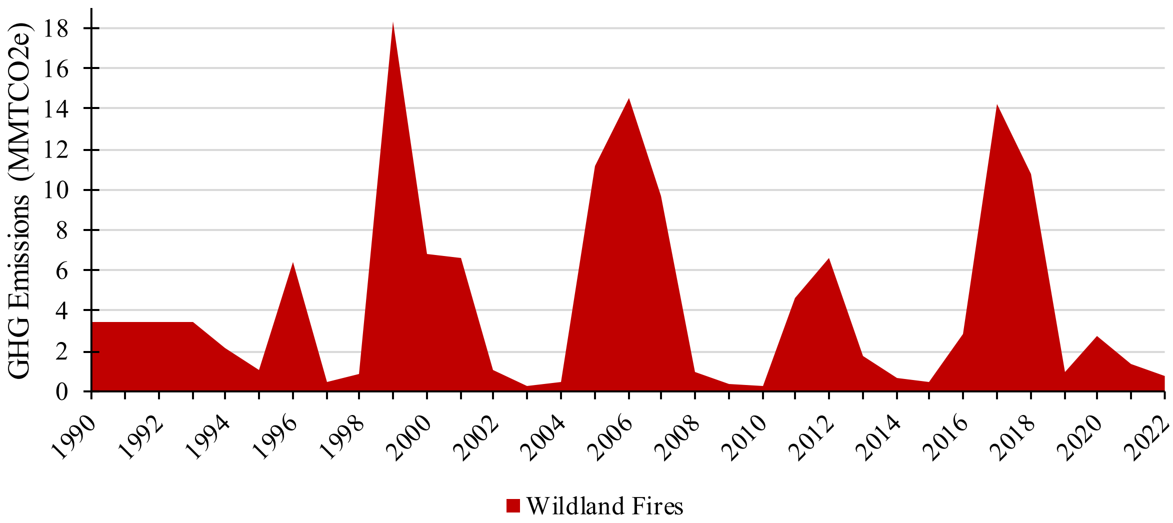

Table 9-2: Wildland Fire GHG Emissions and Total Acres Burned in Nevada, Select Years (MMTCO2e and acres)

	2000	2005	2010	2015	2016	2017	2018	2019	2020
Wildland Fire Emissions – CH_4	6.0364	9.8769	0.2640	0.4413	2.5627	12.6209	9.5067	0.8178	2.4663
Wildland Fire Emissions – N_2O	0.7758	1.2695	0.0339	0.0567	0.3294	1.6221	1.2219	0.1051	0.3170
Total Wildland Fire Emissions	**6.8123**	**11.1464**	**0.2979**	**0.4980**	**2.8921**	**14.2430**	**10.7286**	**0.9229**	**2.7833**
Uncontrolled Fire Acres Burned	635,713	1,032,111	23,869	42,479	265,155	1,329,285	1,001,963	*N/A	*N/A
Prescribed Fire Acres Burned	2,566	13,580	4,771	4,916	6,695	5,198	*N/A	*N/A	*N/A
Total Acres Burned	**638,279**	**1,045,832**	**28,640**	**47,395**	**271,850**	**1,334,483**	**1,001,963**	*N/A	*N/A

*Data not currently available

9.3 Projected Emissions, 2021-2043

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 2016 through 2020 emissions. It is estimated that, on average, the sector will sequester 8.218 MMTCO2e GHG emissions per year. Wildland fire emissions were projected using the average of historical GHG emissions from 1994 through 2022 and are projected to emit 8.921 MMTCO2e GHG emissions per year.

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

As required by NRS 445B.380, this section identifies policy options for each of the six required sectors, organized by sector, that could achieve reductions in projected GHGs. Also as required by NRS 445B.380, the policy options identified in this section were identified through consultation with the Nevada Governor's Office of Energy (GOE), Public Utilities Commission of Nevada (PUCN), Nevada Department of Transportation (NDOT), and the Nevada Department of Motor Vehicles (DMV.

It is important to note that this 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. Important metrics for policy evaluation include GHG emission reduction potential, climate justice considerations, budgetary and economic implications, and implementation feasibility.

Policies are not listed in order of priority or feasibility. Some policies will directly reduce GHG emissions; other policies, programs, and investments listed may provide indirect GHG emission reduction benefits by supporting those policies that directly reduce emissions.

10.1 Economy-Wide Policies

In addition to the sector-specific policies, comprehensive economy-wide programs need further evaluation to determine what may be appropriate for Nevada's GHG emissions profile.

Implement Market-Based Mechanisms

Carbon pricing mechanisms have been effectively implemented across the U.S., both regionally and/or at the state level, to reduce GHG emissions while providing resources to support climate mitigation and adaptation programs. Various models have been designed and implemented in other states and regions, and these options can be explored for determining which market-based mechanism(s) may work best for Nevada.

Integrate Social Cost of GHG Emissions in Planning

The social cost of greenhouse gases (SC-GHG) can be used in planning efforts (such as regional transportation and land use planning) to provide a monetary value for SC-GHG emissions that result from a particular action taken by an agency, including projects, programs, or policies. SC-GHG is the monetary value of the net harm to society associated with adding an amount of GHG emissions to the atmosphere in a given year. Or conversely, SC-GHG can be viewed as the net benefit to society associated with removing/avoiding a set amount of GHG emissions in a given year. In principle, it includes the value of all climate change impacts, including, but not limited to, changes in net agricultural productivity, property damage from increased floods, wildfires, other natural disaster risks, disruption of energy systems, risks of conflict, environmental migration, and ecosystem services. SC-GHG emissions in Nevada should reflect the societal value of reducing GHG emissions by one metric ton of CO_2 equivalent emissions.

10.2 Governance

Adopt Lead-by-Example Programs for State and Local Governments

State agencies can demonstrate leadership in reducing GHG emissions within their activities and operations. Options for these programs range from sector-specific reductions across state executive branch agencies (examples include state-owned building efficiency and fleet electrification), to agency-specific actions and planning initiatives. Lead-by-example program options include:

- Adopt a coordinated, interagency economy-of-scale procurement program for state, county, municipal, and school district fleets to support low and zero emission vehicle (LEV and ZEV, respectively) acquisitions that achieve a reduction in individual unit costs.
- Require climate mitigation goals, resilience to impacts of climate change, environmental justice, or other climate policies to be considered in State planning activities.
- Require consideration of climate mitigation goals, resilience to impacts of climate change, and SC-GHG emissions (including consideration of environmental justice) in state-funded capital investments.
- Implement "buy clean" procurement policies for State agencies that establish maximum allowable global warming potential thresholds for certain construction materials.

POLICY ENACTED: Adopt Purchasing Preference for State Vehicles
In 2023, the Nevada Legislature passed AB 262[67], which declared that it is a state policy goal to support and pursue a transition of all publicly owned vehicles to zero emission fleets by 2050. The bill requires state agencies to give preference to purchasing state vehicles that minimize emissions, the total cost over the life of the vehicle, and/or purchasing vehicles with internal combustion engines that use cleaner fuels.

Establish A Clean Energy Workforce Development Program
Increase training and education around employment and business recruitment opportunities, climate action policies, and new energy efficiency technologies to equip the next generation workforce with the skills and knowledge needed to reach the statewide GHG emissions reduction goals.

Establish State Climate Governance Structure Centered on Equity, Environmental Justice, and Economic Recovery
While this would not directly mitigate GHG emissions, coordination across the Executive Branch and throughout the state is imperative to optimize investments in mitigation policy and support the resilience of communities and natural resources. Many states have adopted novel governance models that also integrate equity, environmental justice, and economic recovery[68].

10.3 Transportation

POLICY ENACTED: Adopt Light Duty Vehicle Emissions Standards
In 2021, Nevada adopted California light-duty vehicle emission standards, established though a waiver application allowable under Section 177 of the Clean Air Act (CAA), for model year 2025 and newer motor vehicles and new motor vehicle engines produced and delivered for sale in the State. These Nevada requirements include:

- Low Emission Vehicle (LEV) standards that set vehicle manufacturer GHG and criteria pollutant emissions standards for new passenger cars and light-duty trucks; and
- Zero Emission Vehicle (ZEV) standard that creates a credit-based program for vehicle manufacturers that requires an increasing percentage of ZEVs.

Adopt Next Generation Vehicle Emission Standards

- Evaluate adoption of the California Air Resources Board Advanced Clean Cars II (ACC II) regulation, which establishes a credit-based program with the goal of 100% of all new light-duty vehicles be electric or plug-in hybrid electric by 2035.

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[67] https://www.leg.state.nv.us/Session/82nd2023/Bills/AB/AB262_EN.pdf
[68] See for instance, Oregon Global Warming Commission, https://www.keeporegoncool.org/tighger, and New Mexico's Climate Change Task Force, https://www.climateaction.nm.gov/who-we-are/.

- Evaluate adoption of California's Advanced Clean Truck Program to reduce engine emissions and increase electrification of medium- and heavy-duty vehicles. The Program requires manufacturers of vehicles of weight Classes 2b through 8 to sell zero-emission trucks as an increasing percentage of their total sales from model year 2024 to model year 2035.

- **POLICY APPROVED: Establish Incentive Program for the Purchase of Zero Emission Medium and Heavy-Duty Vehicles**
  In 2023, Nevada established the Clean Trucks and Buses Incentive Program with the passage of AB 184[69]. The new program provides vouchers ranging from $20,000 to $175,000 to small businesses, local and tribal governments, and state agencies to replace older trucks and buses with zero-emission medium- and heavy-duty vehicles. The program, administered by NDEP and supported by funds from the federal Carbon Reduction Program (23 U.S.C. § 175), is scheduled to begin in 2024.

Adopt Low-Carbon Fuel Standards
Low-Carbon Fuel Standards (LCFS) are a way to establish a requirement for a reduction in the carbon intensity of fuels over a given timeframe for a given sector of the market. LCFS can be fuel- and technology-neutral and assess the lifecycle carbon emissions of fuels. States have employed different approaches that could be considered in Nevada, including:

- Require a 20% carbon reduction in transportation fuels by the year 2030.
- Adopt rules requiring a 10% reduction in carbon intensity of transportation fuels over a 10-year period.
- Reduce lifecycle energy GHG emissions by 10% below 2010 levels by 2025.

Implement State Car Allowance Rebate System ("Cash for Clunkers")
Adopt a program similar to the federal Car Allowance Rebate System, colloquially known as "cash for clunkers" enacted under the 2008 American Recovery and Reinvestment Act, that provides financial incentives for vehicle owners to trade in older, less fuel-efficient vehicles and replace them with new low or zero emission vehicles.

POLICY ENACTED: Close Emissions Inspection Loopholes for Classic Cars License Plates
In 2021, the Nevada Legislature adopted AB 349,[70] changing the special license plate program. The legislation, beginning in 2023, requires all vehicles in the program to obtain special insurance in order to obtain and retain their classic rod or classic vehicle license plate. Vehicles in the program cannot be driven for general transportation purposes or exceed 5,000 miles during the immediately preceding year, or vehicles will be subject to emission control testing requirements similar to other vehicles in Nevada.

Department of Transportation Strategy to Reduce Transportation Emissions
Through the State's Department of Transportation, develop a Transportation Emissions Reduction Program to reduce transportation-related emissions across Nevada.[71]

Reduce Vehicle Miles Traveled (VMT) and Expand Mass Transit
Several options exist to expand the use of non-single-occupant vehicle trips, including, but not limited to, carpooling, transit, micro-transit bicycling, and walking. A strategy could be adopted to further assess and reduce VMT in Nevada. Options to be considered include:

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[69] https://www.leg.state.nv.us/Session/82nd2023/Bills/AB/AB184_EN.pdf
[70] https://www.leg.state.nv.us/App/NELIS/REL/81st2021/Bill/7897/Overview
[71] https://www.dot.nv.gov/Home/Components/News/News/7984/395

- Expand regional transit services through increases in trip frequency, service areas, and improved reliability while also providing greater incentives to increase transit service use.
- Adopt a statewide transportation demand management program for large employers, incentivizing employers to actively participate in minimizing vehicle trips created by their business.
- Adopt parking pricing strategies such as implementing parking charges for parking lots of a certain size in select communities, while providing lower parking costs for carpools and vanpools to encourage the use of these services.
- Adopt a statewide parking policy or policy limited to larger counties that eliminates or precludes minimum parking requirements and 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 discourage more-impactful development and encourage less-impactful development, such as transportation impact fees based on projected increases/decreases in VMT and supports 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.
- Consider opportunities for passenger rail investments along Nevada's busiest corridors through state level rail planning and oversight expertise to identify and seek funding for passenger rail development.[72]

10.3.1 Complex Climate Challenges: Transportation Transformation

The transportation sector is currently Nevada's greatest source of GHG emissions. A two-pronged approach to reduce transportation demand, particularly in urban areas, while significantly increasing the percentage of low- and zero-emissions vehicles on Nevada roads can dramatically reduce transportation-related GHG emissions while advancing the State's economic recovery and rebuilding post-COVID. There are also tangible benefits to the health and safety of Nevadans as air quality would be improved as tailpipe emissions are reduced.

Achieving Nevada's net-zero GHG emissions by 2050 goal will require major changes to the State's transportation system, as well as shifts in travel patterns and personal transportation choices. This in turn will require various degrees of buy-in across Nevada's urban and rural communities. Ameliorating GHG emissions will also necessitate a more-strategic approach to Nevada's investment in transportation infrastructure that includes consideration of the multiple cascading impacts of climate change. Other states are already navigating these issues and succeeding in building modern, low-emissions, climate-resilient transportation systems while accelerating consumer adoption of clean vehicles and alternative transportation options.

Transportation has a significant environmental impact and contributes to climate change beyond the direct impact of GHG emissions from internal combustion engines. This comes in the form of tire dust, urban heat island impacts resulting from expansive parking lots, and more. Further, as seen during the early days of the COVID-19 pandemic, reducing the total volume of miles driven daily has an impact on emissions and can help in achieving GHG reduction goals.

To date, the State of Nevada has invested $705,217 in GOE Renewable Energy funds and $3,506,561 in VW Settlement funds toward electric vehicle charging infrastructure along Nevada's five major corridors (I-80, I-15, US 50, US 93, and US 95). Further, NDOT is slated to receive an additional $38 million for electric vehicle charging infrastructure from the Infrastructure Investment and Jobs Act.

[72] NDOT just received notice of a $3 Billion Federal Railroad Administration Grant for the Brightline West Project connecting Las Vegas and Southern California, which is projected to reduce VMT and GHG emissions along the I-15 Corridor.

Additional programs and initiatives could be explored to support widespread adoption of Nevada's new clean car standards and to support further transportation electrification efforts. These include:

- Provide outreach and education on the benefits of ZEV ownership and the positive health outcomes of transportation electrification.
- Promote existing and evaluate additional ZEV incentives and rebate programs.
- Support electric utility electric vehicle infrastructure planning.
- Review and determine potential changes to electric rate structure to support more ZEV deployment.
- Improve infrastructure in homes and businesses to facilitate the transition to ZEVs.
- Support installation of charging infrastructure in existing facilities.
- Promote inclusion of EV 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[73];
    - Incentivize and increase the development of workplace charging infrastructure for electric vehicles at existing commercial and industrial facilities;
    - Incentivize and increase the development of charging infrastructure for electric vehicles for all types of existing residences, including those in underserved and rural areas;
    - 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;
    - Support 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.

10.4 Electricity Generation

Adopt a Mandatory Renewable Portfolio Standard (RPS) of 100% By or Before 2050

In 2019, the Nevada Legislature passed SB 358, which requires that by 2030, 50% of electricity sold to the State must come from renewable sources. SB 358 also declares that it is State policy to become a leading producer and consumer of clean and renewable energy, with the 2050 goal of all energy sold by providers of electric service to come from renewable sources.

- Provide support to customers willing to invest in additional incremental renewable energy and/or energy storage resources to ensure they receive electric service from 100% renewable energy resources each hour.

Transition from Fossil Fuel-Fired Electricity Generation to Clean Energy Sources

- Enact a freeze on the approval or construction of any new fossil fuel-fired electricity generating sources.
- Accelerate retirement of remaining coal-fired electric generating units (EGUs) operating in Nevada, including merchant and load-serving plants.

[73] Through the Economic Recovery Transportation Electrification Plan (ERTEP), NV Energy will invest nearly $100 million to rapidly expand electric vehicle charging station access across its service territory from 2022 through 2024. https://www.nvenergy.com/cleanenergy/ertep

Require GHG Reduction Plans and Prioritize Decarbonization in Utility Integrated Resource Plans

- Move towards EGUs that have lower carbon intensity as placeholders in integrated resource plan (IRP) proceedings to ensure that IRPs consider GHG emission goals. This will improve the accuracy of future projections of GHG emissions and can occur in the absence of new legislation.
- Prioritize decarbonization in IRP proceedings as part of, or in addition to, the low-carbon base case.
- **POLICY ENACTED: Require Regulated Resource Plans for Natural Gas Utility**

  In 2023, the Nevada Legislature passed SB 281[74], which introduces an IRP procedure for gas utilities in Nevada, similar to the existing requirement for electric utilities. The bill requires gas companies to submit plans every 3 years, outlining gas demand projections, proposed system investments, and cost-benefit analyses of alternative options. The IRP for gas utilities aims to enhance long-term planning, increase investment transparency, and prioritize ratepayer interests, aligning gas utilities more closely with the regulatory framework of electric utilities. Strategically planning natural gas supply is recognized as a pivotal step in attaining the state's emission reduction goals.

- **POLICY ENACTED: Require More In-State Power Generation and Strengthen IRP Process**

  The 2023 Nevada Legislature passed AB 524[75], which modifies the state's long-term energy resource planning process and promotes local clean energy generation to reduce demand for energy on the open market during peak demand. The bill emphasizes the importance of affordability, availability, and reliability of the supply of electricity in Nevada through a several legislative declarations including declaring that "It continues to be in the interest of this State to invest in a portfolio of electric generation supply and demand-side management measures that increase energy reliability and reduce greenhouse gas emissions consistent with state policy."[75]

Prioritize Energy Efficiency and Demand Response Programs

- Prioritize demand-side management programs that reduce electricity usage during periods of time when renewable generating facilities cannot be relied upon (when the sun is not shining, for example).
- Prioritize demand-response programs that shift load to periods of time when renewable resources can be relied upon to serve the load.
- Provide incentives for the purchase of distributed energy storage at homes and businesses.
- Prioritize utility-scale energy/battery storage programs to support peak-energy demand.

10.4.1 Complex Climate Challenges: Transmission Planning and Grid Modernization

Power-sector issues extend beyond Nevada's borders. As Nevada is also geographically located between large urban and economic centers across the West, it serves as a transmission "hub" that plays a critical role in the delivery of electricity for the region. Consequently, transmission and distribution grid planning and modernization is a West-wide effort and the influence of climate change across these western states must be considered in managing both current and future supply and demand.

[74] https://www.leg.state.nv.us/Session/82nd2023/Bills/SB/SB281_EN.pdf
[75] https://www.leg.state.nv.us/Session/82nd2023/Bills/AB/AB524_EN.pdf

Support Efforts to Clean and Modernize the Electricity Grid

Modernizing and upgrading the grid is essential to strengthening the transition of electricity systems while supporting increasing demands posed by transportation and building electrification, resilience of climate impacts of extreme weather, and operating on 100% renewable resources.

The system must 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 distributed energy resources, renewable energy resources, and electric vehicles. It must also 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. The policies listed below may provide indirect GHG emission reduction benefits by supporting policies that directly reduce emissions.

- **Strengthen Grid Resilience**

Provide for the analysis of and/or initiatives to support a modernized grid resilient to future disruptive events, including natural disasters and climate change driven extreme weather, while ensuring that Nevada continues to rate high on the grid modernization index.

In 2019, the Nevada Legislature adopted SB 329, requiring electric utilities to triennially submit a Natural Disaster Protection Plan (NDPP) to the PUCN (NRS 704.7983). The NDPP must identify service territory areas subject to a heightened threat of a fire or other natural disasters, propose and describe cost-effective protocols in mitigating wildfire or other natural disasters, and describe procedures in restoring the distribution system in the event of a natural disaster.

- **Evaluate Regional Energy Markets**

Evaluate regional markets as new tools to integrate more renewables into the grid to realize more renewable efficiency gains.

In 2021, the Nevada Legislature adopted SB 448, which includes a requirement that the PUCN require transmission providers to join a regional transmission organization by January 1, 2030 (NRS 704.79886). Transmission providers are granted the ability to apply to waive or delay this requirement. An RTO enables automated procurement and dispatch in real time to serve regional demand using least-cost resources and can be used to integrate more renewables into the grid to realize more renewable efficiency gains.

10.5 Residential and Commercial

Adopt Energy Codes for Net-Zero Buildings

Bolstering energy codes is a key step towards achieving net-zero buildings. In July 2021, Nevada adopted the 2021 International Energy Conservation Code (IECC) and included additional guidance for “electric vehicle-ready” codes should municipalities choose to integrate them into their codes. Additional steps that can be taken include:

- Adopt a stretch code that improves energy efficiency in new construction by 20% above the currently adopted IECC.
- Assist state, county, and municipal government agencies with the adoption, implementation, and compliance with the most recently published IECC on a three-year cycle.
- Support the renovation of existing homes and businesses to reduce their energy demand and make their homes more energy-efficient.

- Require all new affordable housing developments to operationally invest in net-zero GHG emissions and support retrofit of affordable housing for rooftop solar, on-site energy storage, vehicle charging, and heat pumps.
- Use low-carbon materials in new construction and retrofits, and reuse materials and structures where possible, to reduce embodied GHG emissions.
- 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.

Transition from Residential and Commercial Use of Gas

Planning for the transition from fossil fuels in buildings should consider the following options:

- Provide support for the conversion of fossil fuel-dependent appliances to renewable energy-sourced electric alternatives such as stoves, water heaters, and furnaces.
- Provide support to increase renewable energy-sourced electrification of the built environment for new construction as well as for existing buildings, both residential and commercial, to switch from fossil fuels to all electric.
- Evaluate limitations on the installation of gas lines to newly constructed homes and businesses.
- Establish "electric ready" requirements for homes to support EV charging, electric appliances, and on-site solar and battery storage.
- Consider the role of low-carbon fuels in communities that face challenges in electrification.

Implement a Statewide Benchmarking Program

Energy benchmarking is a continuous process of analyzing the current performance of a building and comparing it to a standard baseline to determine progress toward energy and water efficiency targets. The Energy Star program can be used to track water and energy consumption within the built environment. Within a year of program implementation, a benchmark is established, and the energy efficiency measures identified through an energy audit are prioritized and implemented to reach specific goals. The program, available to public and private buildings, provides a challenge and reward mechanism for buildings that participate and achieve the GHG emissions reduction goals set forth within the program.

Require Residential Energy Labeling and Energy Audits

Such audits would require an energy audit to be performed and provided to buyers during the purchase of a residence, similar to an appraisal or home inspection. The audit provides potential owners the opportunity to negotiate implementing energy audit measures before 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. Other similar consideration could include:

- 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).

POLICY ENACTED: Adopt Appliance and Equipment Efficiency Standards

In 2021, the Nevada Legislature passed AB 383,[76] requiring GOE to adopt appliance efficiency standards through regulation for certain appliances sold in this State. On and after July 1, 2023, new regulated appliances may not be sold, leased, or rented in Nevada unless it meets or exceeds the minimum standards

[76] leg.state.nv.us/App/NELIS/REL/81st2021/Bill/7985/Overview

of energy efficiency established by GOE. On February 21, 2023, GOE adopted a regulation to establish appliance efficiency standards. The regulation requires additional review and approval by the Legislative Commission prior to becoming effective.

Expand the Property-Assessed Clean Energy (PACE) Program
An evaluation of the effectiveness of adopting a statewide residential PACE program should be conducted to determine the scope of expansion of the program.

Expand Energy Savings Performance Contracting
Utilize energy saving performance contracting to identify opportunities for energy conservation measures and implement measures with 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.

Explore Opportunities to Fund Investments in Clean Energy

- Establish a revolving loan fund to be utilized by state and local government to improve the energy efficiency of existing government building stock. Loan funds could be repaid through the realized energy savings which could be collected back into the account and used to further energy-efficiency measures across the existing building stock.
- Provide enhanced support through the Nevada Clean Energy Fund for 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.

10.5.1 Complex Climate Challenges: Green Buildings and Land Use

Net-zero or low-carbon buildings is a nationwide conversation focused on increased efficiency in the built environment, reducing GHG emissions, and improving the performance of existing and future building stock. Increased efficiency in the built environment is recognized globally as a necessary step to aid in reducing GHG emissions while achieving significant cost savings for building owners/occupants.

Policy options to optimize efficiency include building performance standards, beneficial electrification, alternative financing for the low- and moderate-income (LMI) communities, and education surrounding green building practices. However, the State has limited authority when it comes to implementing building efficiency policies. Much of the responsibility along with enforcement is executed and handled by local governments or authorities having jurisdiction.

Land-use decisions should consider evolving and emerging climate impacts. As Nevada grows and urban areas in particular expand to meet the demands of a growing population, communities and infrastructure will be increasingly exposed to climate-driven natural hazards. Beyond wildfire, for example, flooding also poses a risk. Both Reno and Las Vegas already experience urban flooding and are particularly vulnerable to increases in the frequency and size of flood events as the climate warms. When communities prioritize infill and smart growth instead of sprawl to meet new demands, significant GHG emission reductions can be achieved as well as limiting increases in the urban “heat island” effect.

10.6 Industry

Policies focused on increasing the energy efficiency of commercial buildings and renewable power generation will support reduction of GHG emissions in the industrial sector. Additional strategies tailored to industry should:

- Support the implementation of energy-efficient technologies and practices; including more efficient ways to light and heat industrial facilities and run equipment.
- Implement more stringent controls to capture and prevent the release of industrial process emissions.
- Support fuel switching to less carbon intense fuels for stationary combustion sources.

Adopt "Buy Clean" Standards

These are regulations and procurement policies that create maximum allowable global warming potential (GWP) thresholds for certain construction materials (e.g., low-carbon concrete). This can be coupled with programs that promote the production of industrial products from recycled or renewable materials, rather than producing new products from raw materials.

Reduce, Capture, and Recycle Ozone-Depleting Substance Substitutes including Hydrofluorocarbons (HFCs)

The AIM Act of 2021, directs EPA to phase down production and consumption of HFCs by 85% over the next 15 years and support transition to alternatives. On October 5, 2021, EPA issued the first regulation under the Act, which establishes baseline levels, an initial methodology for allocating and trading HFC allowances for 2022 and 2023, and creates a compliance and enforcement system. State policies supporting these efforts could include:

- Evaluate replacement, capture, and recycling (or other measures) that reduce the usage of ozone-depleting substance (ODS) substitutes above threshold amounts.
- Adopt regulations requiring tracking, reporting, and reducing the use of HFCs.
- Enact building codes that require the use of low-GWP refrigerants.
- Establish a GWP limit for new and existing industrial equipment, including stationary refrigeration, and air conditioning.

Adopt More Stringent Controls on Emissions from Oil and Natural Gas Exploration, Production, Transmission, and Distribution Systems

Different strategies are being implemented by states to reduce methane emissions from the oil and gas sectors. These include:

- Ban routine natural gas flaring and venting and reduce fugitive methane emissions from both new and existing facilities, requiring new detection, testing, repair, reporting, and recordkeeping requirements.
- Require oil and gas operators to capture natural gas waste.
- Adopt a clean heat standard, a policy establishing GHG reduction targets for gas distribution utilities. The standard would direct utilities to develop cost-effective plans toward meaningful reductions in emissions resulting from delivering fuel to homes and businesses.

10.7 Waste

Utilize 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.

Food Waste and Landfill Sustainability Practices to Reduce Methane Emissions

- Utilize Landfill Methane Outreach Program data to identify active and retired landfills.

- Adopt practices that reduce waste production and increase diversion of organic waste.
- Support construction of anaerobic digesters and landfill-gas-to-energy (LFGTE) practices of captured methane (CH_4) emissions.

Expand Efforts to Convert Fugitive Methane (CH_4) Emissions to CO_2

- Provide incentives for flaring and LFGTE practices in solid waste landfills and wastewater treatment plants.

10.8 Land Use, Land Use Change, and Forestry

Decrease Risk of Catastrophic Wildfire Events

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

Expand Urban Forestry Programs

- Adopt requirements for increased tree coverage when constructing residences and commercial buildings to increase canopy coverage that also reduce urban heat-island. Tree coverage requirements will help reduce the urban heat island effect as a driver of record setting temperature increases in Las Vegas and Reno.
- Support urban reforestation and management to ensure appropriate investments in landscaping and shade trees that are climate appropriate and consider water supply and other parameters.

POLICY ENACTED: Codify and expand the Urban and Community Forestry Program

In 2023, the Nevada Legislature approved AB 131, which establishes the Urban and Community Forestry Program within the Nevada Division of Forestry (NDF). The program's primary objective is to utilize tree canopies as a solution to counter the urban heat impact caused by rising temperatures and heat-absorbing materials like asphalt. A key aspect of the program involves setting specific targets for urban forests and formulating best practices for local municipalities.

Although the carbon sequestration opportunities of most of Nevada's landscapes are uncertain, the broader ecosystem service benefits of conserving natural lands and ensuring appropriate, smart development can support rebalancing of the climate system and resilience of natural resources. Strategies include:

- Establish and prioritize state land conservation goals.
- Promote land management practices that increase carbon sequestration by natural lands that are typical and/or native to Nevada.
- Expand specific programs (nursery programs, for example) to restore and enhance habitats, including important wetland habitats.
- Expand existing efforts to protect sagebrush habitat using the Sage Grouse Protection Conservation Credit System to include carbon sequestration co-benefits.
- Enhance targeted forest biomass utilization with stringent emissions controls. Targeted programs, like in Lake Tahoe, include co-benefits such as reducing wildfire risk and managing invasives.

RESEARCH CONDUCTED: Refine Understanding of the Carbon Sequestration Potential of Natural and Working Lands

The Nevada Division of Natural Heritage (NDNH) and NDEP contracted with the Desert Research Institute to conduct a review of carbon flux potential for natural and working lands in Nevada. The report, published in December 2023, concluded that arid brushlands, including those in Nevada, have the ability to sequester significant amounts of carbon; however, under certain climatic conditions some sites could become sources of carbon emissions.[77] Additional research on the impacts of temperature and precipitation on carbon flux in arid brushlands, as well as the sequestration potential of other biomes in Nevada, is needed to estimate the carbon flux and sequestration potential of Nevada's natural lands.

Additionally, in 2022, NDNH contracted with The Nature Conservancy to conduct a study quantifying carbon sequestration in degraded sagebrush rangelands in Nevada. The project looked at carbon sequestration potential in rangeland soils and the sequestration benefits (and costs) associated with restoring non-native vegetation with native grasses. Ultimately, the study underscored the potential of rangeland restoration as a natural climate solution, not only for the Intermountain West but also for arid regions worldwide, offering opportunities for increased belowground carbon sequestration.

10.9 Agriculture

Although the carbon sequestration and land management opportunities of most of Nevada's landscapes are uncertain, best practices in land management provide opportunities to ensure carbon sequestration potential is optimized on Nevada's working lands. Strategies include:

- Establish and promote a statewide healthy soils program.
- Support opportunities 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.
- Promote and provide incentives for the adoption of silvopasture practices.
- Promote practices to reduce emissions from enteric fermentation.
- Promote manure and nitrogen fertilizer management practices.

10.10 Policies Enacted

In addition to being included in each of the sectors above, the table below includes a summary of policies included in past inventories that have been completed (See Table 10-1). Based on available information, NDEP included the effect of these policies on GHG emission reduction into the emission projections included in this GHG inventory.

Table 10-1: Summary of Enacted Policies

Emission Sector	Policy	Description	Lead Agencies
Governance	Adopt Purchasing Preference for State Vehicles	October 2023, AB 262 requires state agencies to give preference to purchasing state vehicles that minimize emissions, the total cost over the life of life of the vehicle, and/or purchasing vehicles with internal combustion engines that use cleaner fuels.	Department of Administration
Transportation	Adopt Light-Duty Vehicle Emission Standards	October 2021, Clean Cars Nevada rulemaking sets emission standards for model year 2025 and later light- duty vehicles offered in sale in Nevada starting in 2024.	NDEP and DMV

[77] CO_2-C sequestration potential of native ecosystems of Nevada: a review of reported values and methodologies for accurate greenhouse gas accounting. [December 2023]. https://ndep.nv.gov/air/air-pollutants/greenhouse-gas-emissions

Emission Sector	Policy	Description	Lead Agencies
	Close Classic Car Emission Loophole	June 2021, AB 349 requires insurance coverage for vehicles with "Classic Car" and "Classic Rod" license plates.	DMV
	Establish Incentive Program for the Purchase of Zero Emission Medium and Heavy-Duty Vehicles	Effective January 2024, AB 184 provides vouchers to small businesses, local and tribal governments, and state agencies to replace older trucks and buses with zero-emission medium- and heavy-duty vehicles.	NDEP and NDOT
Electricity Generation	Require Regulated Resource Plans for Natural Gas Utility	Effective January 2024, SB 281 introduces an IRP procedure for gas utilities in Nevada, similar to the existing requirement for electric utilities.	PUCN
	Require More In-State Power Generation and Strengthen IRP Process	October 2023, AB 524 modifies the state's long-term energy resource planning process and promotes local clean energy generation to reduce demand for energy on the open market during peak demand.	PUCN
Residential and Commercial	Adopt Appliance and Equipment Efficiency Standards	June 2021, AB 383 requires adoption of regulations for energy efficiency of certain appliances. February 2023, GOE adopted a regulation to establish appliance efficiency standards. The regulation requires additional review and approval by the Legislative Commission prior to becoming effective.	GOE
Land Use, Land Use Change, and Forestry	Codify and expand the Urban and Community Forestry Program	Effective January 2024, AB 131 sets specific targets for urban forests and formulating best practices for local municipalities.	NDF

Appendix A: Methodology

Introduction

This Appendix includes the description of the methodologies used to estimate historical and projected emissions for the Sectors included in this Report.

Transportation

Historical Emissions

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 SEDS data and one SIT module. Fuel consumption estimates provided by SEDS are used to estimate historical CO_2 emissions from the combustion of fossil 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. 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[78], this report uses the default VMT estimates used in the *CH_4 and N_2O Emissions from Mobile Combustion* module.[79] These estimates are based on national averages prepared by the Federal Highway Administration (FHWA) in their *Highway Statistics* series[80] 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 can 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. Minimum amounts of CH_4 emissions are achieved when hydrogen, carbon, and oxygen are present in the ideal combination for complete combustion.

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[78] Assembly Bill 483 of the 2019 Nevada Legislative Session directed the Nevada Department of Motor Vehicle to conduct a pilot program to gather and report data on annual VMT from all vehicles registered in Nevada, with few exceptions. Once there is historical fuel consumption data reported for the same time period as the mileage reports, NDEP may be able to refine CH_4 and N_2O emissions estimates for the state.

[79] 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 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.

[80] Policy and Governmental Affairs: Office of Highway Policy Information Highway Statistics Series. U.S. Department of Transportation, Federal Highway Administration. [accessed 2021 Oct 25]. https://www.fhwa.dot.gov/policyinformation/statistics.cfm

N_2O formulation in internal combustion engines is not yet well understood, and data on these emissions are limited. It is understood 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.

Projections

CO_2 emissions for the transportation sector are projected using the AEO's Reference case and, when appropriate, alternative statistical methods that consider Nevada-specific historical consumption provided by SEDS. Because the AEO aggregates projected fuel consumption at the regional level,[81] significant discrepancies at the state level between historical and future consumption can sometimes occur. CH_4 and N_2O emissions are projected using a linear trend of historical emissions.

Electricity Generation

Historical Emissions

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 for all three GHGs are quantified using fuel consumption estimates included in the SEDS data. For 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.

Estimates for CH_4 and N_2O emissions (the byproducts of fossil fuel consumption) are determined by applying emission factors for the individual fuel types (such as 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).

Projections

Projected emissions in the sector are determined using state and power plant level data. The EIA's AEO does not consider the most recent IRPs filed by the utilities considered in this report and the region level projections provided by the AEO are not easily disaggregated to the state level for this sector. 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

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

and regulations affecting the future of those units.[82,83] Information was gathered from the following sources:

- EIA Form 923[84] and EIA Form 860[85] for unit level net generation, fuel consumption, reported retirements, and nameplate capacity;
- EPA Air Markets Program Data (AMPD)[86] and the Emissions and Generation Resource Integrated Database (eGRID)[87] for CO_2 emissions, gross generation, heat input, and EGU nameplate capacity;
- NV Energy's 2022-2041 IRP[88] submitted to the PUCN for sales projections, power purchase agreements, supply side plans, and reported remaining useful lives of their fossil fuel-fired fleet[89];
- Idaho Power's 2019 IRP[90] for information on North Valmy Generating Station[91]; and
- The updated RPS specified in NRS 704.7821.

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.

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.[92] When this happens, NDEP simulates fossil fuel peaker and intermediate load units (as

[82] 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.
[83] CO_2 emissions associated with the combustion of petroleum products was projected using a linear trend of 2017 through 2021 historical emissions. Petroleum-based CO_2 emissions accounted for less than 0.05% of sector emissions in 2021.
[84] Form EIA-923. U.S. Energy Information Administration. [accessed 2023 Oct 22]. https://www.eia.gov/electricity/data/eia923/
[85] Form EIA-860. U.S. Energy Information Administration. [accessed 2023 Oct 22]. https://www.eia.gov/electricity/data/eia860/
[86] Air Markets Program Data. U.S. Environmental Protection Agency. [accessed 2023 Oct 22]. https://campd.epa.gov/
[87] Emissions and Generation Resource Integrated Database. U.S. Environmental Protection Agency; 2023 Sept 26. [accessed 2023 Oct 13]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[88] Nevada Power Company d/b/a NV Energy and Sierra Pacific Power Company d/b/a NV Energy. Joint 2022-2041 Integrated Resource Plan, for the three year Action Plan period 2022-2024, and the Energy Supply Plan period 2022-2024. Public Utilities Commission of Nevada. 2021 Jun 1; Docket 21-06001, Amended Filing. [accessed 2021 Oct 13]. http://puc.nv.gov/
[89] 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).
[90] Idaho Power Company. Idaho Power Integrated Resource Plan 2019 Second Amended. 2020 Oct. [accessed 2021 Oct 13]. https://www.idahopower.com/energy-environment/energy/planning-and-electrical-projects/our-twenty-year-plan/
[91] North Valmy Generating Station is co-owned by NV Energy and Idaho Power.
[92] 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.

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 — apart from TS Power — that is, EGUs owned by Nevada Gold Mines LLC (Western 102), 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. For TS Power, it is assumed that the power plant's conversion from a strictly coal-fired facility to a dual fueled, coal- and natural gas-fired facility will be completed by 2023. In the sector-wide projections, it is assumed that TS Power, starting in 2023, operates 50% of the year using coal (January through April and November and December) and 50% of the year using natural gas (May through October). This results in a 17% reduction in facility emissions, or 170,000 metric tons of CO_2 per year.

While this method of projecting emissions may exclude the minor emissions associated with smaller electric generating facilities and some renewable energy providers (for example, geothermal power plants), it currently provides an accurate estimate of electricity generation sector GHG emissions in Nevada through 2040.

Industry

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 for all three GHGs are quantified using fuel consumption estimates included in the SEDS data. For 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.

Estimates for CH_4 and N_2O emissions (the byproducts of fossil fuel consumption) are determined by applying emission factors for the individual fuel types (such as 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. 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 are also considered. 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 liquified petroleum gas 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 EIA's AEO and additional assumptions about future fuel consumption when the disaggregated regional AEO fossil fuel consumption data results in inconsistencies with the historical dataset. Fuel consumption estimates are then subjected to the same quantification method as historical fuel consumption.

Industry Emissions from Industrial Processes

Generally, the SIT's *Industrial Processes* module estimates GHG emissions by either (1) considering the amount of a material produced (produced materials in Nevada being cement, lime, limestone, dolomite, and for a short period of time semiconductors) 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, 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. [93]

For production-based industrial process GHG emissions, projections use the post-Great Recession historical average to estimate emissions. For usage/consumption-based industrial process GHG emissions, projections first estimate the usage/consumption of the GHG and then apportion emissions based on end-use estimates of the final product. For the use of limestone, dolomite, soda ash and the consumption of urea, historical estimates are projected using a linear trend.

For ODS substitutes and electric power transmission and distribution systems, historical emissions are based on U.S. ODS substitute emissions apportioned to Nevada using national and state population estimates. Projections are based on the EPA's *Global Non-CO_2 Greenhouse Gas Emission Projections and Mitigation: 2015-2050*, released in October 2019. The report includes updated U.S. projections through the year 2050. However, in this report, the model used to project U.S. emissions under existing policy only incorporates transition to low-cost, low-GWP alternative to reflect compliance with rules finalized through the Significant New Alternatives Policy (SNAP) Program. In August of 2017 and April of 2019, the U.S. Court of Appeal for the District of Columbia Circuit vacated SNAP Program Rule 20 and Rule 21, respectively. It is also important to note that ODS substitute emissions projections are currently highly uncertain due to the recently finalized HFC phasedown rule, which is not considered in the projections. The Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the American Innovation and Manufacturing (AIM) Act, which the U.S. Congress directed EPA to prepare in the 2021 Consolidated Appropriations Act, will phase down HFC emissions in the United States by 85% over the next 15 years. [94, 95]

Unfortunately, and regardless of the choice of national dataset, the current method of estimating and projecting ODS substitute emissions in Nevada is very likely underestimating emissions. As Nevada's already arid environment is experiencing the effects of climate change sooner and in more significant

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[93] ODS substitute emissions, which are quantified by prorating national emissions (which are themselves reported as a blend of multiple HFCs), currently use IPCC Fourth Assessment Report GWPs.

[94] Final Rule - Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act. U.S. Environmental Protection Agency. [accessed 2021 Dec 1]. https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation

[95] The HFC phasedown rule was finalized in October 2021 and is therefore not considered in this report's emissions projections.

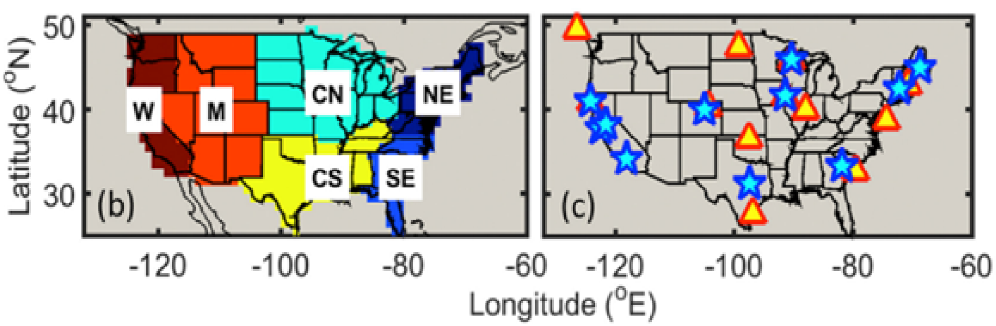
ways than other parts of the country (leading to a higher frequency of weather extremes, including heatwaves), using national estimates and Nevada's population to apportion emissions is likely leading to underestimates of both ODS substitute usage and the associated emissions. More accurately estimating these emissions will require efforts to further characterize the presence and usage of ODS substitutes in Nevada.

ODS Substitute Emissions

Beginning in 2022, the SIT's *Industrial Processes* module provides a new, alternate method in reapportioning state-level emissions of ODS substitutes from the national estimate. In this new method, national emissions are disaggregated to individual states through population distribution and then modified with data pulled from a NOAA analysis to better incorporate the varying nature of ODS substitute emissions across the United States. The analysis relies on atmospheric transport models applied to ground-level and air-level measurement samples of various fluorocarbons to estimate emissions over six regions of the contiguous United States.

Uncertainties associated with this reapportionment method based on the referenced study include limitations in geography (Nevada is grouped into the Mountain Region, where emissions estimates rely on air samples collected in Colorado) and time (study uses data collected from 2008-2014). Uncertainty is also inherent when developing emissions estimates through atmospheric transport modeling. Figure 5-7 illustrates the grouping of the contiguous States into regions, with the Mountain Region indicated in red, and the various locations of ground-level measurements (blue stars) and air-level measurements (yellow triangles) used in the study.[96]

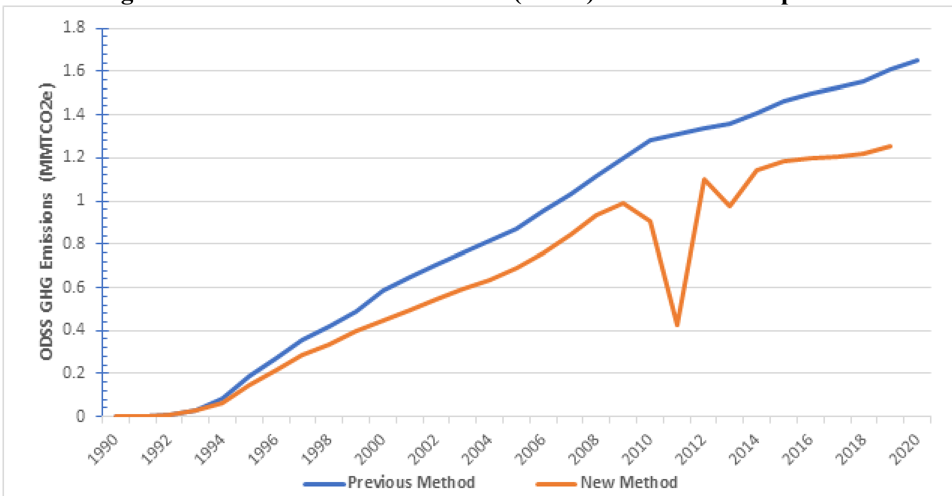
Figure A-1: Study Regions and Sampling Locations



As shown in Figure 5-8, application of the new reapportioning method results in substantial decreases in ODS substitutes emissions for Nevada, as opposed to the method used in previous reporting that strictly disaggregates national emissions to individual states by population distribution only. As stated previously, it is expected that true statewide ODS substitutes emissions in Nevada are larger than what is apportioned strictly by population due to the State's increasingly hot and dry climate, warranting a larger reliance on air conditioning compared to the national average. The new reapportionment method provides estimates that are lower for Nevada, and also shows a highly variable emissions profile from 2008 to 2014 that does not agree with the overall trend and may indicate a possible gap between study-level emissions and inventory forecasting. For the purpose of this report, the more conservative approach is used and ODS substitutes emissions remain to be estimated by population until further confirmation of the new method is provided.

[96] Considerable Contribution of the Montreal Protocol to Declining Greenhouse Gas Emissions from the United States. Hu, L., et al.; 14 Aug 2017. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL074388

Figure A-2: Nevada ODS Substitute (ODSS) Emissions Comparison



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 through 2041. 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 sub-sector emissions estimates.

Residential and Commercial

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).[97] 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.

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

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 (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.

Waste

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
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.[98] 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.[99]

[98] 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.
[99] 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.

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.

Wastewater Methodology

Wastewater emissions are estimated using the SIT's *Wastewater* module. In most cases, CH_4 and N_2O emissions are calculated as:[100,101]

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

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.

Additionally, the opportunity for flaring and LFGTE projects also exists with wastewater treatment facilities.[102] However, the *Wastewater* module does not provide the data nor does it provide a method for quantifying the impact of these avoided emissions.

Agriculture

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.

[100] 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.
[101] 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.
[102] For example, the Truckee Meadows Water Reclamation Facility utilizes flaring/LFGTE to mitigate facility CH_4 emissions.

Table A-1: 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. 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. 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. 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.

Land Use, Land Use Change, and Forestry

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).[103,104] The module includes, for example, estimates of average biomass density in Nevada and the relative combustion efficiency of various land types.

Table A-2: 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.

[103] National Interagency Fire Center. [accessed 2019 Sep]. https://www.nifc.gov/
[104] 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.

Appendix B: Energy Flows

The U.S. Department of Energy's Lawrence Livermore National Laboratory studies the interconnection of energy, fuel sources, outputs, and GHG emissions. Their series of energy flow charts present the complex relationship between sources of energy and their final end-use.[105] Figure B-1 (on the next page) is Lawrence Livermore National Laboratory's flow chart estimation of energy consumption in Nevada in 2019. The illustration presents their estimation (using EIA's State Energy Data System as inputs) of all the energy consumed in Nevada, in units of trillions of British Thermal Units (BTUs), with the widths of the bands in the flow chart being linearly proportional to the quantities of energy moving through the system and being consumed by the four economic sectors in Nevada that consume fossil fuels (that is, transportation, electricity generation, industry, and residential and commercial). The boxes on the right represent the final disposition of the energy; either Rejected Energy, which is wasted energy lost through heat loss, friction, or other inefficiencies, or Energy Services, which represents the energy that has been consumed for a beneficial purpose.

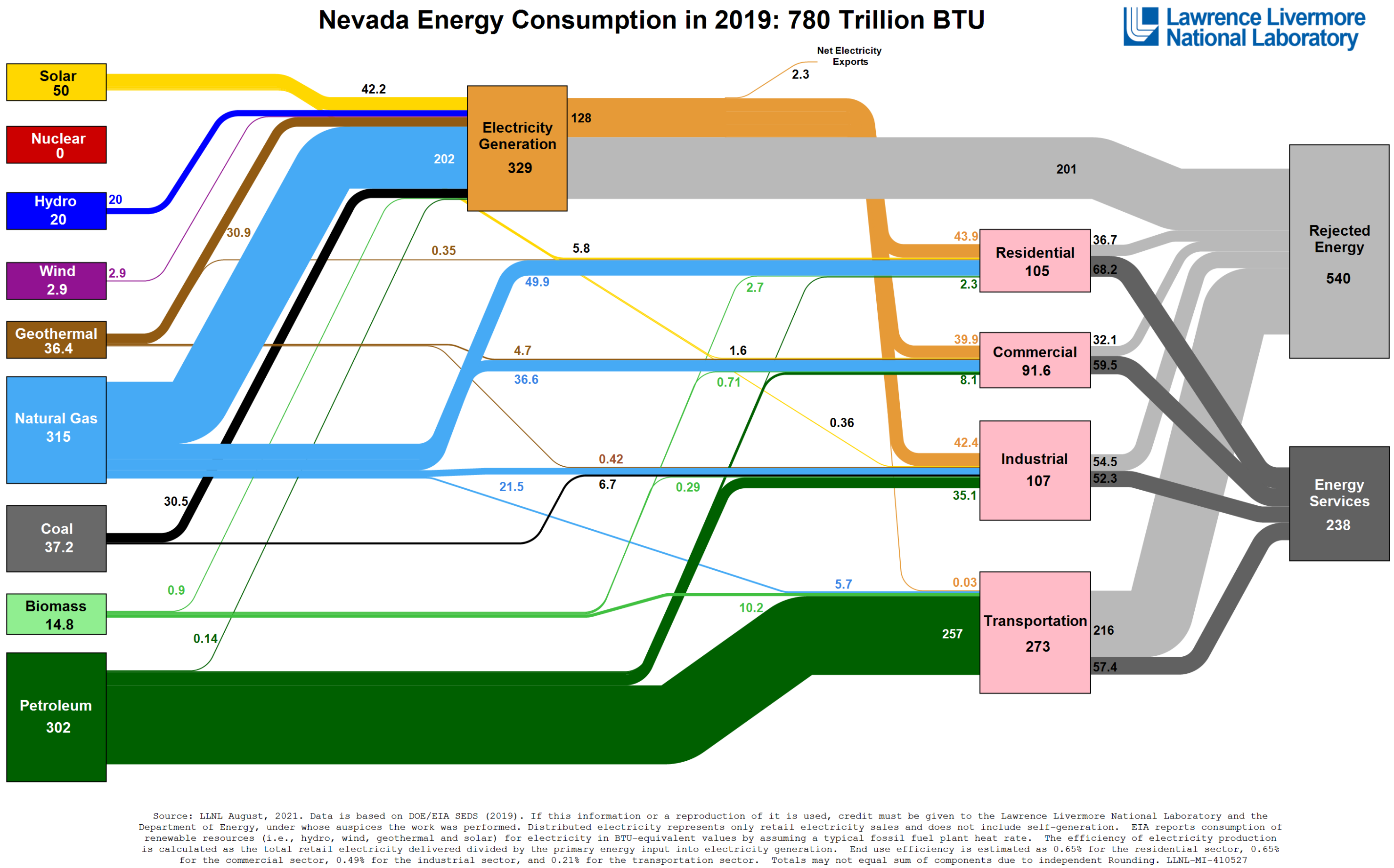
Figure B-2 illustrates Lawrence Livermore National Laboratory's flow chart estimation of energy-related CO_2 emissions in Nevada in 2017 (the most recent year of their CO_2 estimates). Presenting the same fuel sources, this flow chart illustrates CO_2 emissions, in million metric tons (MMT), and connects the economic sectors where emissions ultimately occur to their fossil fuel sources. Notice that because of the different approaches and methodologies used to derive CO_2 emissions, sector totals do not equal the estimates otherwise included in this report for 2018.

Looking at both figures together, the prevalence of natural gas and petroleum as the two largest sources of energy-related emissions is evident. However, the figures also clearly illustrate an opportunity to expand the use of zero and near-zero emission renewable energy sources in Nevada through increasing electrification. By replacing activities that currently depend on fossil fuels with electric equivalents (electric cars, stoves, and heating being some examples) and then further increasing our dependence on renewable energy sources to generate electricity, Nevada can reduce GHG emissions and decarbonize.

This overview of energy flows does not portray all of the complexities of these sectors, nor does it illustrate the many ways in which GHG emissions can be reduced through energy efficiency gains. However, through Lawrence Livermore National Laboratory's energy flow charts, the interrelated nature of energy systems, carbon dioxide emissions, and Nevada's potential opportunities to decarbonize is made clearer.

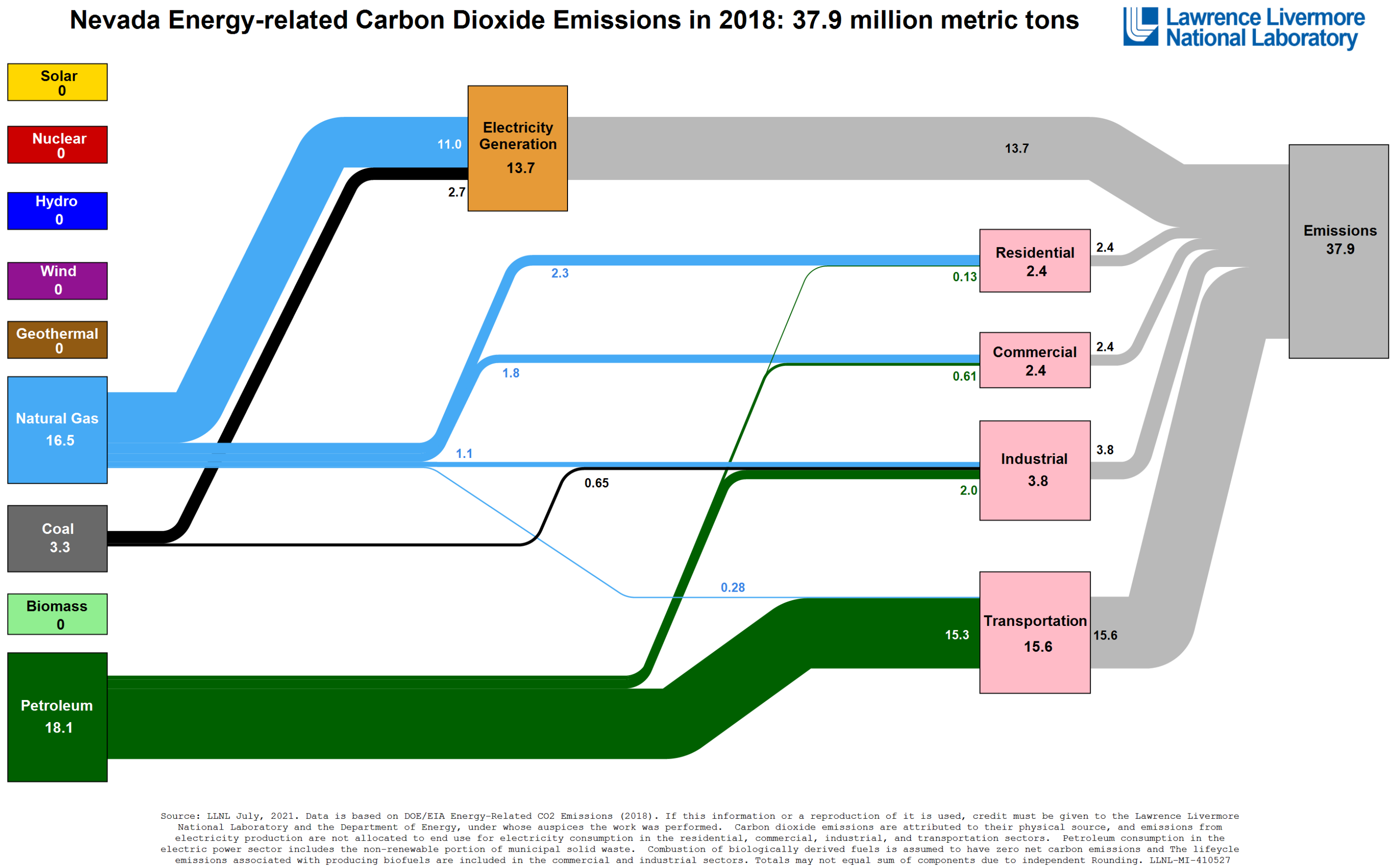
[105] LLNL Flow Charts. Lawrence Livermore National Laboratory. [accessed 2020 Nov 2]. https://flowcharts.llnl.gov/

Figure B-1: Estimated Nevada Energy Consumption in 2019: 780 Trillion BTU[106]



[106] Source: LLNL August 2021. Data is based on DOE/EIA SEDS (2019). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory on the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.49% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

Figure B-2: Estimated Nevada Energy-Related Carbon Dioxide Emissions in 2018: 37.9 MMTCO2e [107]



[107] Source: LLNL July 2021. Data is based on DOE/EIA Energy-Related CO2 Emissions (2018). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory on the Department of Energy, under whose auspices the work was performed. Carbon emissions are attributed to their physical source, and emissions from electricity production are not allocated to end use for electricity consumption in the residential, commercial, industrial, and transportation sectors. Petroleum consumption in the electric power sector includes the non-renewable portion of municipal solid waste. Combustion of biologically derived fuels is assumed to have zero net carbon emissions and the lifecycle emissions associated with producing biofuels are included in the commercial and industrial sectors. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527