Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2040

Nevada Division of Environmental Protection
2020 Supplemental Report

Submitted in accordance with NRS 445B.380

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Acronyms and Abbreviations

AEO	Annual Energy Outlook
AMPD	Air Markets Program Data
BTU	British Thermal Unit
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CNG	Compressed Natural Gas
CO2e	Carbon dioxide equivalent
COP21	21^{st} Session of the United Nations' Conference of Parties
eGRID	Emission & Generation Resource Integrated Database
EGU	Electric Generating Unit
EIA	United States Energy Information Administration
EO	Executive Order
EPA	United States Environmental Protection Agency
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Reporting Program
GWP	Global Warming Potential
IECC	International Energy Conservation Code
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
LBE	Lead by Example
LEV	Low Emission Vehicle
LFGTE	Landfill-Gas-to-Energy
LMOP	Landfill Methane Outreach Program
LNG	Liquefied Natural Gas
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
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
ppm	Parts per million
PUCN	Public Utilities Commission of Nevada
RPS	Renewable Portfolio Standard
SAFE	Safe and Affordable Fuel-Efficient Vehicles
SB	Senate Bill
SNAP	Significant New Alternatives Policy
SIT	State Inventory Tool
SPPC	Sierra Pacific Power Corporation
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
$CaMg(CO_3)_2$	Dolomite
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon dioxide
$CO(NH_2)_2$	Urea
HFC	Hydrofluorocarbon
NCO	Cyanate
NH	Imidogen
NO	Nitrogen Oxide
NOx	Oxides of Nitrogen
N_2O	Nitrous Oxide
PFC	Perfluorocarbon
SF_6	Sulfur hexafluoride

Executive Summary

Introduction

The Nevada Division of Environmental Protection is pleased to present the 2020 report, *Nevada Statewide Greenhouse Gas Inventory and Projections, 1990 to 2040*. This report has been prepared pursuant to Nevada Revised Statutes (NRS) 445B.380[1] as amended by Senate Bill (SB) 254, which was approved by the Nevada Legislature during the 2019 Legislative Session and signed by Governor Sisolak on June 3, 2019.

As required by NRS 445B.380, this report contains an updated inventory of greenhouse gas (GHG) emissions in Nevada and a statement of policies to help inform the development of future policy initiatives designed to reduce GHG emissions statewide. The GHG inventory is based on data from 2017, the most recent year for which comprehensive data is available. Pursuant to SB 254, this report includes an updated inventory and projection of GHG emissions for the largest emitting sectors (transportation and electricity generation); the industry sector was also included, given the potential for rising emissions from Ozone Depleting Substance (ODS) substitutes. 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 "statement of policies" included in this report repeats the statement of policies included in the 2019 report; and identifies, and provides a reference to, those policies and policy analyses included and considered in the *2020 State Climate Strategy*[2]. Further development and review of policies will be pursued as part of the overall Nevada Climate Initiative.

Importantly, SB 254 established emissions reduction goals for all GHG emitting sectors of the state's economy. Past policy was solely focused on reducing GHG emissions from the electricity generation sector via the statutorily required Renewable Portfolio Standard (RPS). Nevada led the nation as one of the first states to establish an RPS in 1997 and increased the RPS most recently during the 2019 Legislative Session with SB 358 that requires 50% of electricity sold in Nevada to originate from renewable energy sources by 2030[3]. While the express purpose of Nevada's RPS is the expansion of renewable energy ***use*** statewide in Nevada, the secondary benefit has been a significant reduction in GHG pollution from the electricity generation sector through the expanded ***production*** of renewable electricity in Nevada. Renewable electricity ***use*** and ***production*** in Nevada are not synonymous.

Building upon the RPS, SB 254 broadened Nevada's climate ambition by setting forth economy-wide GHG reduction goals of 28% below 2005 levels by 2025, 45% below 2005 levels by 2030, and zero or near-zero by 2050. These economy-wide GHG emissions reduction goals generally correspond to similar

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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] State of Nevada Climate Initiative: Our Strategy. Nevada Department of Conservation and Natural Resources. [accessed 2020 Dec 23]. https://climateaction.nv.gov/our-strategy/
[3] 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).

reductions required pursuant to Nevada joining the U.S. Climate Alliance in March of 2019.[4] Further, the goals embodied in SB 254 and via the U.S. Climate Alliance are both reflected as priorities under Executive Order (EO) 2019-22, issued by Governor Sisolak in November 2019. One of the core directives required under EO 2019-22 directs the executive branch to build upon the Statement of Policies included in this report by evaluating, identifying, and analyzing the most effective climate policies and regulatory initiatives for Nevada in a comprehensive State Climate Strategy. The State Climate Strategy serves as a framework for policymakers to evaluate the alignment of various climate policies and programs with timelines and benchmarks to achieve GHG reduction goals.

Assumptions and Key Findings

Under SB 254 and EO 2019-22, Nevada has set forth aggressive, but necessary, benchmarks for reducing GHG emissions and mitigating climate impacts throughout Nevada. Based on the policies considered in this report[5], excluding any impact from the COVID-19 pandemic, and based on the best available data, Nevada is anticipated to reduce economy-wide GHG emissions by 24% below 2005 levels in 2025 (4% short of the SB 254 goal of 28%) and by 27% below 2005 levels in 2030 (18% short of the SB 254 goal of 45%). These projections assume the following:

- Projections in this report do not account for the impact of the COVID-19 pandemic, as tools and datasets used for the preparation of this report predate 2020 (see Section 1.3);
- Recently increased RPS requirements are fully met (see Section 4.2 and Section 4.4);
- Tier 3 federal passenger car and light-duty truck fuel economy standards are not rolled back (see Section 3.4);
- Planned coal-fired electric generating unit retirements (see Section 4.2);
- Anticipated natural gas-fired electric generating unit retirements (see Section 4.2);
- Existing emissions standards for the oil and natural gas industry, including exploration, production, and delivery, remain in effect (see Section 5.4); and
- Increase in emissions from ODS substitutes are curbed by a larger use of substitutes with lower Global Warming Potential, as driven by innovation and federal regulation and policies (see Section 5.1.1 and Section 5.4).

Through 2040, 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 policy parameters. As such, managing GHG emissions from these two sectors should be a priority for policymakers in both the near- and long-term.

Other key findings from the report include:

[4] Nevada Governor Steve Sisolak Joins U.S. Climate Alliance. US Climate Alliance; 2019 Mar 12. [accessed 2019 Nov 14]. https://www.usclimatealliance.org/publications/2019/3/12/nevada-governor-steve-sisolak-joins-us-climate-alliance

[5] 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 2.2 Emissions Projections, 2018-2040 for more information).

- In 2017, Nevada contributed 0.68% of the U.S.'s total gross GHG emissions, despite having 0.91% of the population;
- As of 2015, the transportation sector accounts for the greatest percentage of GHG emissions, increasing to 36% of gross GHG emissions in Nevada in 2017;
- Based on the policies considered in this report, and using pre-COVID datasets, transportation sector emissions are projected to peak in 2020, and then follow a very gradual downward trend through 2040. This downward trend is not sufficient to meet the SB 254 targets in either 2025 or 2030;
- GHG emissions from the electricity generation sector are expected to continue to decrease through 2040, with the conditional retirement of the North Valmy Generating Station in Nevada and the increased RPS established by SB 358 (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 fueled, coal- and natural gas-fired facility; and
- Industrial process sub-sector emissions are expected to continue to increase, as the use of ODS substitutes continue to increase — the magnitude of this increase, however, is uncertain.

Summary of Changes from 2019 Report

Key changes from the previous 2019 report include:

- Updated analysis of the transportation and electricity generation sectors;
- Additional analysis of the industrial sector, including GHG contributions from ODS substitutes using two alternative data sets;
- Discussion of COVID-19 impact on GHG emissions;
- Summary of the *2020 State Climate Strategy*;
- Updated to 2019 version of EPA State Inventory Tool (SIT);
- Revised Statement of Policies to adopt by reference the policy assessments from the *2020 State Climate Strategy*; and
- This 2020 report further validates Nevada's GHG reduction trajectory established in the 2019 report.

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 *2020 State Climate Strategy*, and other relevant input from state agencies, stakeholder groups, university and scientific experts, and the general public.

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

Summary Figures and Tables

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

Figure ES-1 illustrates Nevada's net GHG emissions broken down by each of the seven individual sectors included in the report (transportation, electricity generation, industry, residential and commercial, waste, agriculture, and land use, land use change, and forestry) from 2005 through 2017 and projected emissions from each of these sectors from 2018 through 2030. Note that this report includes updated projections only for the transportation, electricity generation, industry, and residential and commercial sectors[6]. 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 2017 come primarily from the electricity generation sector with some reductions from the transportation sector. Future projections indicate that current policies will achieve reductions in the electricity generation sector primarily due to the recently increased RPS and, unless more aggressive policies are adopted at the state and federal level, only slight decreases in the transportation sector. Note that projections do not include any impact on emissions from the COVID-19 pandemic.

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

Figure ES-2 illustrates the relative contribution of gross GHG emissions from each sector for select years (the 2005 benchmark year, 2017 most recent inventory, 2025, and 2030).

Reported total emissions from the transportation, industry, and residential and commercial sectors increased by 1 MMTCO2e between 2016 and 2017 but were offset by a similar decrease in emissions from the electricity generation sector.

Although emissions from the transportation sector show a net decrease over the projection period, it remains the leading sector of GHG emissions in Nevada starting in 2015. The electricity generation sector's contribution is predicted to continue to decrease from 30% in 2017, to 27% in 2025, down to 25% by 2030; contributions from industry are expected to remain stable, around 16%, but a large uncertainty is associated with the sector projections, due to the uncertainty in the federal regulatory framework and lack of state and local data on the use of ODS substitutes.

[6] NRS 445B.380 requires updates to the transportation and electricity generation sectors only. While not required by NRS 445B.380, an analysis of the sources and amounts of GHG emissions from industry is included in this report because of the significance of ozone depleting substance (ODS) substitute emissions identified in NDEP's 2019 report. Further, updated emissions for the residential and commercial sector are included because they are estimated with the same tools that NDEP uses for the transportation and electricity generation sectors.

Figure ES-1: Nevada Historical and Projected Net GHG Emissions and Sinks by Sector, 2005-2030, with Projections Beginning in 2018 and Comparisons to Nevada's Emission Reduction Goals for 2025 and 2030

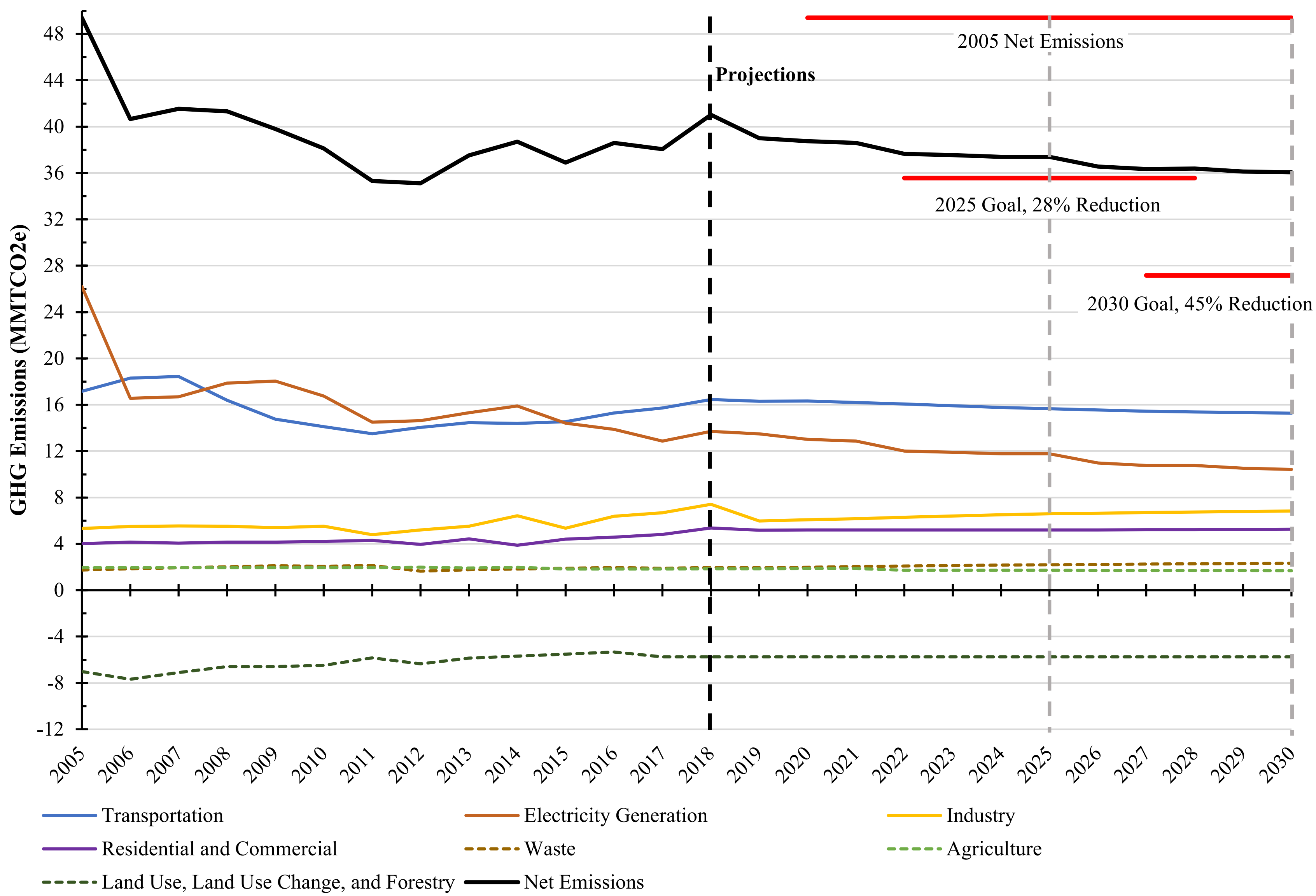
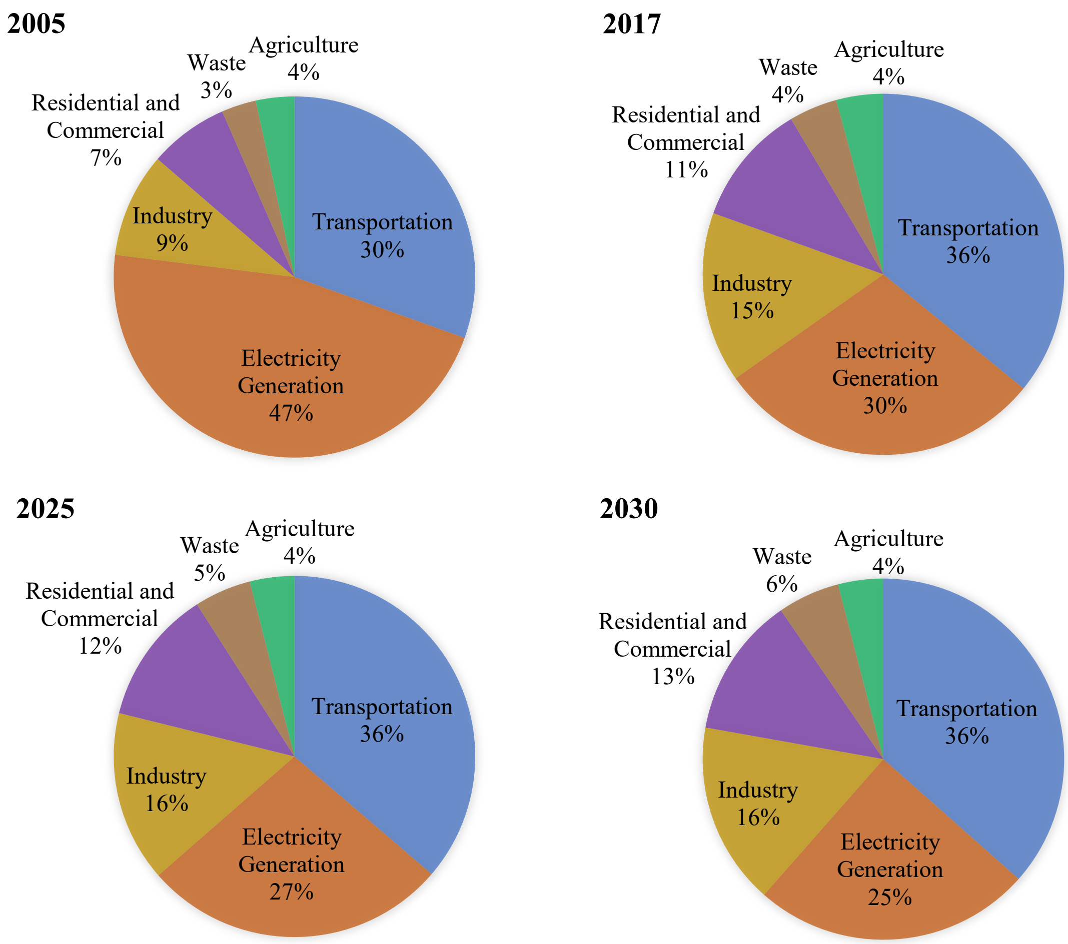


Table ES-1: Nevada Net GHG Emissions Comparison with Nevada's Emission Reduction Goals (MMTCO2e and Percent)

	2005	2025	2030
Net Emissions	49.397	37.387	36.063
Projected Emissions Reduction	-	12.010	13.334
Projected Percent Reduction	**-**	**24%**	**27%**
SB 254 Emissions Goals	-	35.566	27.168
SB 254 Emissions Reductions	-	13.831	22.229
SB 254 Percent Reduction	-	28%	45%
SB 254 Percent Deficit	-	4%	18%
Estimated Additional Emissions Reductions Required	**-**	**1.821**	**8.895**

Figure ES-2: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2017, 2025, and 2030



Introduction

1.1 Overview

The *Nevada Greenhouse Gas Emissions Inventory and Projections, 1990-2040* is an inventory of greenhouse gas (GHG) emissions in Nevada starting in 1990 and a projection of GHG emissions in Nevada through 2040. In accordance with Nevada Revised Statutes (NRS) 445B.380, this report includes:

- The sources and amounts of GHG emissions in Nevada from transportation (Section 3), electricity generation (Section 4), and industry sectors (Section 5)[7];
- A quantification of GHG emissions reductions required to achieve the 2025 and 2030 reduction goals;
- Adoption by reference of the policy assessment sections of the *2020 State Climate Strategy*, which includes:
  - 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;
  - A qualitative assessment of whether the identified policies support long-term reductions of GHG emissions to zero or near-zero levels by the year 2050;

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. Apart from those emissions which are quantified for Nevada using apportioned national emissions, this report uses the GWPs from the Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report.[8,9,10]

[7] While the sources and amounts of GHG emissions from industry are not required by NRS 445B.380 for this report, they are included because of the significance of ozone depleting substance (ODS) substitute emissions identified in NDEP's 2019 report.
[8] GHG emissions quantified using this method generally depend on IPCC Fourth Assessment Report GWPs and are noted as such throughout the report.
[9] Previous inventories have utilized GWPs from previous IPCC assessments.
[10] 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.

Table 1-1: The GHGs and 100 year GWPs without Climate Carbon Feedbacks[11] for the GHGs Considered in this Report[12]

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[13]:

- Transportation
- Electricity Generation
- Industry

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

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.

[11] 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 changes further 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*

[12] IPCC (2013) Appendix 8

[13] NRS 445B.380 requires updates to the transportation and electricity generation sectors only. While not required by NRS 445B.380, an analysis of the sources and amounts of GHG emissions from industry is included in this report because of the significance of ozone depleting substance (ODS) substitute emissions identified in NDEP's 2019 report. Further, updated emissions for the residential and commercial sector are included because they are estimated with the same tools that NDEP uses for the transportation and electricity generation sectors.

historical and projected GHG emissions estimates. Sectors also included in this report, but which are not detailed in the same way include:

- Residential and Commercial
- Waste
- Agriculture
- Land Use, Land Use Change, and Forestry (LULUCF)

While historical and projected GHG emissions from these sectors are presented for reference in Sections 2.1 and 2.2 of this report, detailed descriptions of these sectors are not.[14] 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.

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 2019 release of the United States Environmental Protection Agency's (EPA's) State Inventory Tool (SIT)[15], the 2019 release of the United States Energy Information Administration's (EIA's) *Annual Energy Outlook* (AEO)[16], recommendations developed by the IPCC, and additional federal, state, and local data sources that were used to increase the accuracy of the SIT. In the absence of available data, the most technically appropriate statistical methodology was used to either interpolate or extrapolate the missing data. The methods presented in this report are considered by the NDEP to be the most reliable methods available at the time this report was prepared.

Historical and projected GHG emissions in this report are based on data made publicly available in 2019 or earlier. Therefore, changes in emissions due to the COVID-19 pandemic are neither considered in the data used to prepare this report nor are they reflected in the near-term emissions projections herein presented. For this reason, reported emission projections, especially near-term projections, are very

[14] NDEP's 2019 report, *Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2039* includes detailed descriptions for these four sectors and can be found online at https://ndep.nv.gov/air/air-pollutants/greenhouse-gas-emissions.
[15] State Inventory and Projection Tool. US Environmental Protection Agency; 2019 Dec 10. [accessed 2020 Sep 21]. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[16] Annual Energy Outlook 2019: with projections to 2050. US Energy Information Administration. [released 2019 Jan 24; accessed 2020 Sep 29]. https://www.eia.gov/outlooks/archive/aeo19/

uncertain, and should be referenced with caution. More discussion on the potential effects of the COVID-19 pandemic on projected GHG emissions can be found in Section 1.3.

In the case of emissions from ozone depleting substance (ODS) substitutes in the industrial processes sub-sector, projected emissions were developed using two distinct data sources, namely the EPA's 2012 report *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030*, and the EPA's 2019 report *Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation: 2015-2050*. Section 5.1.1 discusses in detail the data sources, and the reason for substantially different projections at the national and state level. However, throughout the report, figures and tables present only the projections from the EPA's 2019 report as they represent, even though affected by uncertainty, the most recent dataset available.

1.2.1 EPA's State Inventory Tool

The SIT is a regularly updated suite of Microsoft Excel-based modules designed to assist states in developing their own GHG emissions inventories and projections from 1990 through 2050 and is developed in part with the data used to prepare the EPA's national GHG emissions inventory.[17] While the SIT's default input data were used as the primary resource in preparing this report, when more accurate data or methods were available, they were utilized. For instance, NDEP used the IPCC's Fifth Assessment Report GWPs for the GHGs considered in this report, rather than the IPCC's Fourth Assessment Report GWPs. Also, projections for the electricity generation sector were prepared using Nevada specific information such as the recently updated Renewable Portfolio Standard (RPS) and utility regulatory filings. Primary sources of data used by the SIT and/or NDEP to prepare the emissions inventory and projections are listed in Table 1-3.

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

Sector	Source/Resource	Information Utilized
All Sectors	United States Census Bureau[18]	U.S. population data
	Nevada State Demographer[19]	Nevada population data
Transportation	EIA	Historical fossil fuel consumption data AEO projections
Electricity Generation	EIA[20]	Historical fossil fuel consumption data Electricity Generation data
	EPA Emissions & Generation Resource Integrated Database (eGRID)[21]	Electric generating unit (EGU) data
	EPA Greenhouse Gas Reporting Program (GHGRP)[22]	EGU data

[17] The 2019 release of the State Inventory Tool included data to inventory historical emissions from 1990 through 2017 and methods to project emissions from 2018 through 2050.
[18] 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
[19] Hardcastle J. Nevada County Population Projections 2019 to 2038. Nevada Department of Taxation, Nevada State Demographer; 2019 Oct 1. https://tax.nv.gov/Publications/Population_Statistics_and_Reports/
[20] U.S. Energy Information Administration Electricity Generation Data. [released 2020 Jun 26; accessed 2020 Sep 30]. https://www.eia.gov/state/seds/
[21] Emissions and Generation Resource Integrated Database. U.S. Environmental Protection Agency; 2018 Feb 15. [accessed 2019 Aug 1]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

Sector	Source/Resource	Information Utilized
	Public Utilities Commission of Nevada (PUCN)[23]	Utility regulatory filings
Industry	EIA[24]	Historical fossil fuel consumption data AEO projections Oil and natural gas production data
	United States Geological Survey Minerals Yearbook[25]	Annual production and consumption for different minerals
	EPA Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030[26]	U.S. HFC emissions projections
	EPA Global Non-CO_2 Greenhouse Gas Emission Projections and Mitigation: 2015-2050[27]	U.S. HFC emissions projections
	United Nations Framework Convention on Climate Change GHG Data Interface[28]	U.S. historical fluorinated compound emissions data
	U.S. Department of Transportation Pipeline and Hazardous Material Safety Administration[29]	Natural gas transmission and distribution data

1.2.2 EIA's Annual Energy Outlook

The AEO is an annual report prepared by the EIA that provides modeled projections of U.S. energy usage through 2050. The AEO considers multiple cases, each with multiple assumptions, regarding "macroeconomic growth, world oil prices, and technological progress."[30] Of these cases, the Reference case is utilized by the SIT in its energy consumption projections. That is, the AEO is utilized for projecting energy consumption from the combustion of fossil fuels from transportation, electricity generation, industry, and the residential and commercial sectors. Generally, the Reference case assumes trend improvements in known technologies will continue and current laws and regulations (at the time the AEO was released) affecting energy will remain unchanged. The potential impacts of proposed legislation, regulations, and standards are not considered in the Reference case.

[22] Greenhouse Gas Reporting Program. U.S. Environmental Protection Agency [accessed 2019 Aug 1]. https://www.epa.gov/ghgreporting
[23] State of Nevada Public Utilities Commission. [accessed 2019 Apr 15]. http://puc.nv.gov/
[24] U.S. Energy Information Administration State Energy Data System. [accessed 2020 Sep 30]. https://www.eia.gov/state/seds/
[25] National Minerals Information Center. U.S. Geological Survey. [accessed 2020 Oct 1]. https://www.usgs.gov/centers/nmic
[26] U.S. Environmental Protection Agency. Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030. U.S. Environmental Protection Agency Office of Atmospheric Programs; released 2012 Dec. Washington D.C. EPA 430-R-12-006. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-ghg-emissions-1990-2030
[27] 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 2020 Oct 26]. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-greenhouse-gas-emission-projections
[28] GHG Data Interface. United Nations Framework Convention on Climate Change. [accessed 2020 Oct 16]. https://di.unfccc.int/
[29] Pipeline and Hazardous Materials Safety Administration. U.S. Department of Transportation. [accessed 2020 Oct 1]. https://www.phmsa.dot.gov/
[30] Annual Energy Outlook 2019, p9.

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

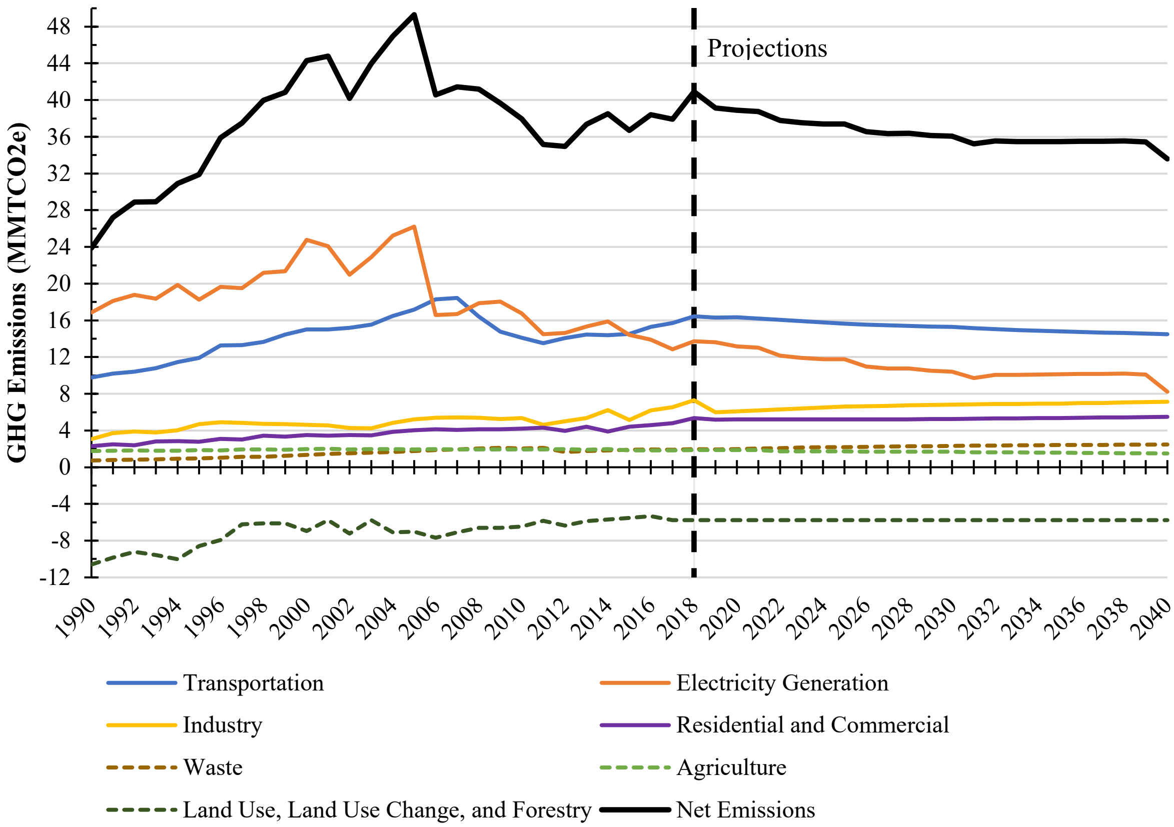
Historical and projected GHG emissions in this report are based on data made publicly available in 2019 or earlier. Therefore, changes in emissions due to the COVID-19 pandemic are neither considered in the data used to prepare this report nor are they reflected in the near-term emissions projections herein presented. However, assessments quantifying the effects of the pandemic on national changes in GHG emissions have been conducted and can provide some insight into changes in Nevada's emissions due to the pandemic.

The unprecedented global shutdown driven by the COVID-19 outbreak in early 2020 brought significant declines in many forms of transportation as people were confined to their homes. The decline in travel drove a roughly 17% reduction in daily global CO_2 emissions at the peak of global stay-at-home orders in April 2020 compared with April 2019 data. Total worldwide annual emissions for 2020 may decline by 4–7% relative to 2019 depending on the trajectory of the pandemic and related restrictions.[31] However, the overall impact of these reductions on total atmospheric GHG concentrations and global temperatures is estimated to be negligible. The rate at which human activities are adding GHGs to the air far exceeds the natural processes that remove them. This has been occurring for at least the last century, at rapidly increasing rates. Even a full year of reduced emissions cannot significantly compensate for the large amount of GHGs already released into the atmosphere. Total concentrations of CO_2 are expected to be 0.3 parts per million (ppm) below what they would have been had the world not had to stay home in the spring.[32] To put this in perspective, from 2010 to 2020, the increase in concentrations averaged 2.4 ppm per year, or 24 ppm in total.[33] The reduction in activity during spring 2020 will have a marginal impact on reducing global temperatures and demonstrates the scale of global action necessary to reduce GHG emissions.

[31] Le Quéré, C., Jackson, R.B., Jones, M.W. et al. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. Nat. Clim. Chang. 10, 647–653 (2020). https://doi.org/10.1038/s41558-020-0797-x
[32] Betts R, Jones C, Yuming J, Keeling R, Knight J, Scaife A. Analysis: What impact will the coronavirus pandemic have on atmospheric CO2? CarbonBrief; released 2020 Jul 5. [accessed 2020 Dec 22]. https://www.carbonbrief.org/analysis-what-impact-will-the-coronavirus-pandemic-have-on-atmospheric-co2
[33] Earth System Research Laboratories Global Monitoring Laboratory. National Oceanic &Atmospheric Administration [accessed 2020 Dec 22]. https://www.esrl.noaa.gov/gmd/

State of Nevada Greenhouse Gas Emissions

Figure 2-1: Nevada Historical and Projected Total GHG Emissions and Sinks by Sector, 1990-2040, with Updated Projections Beginning in 2018



2.1 GHG Emissions, 1990-2017

GHG emissions in Nevada peaked in 2005, when net GHG emissions totaled 49.397 MMTCO2e.[34] Overall, net GHG emissions in 2017 were 22.9% 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, rather than any significant change in the transportation sector. For 2017, Nevada's net GHG emissions totaled 38.066 MMTCO2e, with transportation accounting for 35.9% 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, about 15% of 2017's electricity generation sector GHG emissions (1.984 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 the material production (such as paper, cardboard, aluminum, etc.) even though the emissions associated with material production may not occur within the state, and as such this reduction in emissions is not reflected in this report.

Figure 2-2 illustrates updated GHG emissions from the transportation, electricity generation, industry, and residential and commercial sectors from 1990 through 2017 as well as emissions and sinks from the agriculture, waste, and LULUCF sectors from NDEP's 2019 report. Table 2-1 lists Nevada's GHG emissions and sinks by sector for select years. Note that because the SIT's CO_2 from Fossil Fuel Combustion and Stationary Combustion modules quantify residential and commercial sector emissions in addition to emissions from the transportation sector, electricity generation sector, and industry stationary combustion sub-sector, they are also updated in this year's report.

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

Figure 2-2: Nevada Total GHG Emissions and Emissions from Individual Sectors, 1990-2017

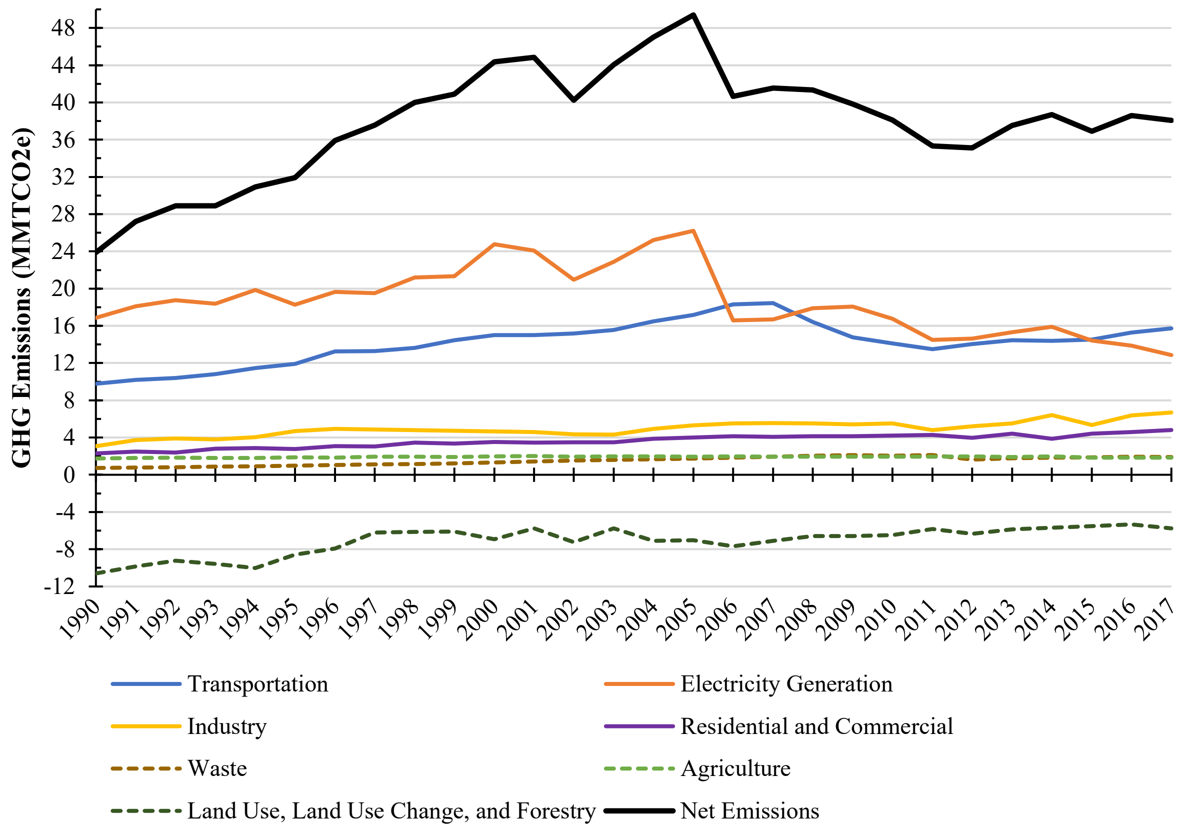


Table 2-1: Nevada GHG Emissions and Sinks by Sector, Select Years (MMTCO2e)

Sector	1990	1995	2000	2005	2010	2014	2015	2016	2017*
Transportation	9.778	11.901	15.017	17.171	14.105	14.388	14.535	15.295	15.722
Electricity Generation	16.849	18.263	24.768	26.211	16.746	15.893	14.415	13.887	12.858
Industry	3.069	4.706	4.671	5.326	5.529	6.416	5.345	6.385	6.690
Residential and Commercial	2.295	2.783	3.512	4.015	4.223	3.880	4.402	4.583	4.806
Waste	0.731	0.976	1.340	1.749	2.060	1.831	1.890	1.950	1.897*
Agriculture	1.752	1.863	1.980	1.942	1.933	1.973	1.822	1.835	1.840*
LULUCF	-10.596	-8.576	-6.933	-7.017	-6.476	-5.686	-5.509	-5.331	-5.747*
Gross Emissions	34.474	40.493	51.288	56.414	44.595	44.382	42.409	43.935	43.813
Net Emissions	23.877	31.917	44.355	49.397	38.120	38.695	36.900	38.604	38.066

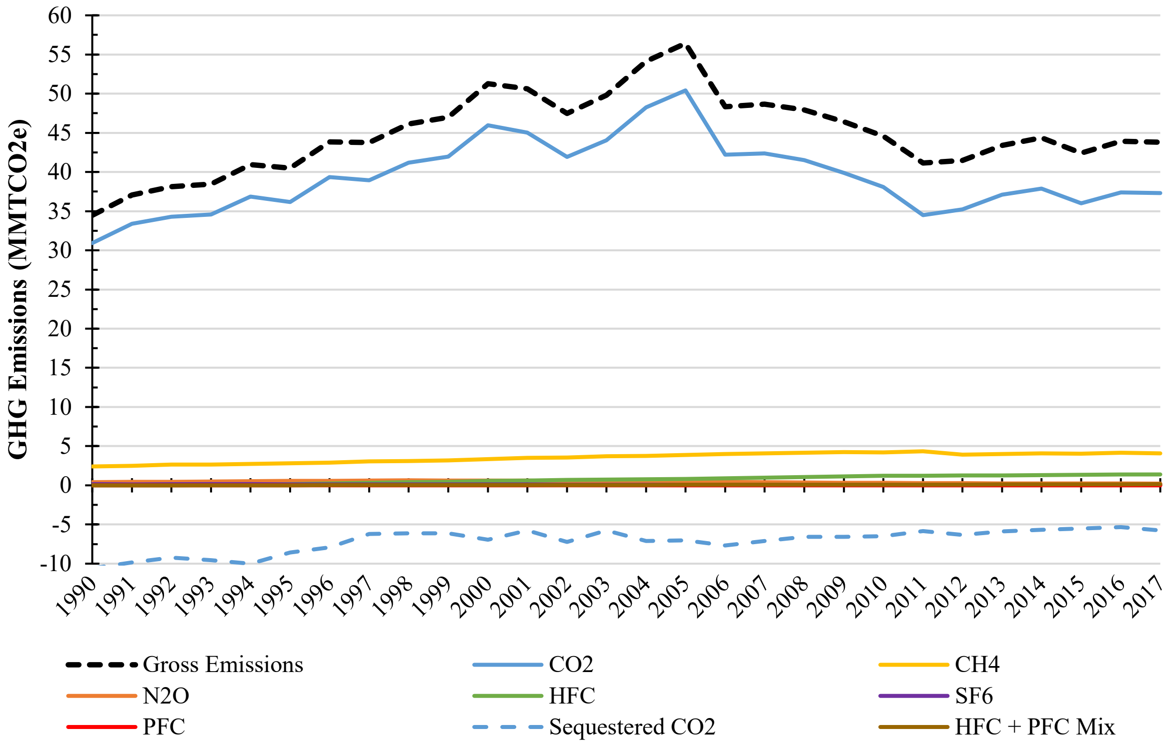
* Note that 2017 emissions from Waste, Agriculture, and LULUCF are projections presented in NDEP's 2019 report.

The primary GHG in Nevada is CO_2, which accounted for more than 86% of gross GHG emissions in 2017. Figure 2-4 illustrates Nevada's total GHG emissions and GHG emissions by individual GHGs for 1990 through 2017. 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

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

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 HFC, PFC, 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).

Figure 2-3: Nevada Gross GHG Emissions and GHG Emissions by Individual GHG, 1990-2017



GHG emissions in Nevada are generally tied to the State's population and economy. As the population increases, activities such as the need to travel, for electricity, for heating and cooling homes and businesses, and the total amount of waste generated all increase. Under the policies considered in this report, this results in modest annual increases in GHG emissions. Economic expansion/retraction can also lead to changes in GHG emissions. Table 2-2 lists the annual changes in GHG emissions in Nevada by sector for 2012 through 2017. Since 2012, net GHG emissions have increased by 2.950 MMTCO2e.

Table 2-2: Annual Changes in Nevada GHG Emissions by Sector, 2012-2017 (MMTCO2e and Percent)

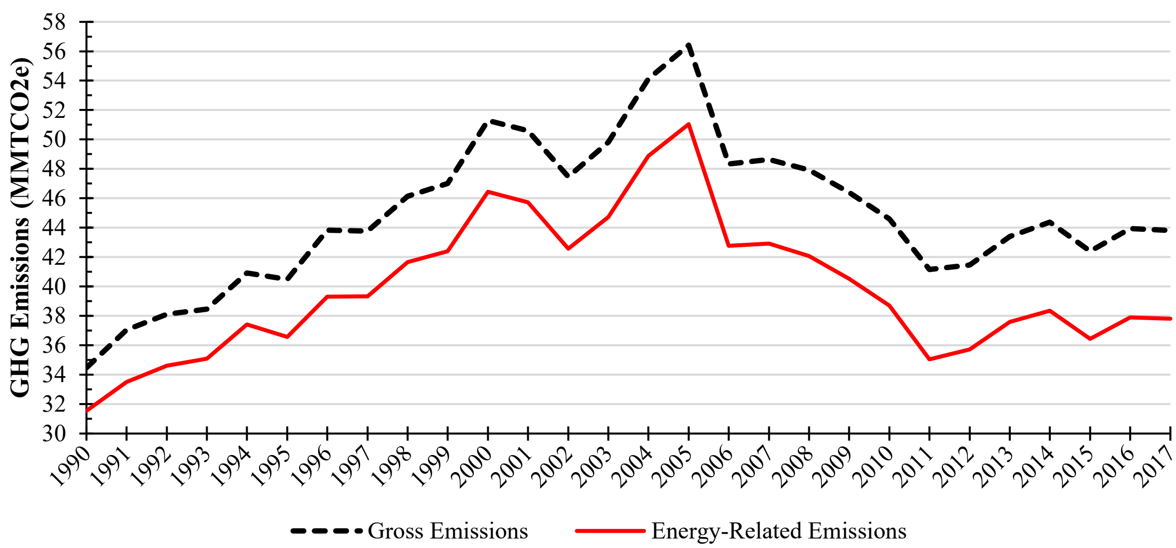
Sector	2012-2013		2013-2014		2014-2015		2015-2016		2016-2017*	
Transportation	0.404	2.87%	-0.071	-0.49%	0.147	1.02%	0.760	5.23%	0.427	2.79%
Electricity Generation	0.697	4.77%	0.573	3.74%	-1.478	-9.30%	-0.528	-3.67%	-1.028	-7.40%
Industry	0.323	6.23%	0.901	16.33%	-1.071	-16.70%	1.040	19.46%	0.305	4.77%
Residential and Commercial	0.465	11.76%	-0.539	-12.20%	0.521	13.43%	0.182	4.13%	0.222	4.85%
Waste	0.125	7.58%	0.060	3.38%	0.059	3.23%	0.060	3.17%	-0.053*	-2.69%
Agriculture	-0.078	-3.94%	0.063	3.29%	-0.151	-7.63%	0.013	0.69%	0.005*	0.25%
LULUCF	0.478	-7.54%	0.179	-3.05%	0.177	-3.12%	0.178	-3.22%	-0.416*	7.80%
Gross Emissions	**1.935**	**4.67%**	**0.987**	**2.27%**	**-1.973**	**-4.45%**	**1.526**	**3.60%**	**-0.122**	**-0.28%**
Net Emissions	**2.414**	**6.87%**	**1.166**	**3.11%**	**-1.796**	**-4.64%**	**1.704**	**4.62%**	**-0.538**	**-1.39%**

* Note that 2017 emissions from Waste, Agriculture, and LULUCF are projections presented in NDEP's 2019 report.

2.1.1 Fossil Fuels, Energy Flows, 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 51.041 MMTCO2e emissions in 2005 and 37.816 MMTCO2e emissions in 2017, or, 90.5% and 86.3% of Nevada's gross GHG emissions, respectively. Figure 2-3 illustrates both Nevada's gross GHG emissions and energy-related emissions from 1990 through 2017. 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, 1990-2017



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.[38] Figure 2-5 (on the next page) is Lawrence Livermore National Laboratory's flow chart estimation of energy consumption in Nevada in 2018. 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.

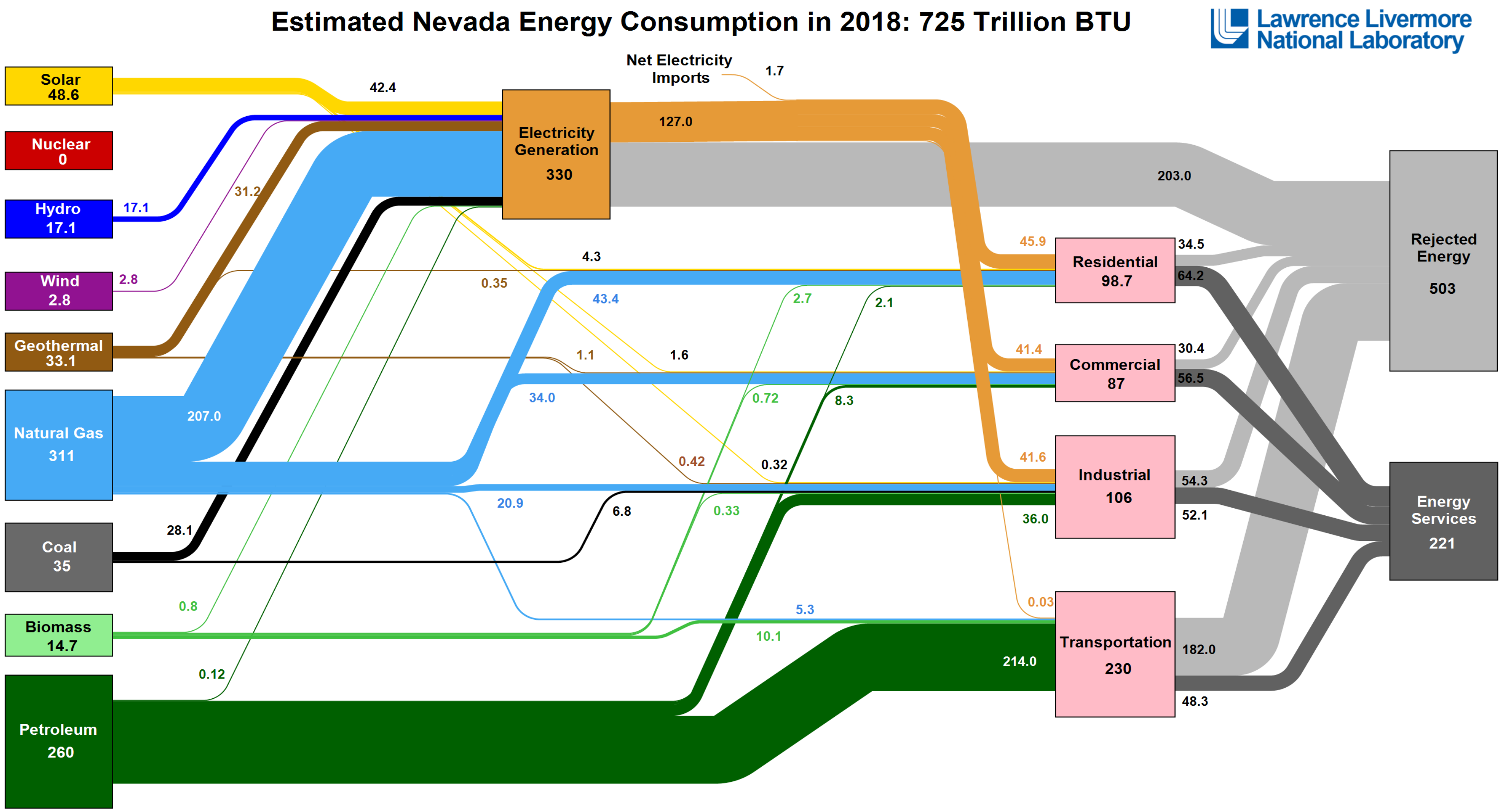
Figure 2-6 illustrates Lawrence Livermore National Laboratory's flow chart estimation of energy-related CO_2 emissions in Nevada in 2017 (the most recent year of their CO_2 estimates). Presenting the same fuel sources, this flow chart illustrates CO_2 emissions, in million metric tons (MMT), and connects 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 2017.

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.

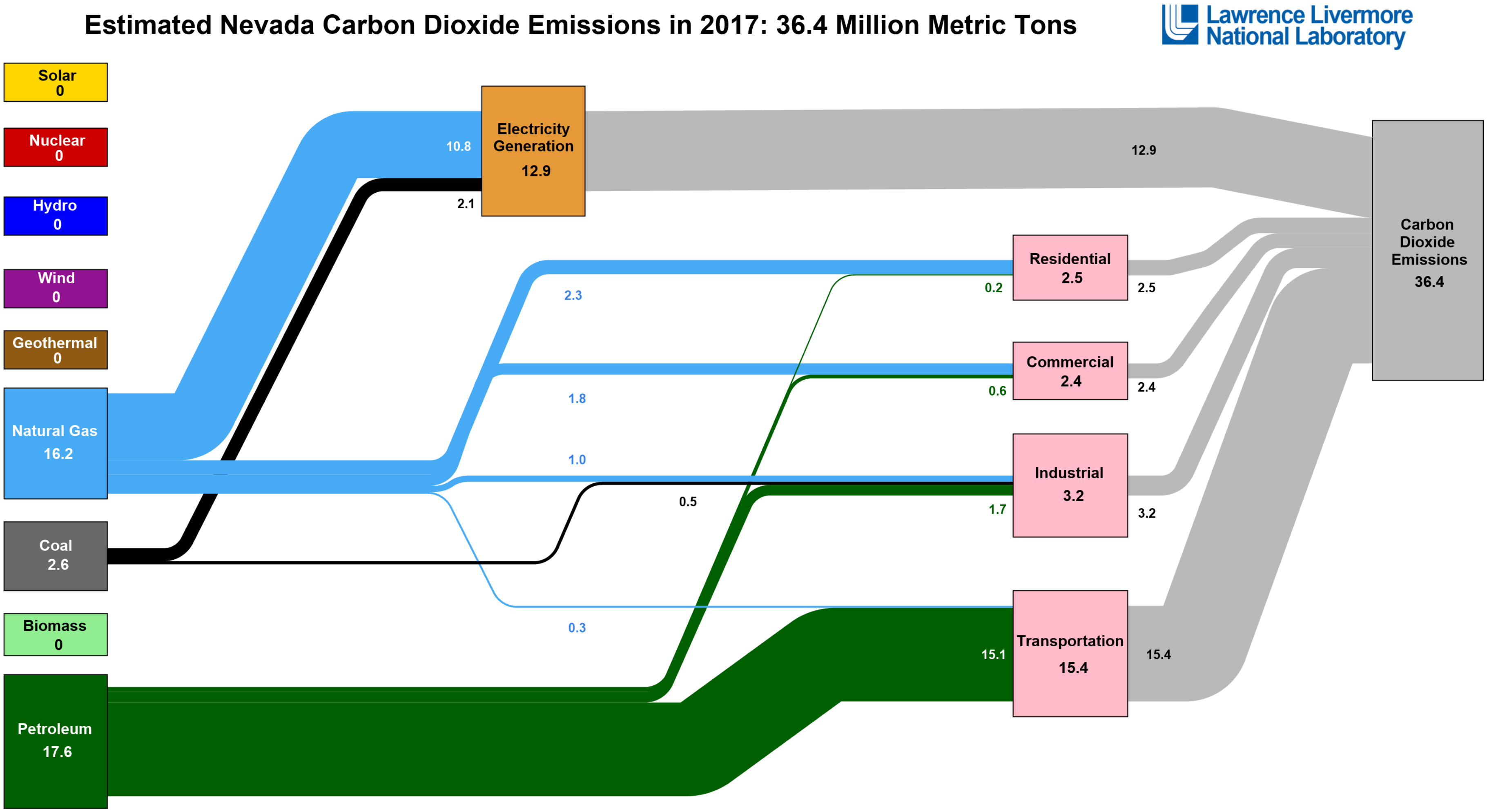
[38] LLNL Flow Charts. Lawrence Livermore National Laboratory. [accessed 2020 Nov 2]. https://flowcharts.llnl.gov/

Figure 2-5: Estimated Nevada Energy Consumption in 2018: 725 Trillion BTU[39]



[39] Source: LLNL June, 2020. 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 65% for the residential sector, 65% for the commercial sector, 49% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

Figure 2-6: Estimated Nevada Carbon Dioxide Emissions in 2017: 36.4 MMTCO2e[40]

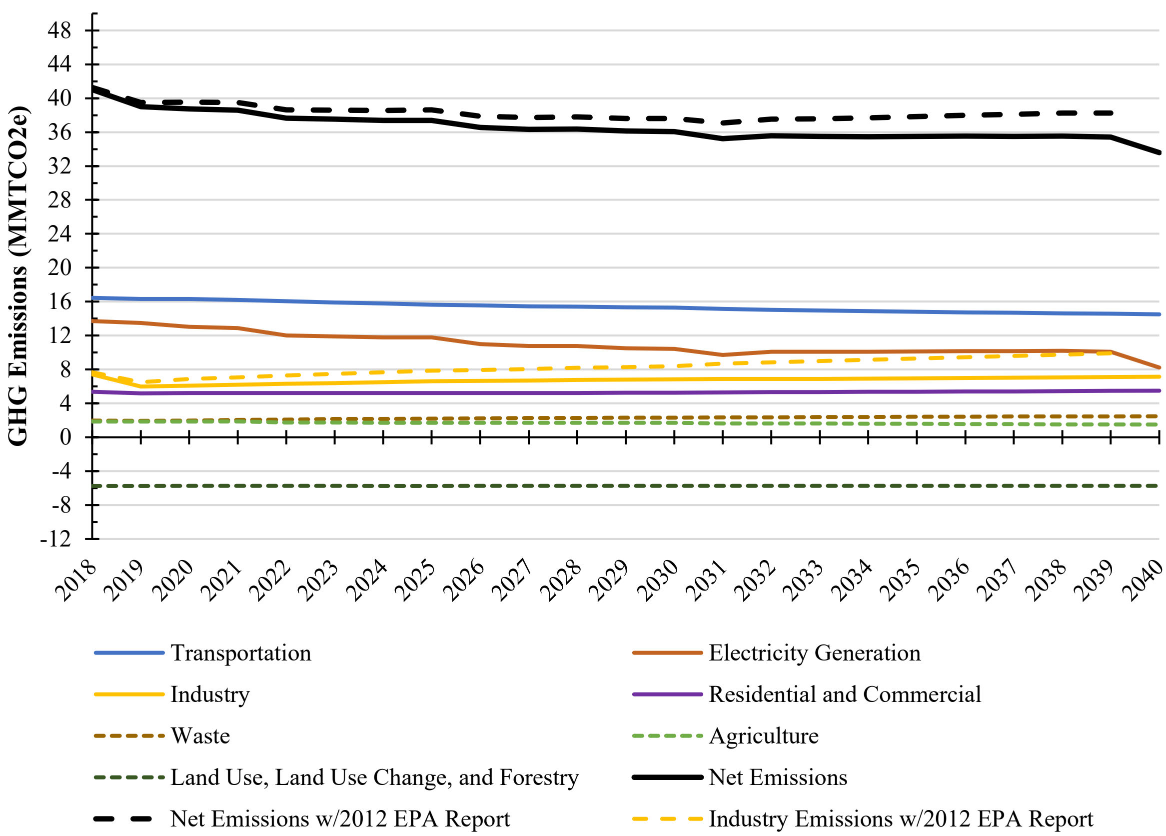


[40] Source: LLNL July, 2019. Data is based on DOE/EIA State Carbon Dioxide Emissions Data (2018). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory on the Department of Energy, under whose auspices the work was performed. Carbon emissions are attributed to their physical source, and 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 – the lifecycle emissions associated with producing biofuels are included in commercial and industrial emissions. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

2.2 Emissions Projections, 2018-2040

Projected GHG emissions in this report are based on data made publicly available in 2019 or earlier. Therefore, changes in emissions due to the COVID-19 pandemic are neither considered in the data used to prepare this report nor are they reflected in the near-term emissions projections herein presented. Under the policies considered in this report, GHG emissions in Nevada, without considering the impact of the COVID-19 pandemic, are projected to remain relatively constant through 2040. Net GHG emissions in 2025 are projected to be 37.387 MMTCO2e, 24.3% below 2005 levels, net GHG emissions in 2030 are projected to be 36.063 MMTCO2e, 27.0% below 2005 levels, and net GHG emissions in 2040 are projected to be 33.582 MMTCO2e, or 32.0% below 2005 levels. The sectors whose emissions are projected to increase through 2040 are industry (0.443 MMTCO2e), residential and commercial (0.685 MMTCO2e), and waste (0.580 MMTCO2e); uncertainty regarding the transportation sector and ODS substitute emissions in the industrial process sub-sector through the reporting period remain a concern. Figure 2-7 illustrates Nevada's projected total GHG emissions and the emissions from individual sectors from 2018 through 2040.[41]

Figure 2-7: Projected Nevada Net GHG Emissions and Emissions from Individual Sectors, 2018-2040



[41] Note that emissions projections for 2040 from the waste, agriculture, and land use, land use change, and forestry sectors are the result of the same methods that were applied in NDEP's 2019 report being applied through the year 2040 rather than 2039.

Also illustrated in Figure 2-7 is the high level of uncertainty regarding ODS substitute emissions (more thoroughly detailed in Section 5.1.1). That is, two projections for industry are presented, a solid line that uses the HFC emissions projections in the EPA's 2019 report, *Global Non-CO2 GHG Emission Projections and Mitigation: 2015-2050*, and the second, a dashed line, uses the HFC emissions projections in the EPA's 2012 report, *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030*[42], which are the HFC emissions projections used in NDEP's 2019 report. The difference in the industry sector emissions using these two datasets is significant; there are 1.243 MMTCO2e emissions less in Nevada in 2025 using the EPA's 2019 report, and 1.550 MMTCO2e and 2.826 MMTCO2e emissions less in Nevada in 2030 and 2039, respectively. In this report, NDEP uses the EPA's 2019 report in our statewide emissions projections, but the results from both datasets are illustrated due to recent court cases that have vacated EPA rules regulating ODS substitute usage and created uncertainty regarding the emissions projections in the EPA's 2019 report. These projections also do not account for the effects of the anticipated ODS substitute reduction components included in the second federal coronavirus relief bill, the Consolidated Appropriations Act, 2021.

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. These changes are reducing or eliminating the stringency of existing policies and will result in an increase in GHG emissions.

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

Sector	Policy	Current Status
Transportation	Tier 3 passenger car and light duty truck fuel economy standards	Rolled back with the finalization of Part Two of the Safer Affordable Fuel-Efficient (SAFE) Vehicle Rule on April 30, 2020. There are two ongoing federal lawsuits regarding this rollback, one of which is being led by the State of California that Nevada has signed onto.
	Phase 2 greenhouse gas emissions standards for medium- and heavy-duty vehicles	As they apply to truck trailers, the phase 2 fuel economy standards in this rule were stayed by the United States Court of Appeals for the D.C. Circuit on September 29, 2020.
Electricity Generation	The updated RPS in NRS 704.7821	No changes to the RPS are currently expected.
	The voluntary retirement of the North Valmy Generating Station, with Unit 1 shutting down in 2021 and Unit 2 shutting down in 2025	Because the retirements are still voluntary, it is unknown whether or not these retirements will happen according to this timeline.

[42] U.S. Environmental Protection Agency. Global Anthropogenic Non-CO_2 Greenhouse Gas Emission: 1990-2030. U.S. Environmental Protection Agency Office of Atmospheric Programs; released 2012 Dec. Washington D.C. EPA 430-R-12-006. [accessed 2020 December 22]. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-ghg-emissions-1990-2030

Sector	Policy	Current Status
	The Integrated Resource Plan (IRP) approved retirement dates and depreciation-based retirement dates of NV Energy's natural gas-fired electricity generating resources	No changes are currently expected.
Industry	2012 and 2016 new source performance standards (NSPS) for the oil and natural gas industry	The EPA finalized a rollback of the 2012 and 2016 NSPSs for the oil and natural and gas industry on August 13, 2020.
	Significant New Alternatives Policy (SNAP) Program regulating ODS substitutes	SNAP Rule 20 was vacated by the D.C. Circuit Court on August 8, 2017.
		SNAP Rule 21 was vacated by the D.C. Circuit Court on April 5, 2019.
	Phasedown of HFC at national level included in the second federal coronavirus relief bill, the Consolidated Appropriations Act, 2021.	NDEP was not able to assess the specific effects of this legislation on anticipated HFC use projections in Nevada.

2.3 Nevada's Emission Reduction Goals, the State of Nevada Climate Initiative and 2020 Climate Strategy

On March 12, 2019, Governor Steve Sisolak announced that Nevada would join the U.S. Climate Alliance, a bipartisan coalition of 25 state governors committed to realizing the goals of the Paris Agreement, including reducing GHG emissions to keep global temperature rise well below 2ºC (3.6ºF). During the 2019 session, the Legislature passed multiple climate-forward bills including SB 358 to increase the statewide renewable portfolio standard (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. This legislation also set aggressive, 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). The NDEP's 2019 GHG emissions inventory shows that under the policies considered in this report, Nevada will fall 4% short of the 2025 goal and 18% short of the 2030 goal if no additional action is taken by state and local governments.

In November 2019, Governor Sisolak issued an executive order on climate change (EO 2019-22) directing State of Nevada agencies to identify and evaluate policies and regulatory strategies to achieve economy-wide GHG emissions-reduction targets established by SB 254. The Department of Conservation and Natural Resources and the Governor's Office of Energy were tasked with coordination and implementation of the EO, including development of Nevada's first comprehensive *State Climate Strategy*.

Consistent with the goals of the EO to ensure a vibrant, climate-resilient future for Nevada, Governor Sisolak launched the State of Nevada Climate Initiative (NCI) in the summer of 2020.[43] The NCI is

[43] State of Nevada Climate Initiative. Nevada Department of Conservation and Natural Resources. [accessed 2020 Dec 23]. http://climateaction.nv.gov/

focused on helping inform and coordinate the new policies necessary to reduce Nevada's economy-wide GHG emissions and help establish more resilient communities that are prepared to successfully adapt to changing environmental and climatic conditions. The *2020 State Climate Strategy*[44] builds a foundation for future climate action under the NCI in anticipation of the need to take climate action on multiple fronts and serves as a roadmap for policymakers at all levels of government in Nevada for achieving the state's collective climate goals.

Reported total emissions from the transportation, industry, and residential and commercial sectors increased by 1 MMTCO2e between 2016 and 2017 but were offset by a similar decrease in emissions from the electricity generation sector.

Table 2-4 lists Nevada's net GHG emissions by sector for 2005, 2017, 2025, and 2030 and Figure 2-7 illustrates the relative contributions of GHG emissions from the various sectors for 2005, 2017, 2025, and 2030. Figure 2-8 illustrates Nevada's net GHG emissions by sector from 2005 through 2030 with NRS 445B.380's 2025 and 2030 emission reduction goals included for comparison. Because Figure 2-8 is illustrating net GHG emissions, the carbon sequestered by the land use, land use change, and forestry sector is shown as a negative striped region being overlaid by transportation sector emissions. Finally, Table 2-5 compares 2005 net GHG emissions against 2025, 2030, and NRS 445B.380's emission reduction goals for 2025 and 2030.

As required by NRS 445B.380, Table 2-5 provides a quantification of the reductions in GHG emissions necessary to achieve the GHG emissions reductions goals for 2025 and 2030. Based on current projections, and without considering the impact of the COVID-19 pandemic, Nevada is within 1.9 MMTCO2e (or 4%) of the 2025 goal. It is still possible for Nevada to meet the 2025 goal if strategic, near term investments and policies are approved by the Legislature. But Nevada is currently projected to fall well short of its 2030 goal for GHG emissions reductions unless more aggressive investment and policies are adopted in both the near and medium term. Based on the policies in Nevada considered in this report, by 2030, it is estimated that Nevada will fall 18% short of achieving the 2030 goal of a net GHG emissions reduction of 45% (22.184 MMTCO2e) below 2005 levels.

The overarching goals of the *2020 State Climate Strategy* are to: (1) provide a framework for reducing Nevada's GHG emissions across all economic sectors; (2) lay the groundwork for climate adaptation and resilience; and (3) establish a structure for continued, ongoing climate action across the state.

The *2020 State Climate Strategy* informs policymaking on how Nevada will achieve the ambitious targets established by SB 254 and provides an integrated framework for evaluating climate policies that make sense for Nevada. Given the complexities of climate change, it is imperative that policies to reduce GHG emissions be approached systematically so there is a clear understanding of the benefits and tradeoffs. This will optimize effectiveness of each given policy and therefore maximize the benefits for all Nevadans. By taking a smart, strategic approach to addressing climate change in Nevada, the state can

[44] State of Nevada Climate Initiative: Our Strategy. Nevada Department of Conservation and Natural Resources. [accessed 2020 Dec 23]. https://climateaction.nv.gov/our-strategy/

fully capture the economic benefits of clean technologies and lead our peers in neighboring western states.

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

Sector	2005	2017*	2025	2030
Transportation	17.183	15.722	15.653	15.280
Electricity Generation	26.211	12.858	11.765	10.423
Industry	5.326	6.690	6.602	6.828
Residential and Commercial	4.015	4.806	5.204	5.268
Waste	1.749	1.897*	2.198	2.323
Agriculture	1.942	1.840*	1.713	1.688
LULUCF	-7.017	-5.747*	-5.747	-5.747
Net Emissions	**49.397**	**38.066**	**37.387**	**36.063**

* Note that 2017 emissions from Waste, Agriculture, and LULUCF are projections first presented in NDEP's 2019 report.

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

	2005	2025	2030
Net Emissions	49.397	37.387	36.063
Projected Emissions Reduction	-	12.010	13.334
Projected Percent Reduction	**-**	**24%**	**27%**
SB 254 Emissions Goals	-	35.566	27.168
SB 254 Emissions Reductions	-	13.831	22.229
SB 254 Percent Reduction	-	28%	45%
SB 254 Percent Deficit		4%	18%
Estimated Additional Emissions Reductions Required	-	**1.821**	**8.895**

Figure 2-8: Relative Contributions of Nevada's Gross GHG Emissions by Sector, 2005, 2017, 2025, and 2030

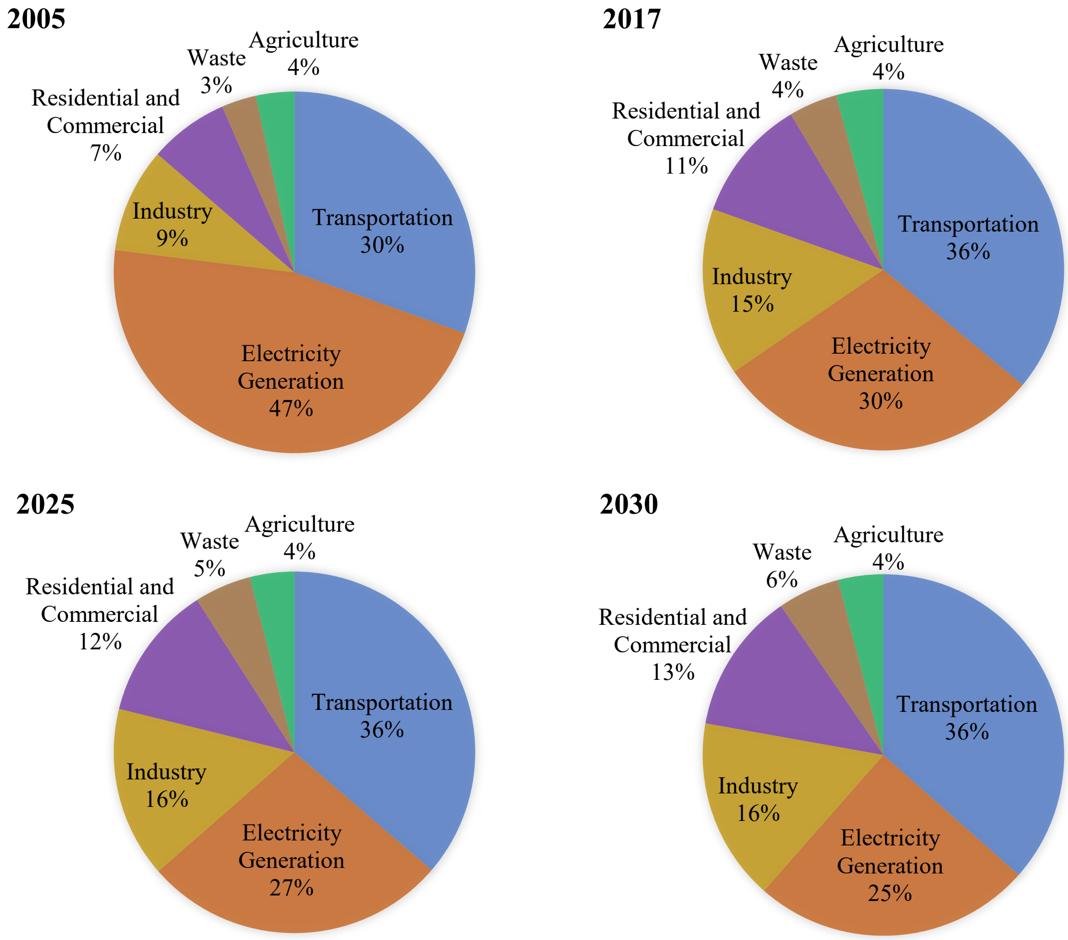
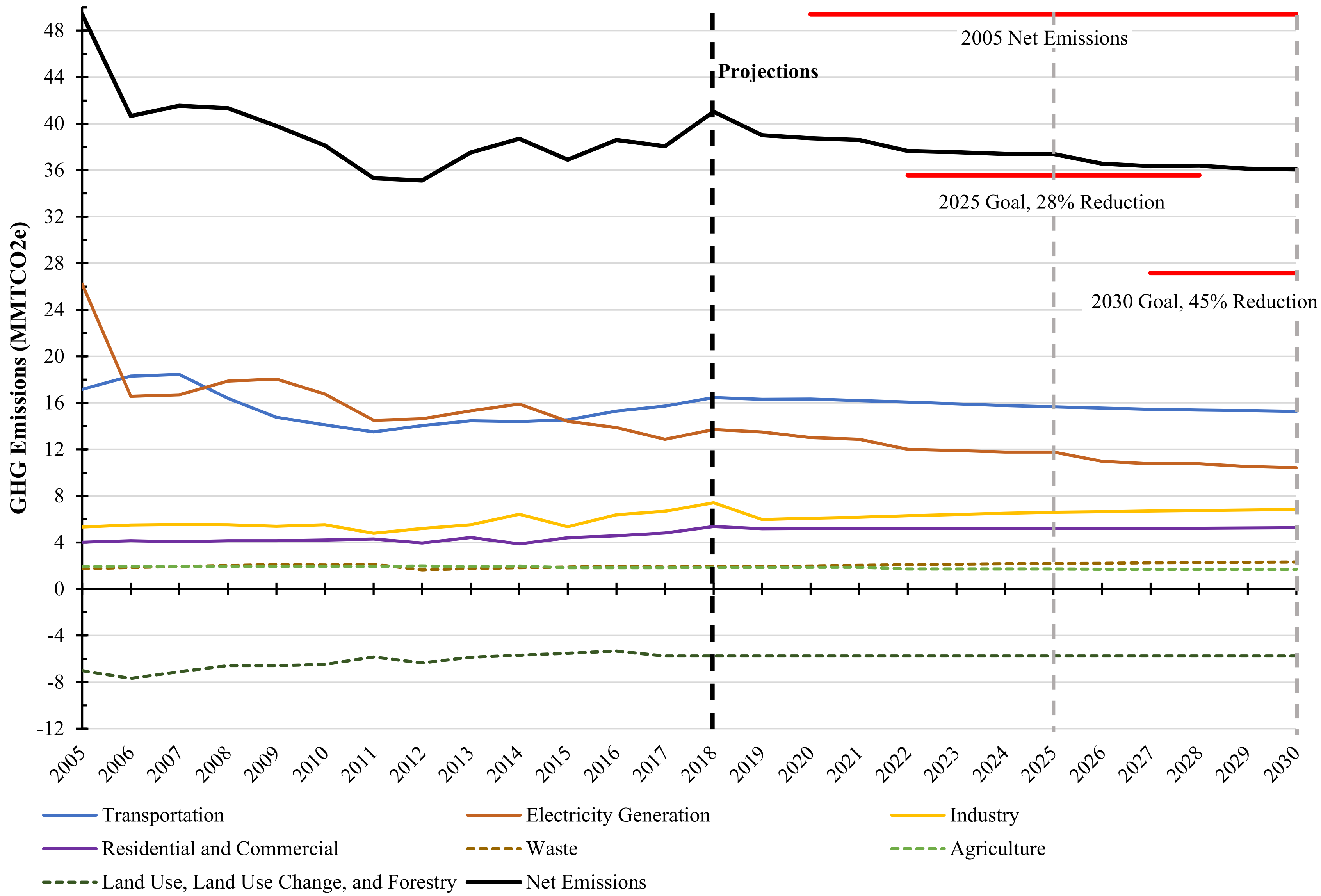


Figure 2-9: Nevada Historical and Projected Net GHG Emissions and Emissions by Sector, 2005-2030, with Updated Projections Beginning in 2018 and Comparison to NRS 445B.380's 2025 and 2030 Goals



Transportation

Figure 3-1: Nevada Net GHG Emissions with Transportation Sector Emissions Emphasized and Updated Projections Beginning in 2018, 1990–2040

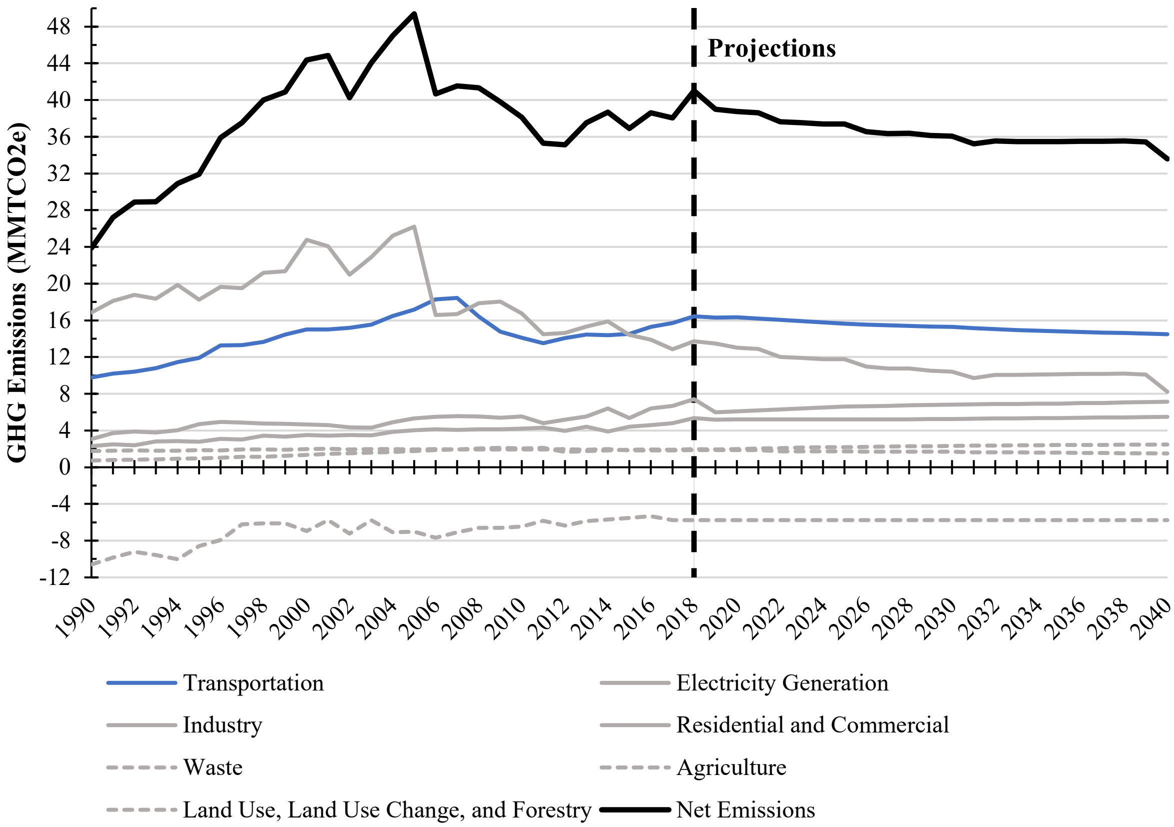
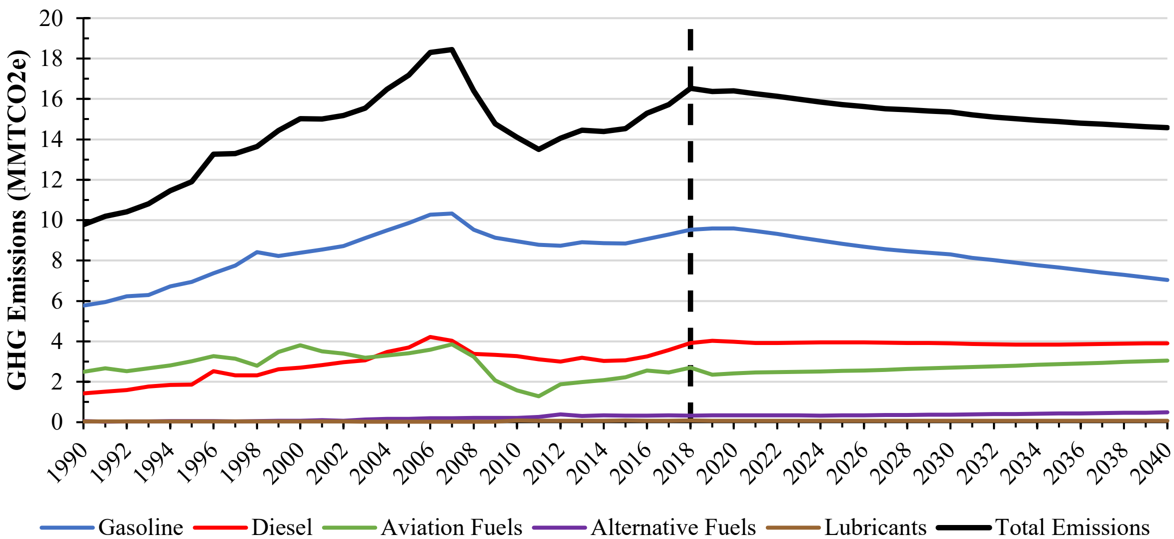


Figure 3-2: Transportation Sector GHG Emissions and Emissions by Fuel Type with Projections Beginning in 2018, 1990–2040



3.1 Overview

The transportation sector exceeded electricity generation in 2015 becoming the largest sector of GHG emissions in Nevada. In 2017, there were 15.722 MMTCO2e emissions attributed to transportation in Nevada, more than 36% of the State's total GHG emissions. Based on the pre-COVID datasets used to prepare this report, the transportation sector is projected to remain the largest sector of GHG emissions in Nevada through 2040. The types of GHGs emitted from this sector are CO_2, CH_4, and N_2O. CH_4 and N_2O account for less than 1% of transportation's 2017's GHG emissions. Total transportation sector emissions for 1990 through 2040, along with the minor impact of CH_4 and N_2O, are illustrated in Figure 3-2. Sector emissions are estimated to be 17.171 MMTCO2e for 2005 and are projected (using pre-COVID data) to be 15.653 MMTCO2e in 2025 and 15.280 MMTCO2e in 2030.

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

3.2 Methodology

Transportation sector GHG emissions are the result of fossil fuel combustion and, to a much lesser extent, the byproducts (CH_4 and N_2O) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *CO_2 from Fossil Fuel Combustion* module estimates CO_2 emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. CO_2 emissions are the direct result of the combustion of fuel and are determined by analyzing the type and quantity of fuel combusted. 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[45], this report uses the default VMT estimates used in the *CH_4 and N_2O Emissions from Mobile Combustion* module.[46] These estimates are

[45] 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.
[46] Improved estimates of VMT in Nevada, in addition to accurate vehicle registration information, would be necessary to improve emissions estimates. Additionally, the *CH_4 and N_2O Emissions from Mobile Combustion* module includes a method for estimating CO_2 emissions using a similar method. Analyzing the potential impact of

based on national averages prepared by the Federal Highway Administration (FHWA) in their *Highway Statistics* series[47] 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. The lowest amount of CH_4 emissions are achieved when hydrogen, carbon, and oxygen are present in the ideal combination for complete combustion.

N_2O formulation in internal combustion engines is not yet well understood, and data on these emissions are 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. CH_4 and N_2O account for less than 1% of 2017's transportation sector GHG emissions.

GHG emissions for the transportation sector are projected using the SIT's *Energy Consumption Projections Tool* from 2018 through 2040 for all fuels except for motor gasoline. The 2019 release of the SIT projection tool does not remove the ethanol portion of blended motor gasoline the way that it does for historical estimates, which creates a significant disparity between historical and projected emissions. Motor gasoline emissions are thus the same as those included in the 2019 report, that is, the 2018 SIT projection from 2018 through 2030 and a linear trend of these projections applied through 2040.[48,49] For CO_2 emissions (apart from motor gasoline-related CO_2 emissions), the projection tool uses EIA State Energy Data (aggregated at the regional level[50]) and the EIA's 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* module. CH_4 and N_2O emissions are projected using a linear trend of historical emissions.

3.3 GHG Emissions 1990-2017

Transportation sector emissions peaked in 2007 at 18.444 MMTCO2e. The reduced emissions in the years following the 2007 peak were likely due to the Great Recession which caused a reduction in

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

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

[48] Biogenic emissions are generally not included in GHG emissions estimates.

[49] Further, the EIA's 2019 AEO reports there being no significant revisions or updates between the 2018 and 2019 versions of the report.

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

transportation activity across the country. Sector emissions are estimated to be 17.171 MMTCO2e for 2005 and 15.722 MMTCO2e for 2017. Figure 3-3 shows transportation sector GHG emissions in Nevada from 1990 through 2017 by fuel type and Table 3-1 lists transportation sector GHG emissions in Nevada for select years. In both Figure 3-3 and Table 3-1, aviation fuels include kerosene, naphtha, and aviation gasoline and alternative fuels include the combined emissions from the use of 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, 1990–2017

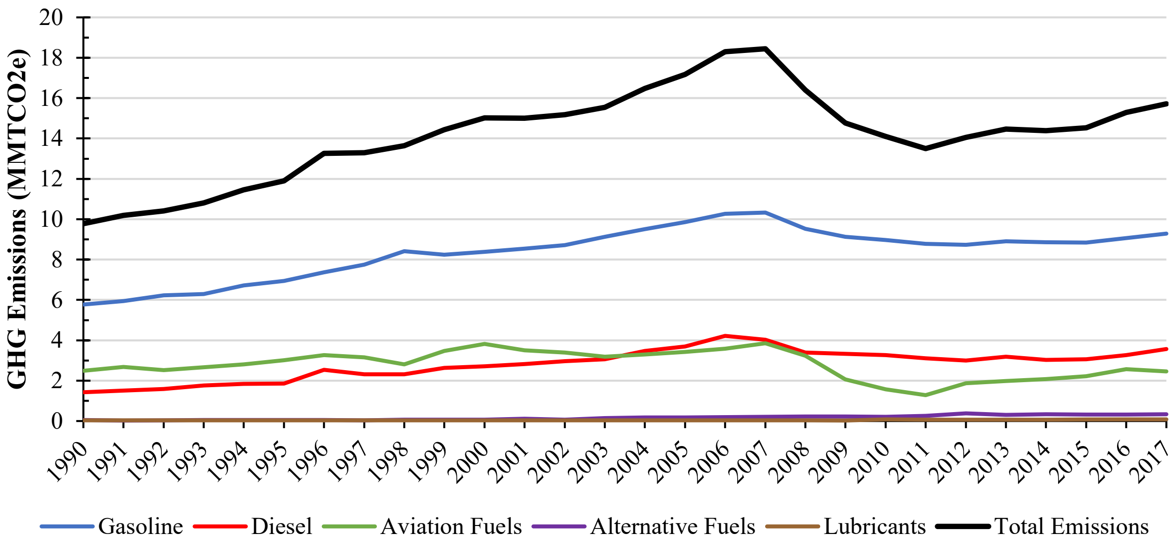


Table 3-1: Transportation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2014	2015	2016	2017
Gasoline	5.773	6.946	8.389	9.855	8.964	8.865	8.848	9.068	9.286
Diesel	1.426	1.857	2.706	3.695	3.269	3.036	3.066	3.259	3.565
Aviation Fuels	2.496	3.014	3.815	3.419	1.579	2.083	2.222	2.565	2.458
Alternative Fuels	0.049	0.051	0.071	0.172	0.215	0.332	0.320	0.326	0.338
Lubricants	0.035	0.033	0.036	0.030	0.079	0.072	0.079	0.078	0.075
Total Emissions	**9.778**	**11.901**	**15.017**	**17.171**	**14.105**	**14.388**	**14.535**	**15.295**	**15.722**

Transportation sector GHG emissions have increased by 14.1% (2.217 MMTCO2e) since the recent sector low in 2011 of 13.505 MMTCO2e. This increase has been driven largely by aircraft (that is, aviation fuels) and to a lesser extent highway vehicles[51]. Through 2017, emissions from aircraft continued to return to pre-recession levels as emissions increased by 47.8% (1.175 MMTCO2e) since 2011. Without the increasingly stringent federal highway vehicle fuel economy standards of the 2010's,

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

it is likely that current transportation sector emissions would be much higher. Annual changes in transportation sector GHG emissions by fuel from 2012 through 2017 are listed in Table 3-2.

Table 3-2: Annual Change in Transportation Sector GHG Emissions in Nevada by Fuel Type, 2012-2017 (MMTCO2e and Percent)

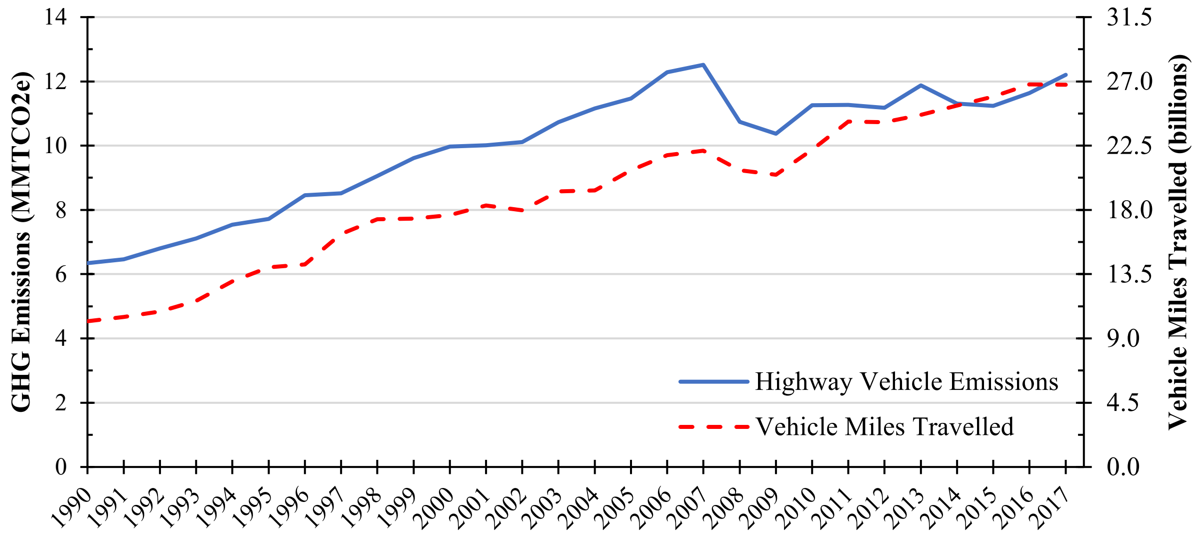
Fuel Type	2012-2013		2013-2014		2014-2015		2015-2016		2016-2017	
Gasoline	0.176	2.02%	-0.048	-0.54%	-0.017	-0.19%	0.220	2.49%	0.218	2.41%
Diesel	0.183	6.10%	-0.147	-4.61%	0.030	0.97%	0.193	6.29%	0.306	9.40%
Aviation Fuels	0.110	5.89%	0.102	5.12%	0.139	6.68%	0.343	15.43%	-0.107	-4.19%
Alternative Fuels	-0.071	-18.73%	0.023	7.43%	-0.012	-3.67%	0.006	1.95%	0.012	3.75%
Lubricants	0.005	7.70%	0.000	-0.37%	0.007	9.79%	-0.002	-2.38%	-0.002	-3.22%
All Fuel Types	**0.404**	**2.87%**	**-0.071**	**-0.49%**	**0.147**	**1.02%**	**0.760**	**5.23%**	**0.427**	**2.79%**

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

NHTSA and EPA coordinate their efforts to set standards for highway vehicles that ensure vehicle/passenger safety while improving fuel economy and reducing vehicle emissions (especially smog-forming pollutants like particulate matter, or PM, and oxides of nitrogen, or NOx). These efforts have been generally successful. Across the country, this has had the effect of minimizing the impact of highway vehicle GHG emissions in spite of increasing VMT. Since 2009 (both the recent low for highway vehicle GHG emissions and the end of the Great Recession), it is estimated that total VMT in Nevada has increased by 30% (that's more than 6.3 billion additional miles travelled annually compared to 2009) while emissions have only increased by 9%. Figure 3-4 illustrates the relationship between estimated highway vehicle GHG emissions and total VMT from 1990 through 2017 in Nevada.

Figure 3-4: Highway Vehicle GHG Emissions in Nevada and Total VMT, 1990-2017



3.4 Emissions Projections, 2018-2040

There is a high degree of uncertainty with transportation sector projections. This is due in large part to the COVID-19 pandemic (see Section 1.3) and the finalized federal rollback of passenger car and light-duty truck fuel economy standards. In April, 2020, NHTSA and EPA finalized the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part Two.[52] This rule rolls back the Tier 3 passenger car and light-duty truck fuel economy standards for vehicle model years 2021 through 2026.[53] According to the EPA, this rule will "increase stringency of [Corporate Average Fuel Economy] CAFE and CO2 emissions standards by 1.5% each year through model year 2026, as compared with the standards issued in 2012, which would have required about 5% annual increases."[54]

As mentioned in Section 3.2, the SIT's *Energy Consumption Projections Tool* depends on the EIA's 2019 AEO Reference case to project emissions. Similar to the 2018 AEO, the 2019 AEO Reference case assumes the existing Tier 3 light-duty vehicle emissions standards through model year 2025 and Phase 2 standards for medium- and heavy-duty vehicles through model year 2027.[55,56] In addition to highway

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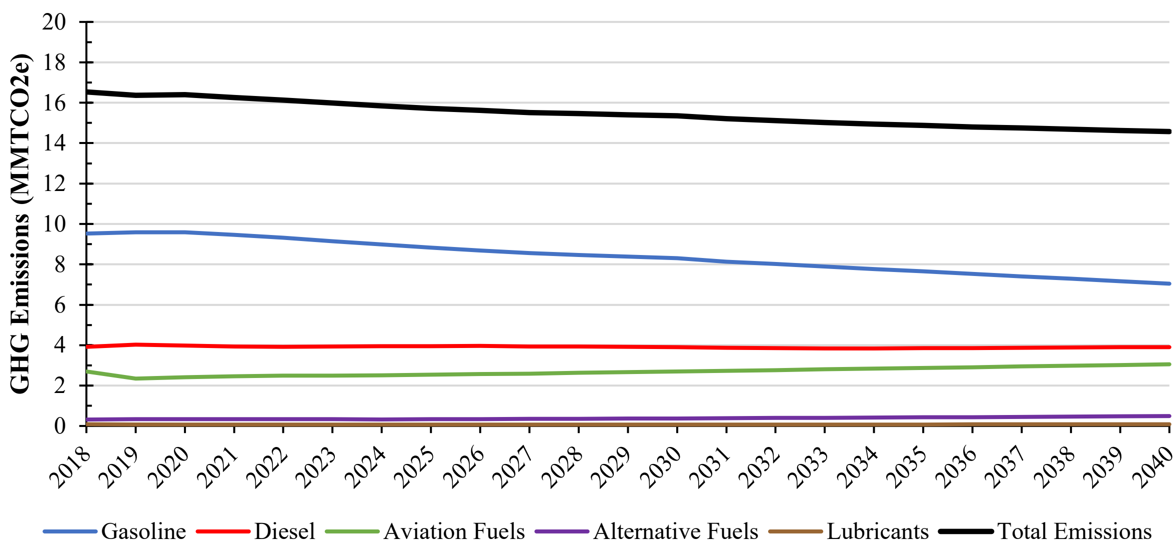
[52] U.S. Department of Transportation, National Highway Traffic Safety Administration and U.S. Environmental Protection Agency. The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks. Federal Register. 2020 Apr 30; Vol 85, No. 84, Rules and Regulations, 24174. https://www.govinfo.gov/content/pkg/FR-2020-04-30/pdf/2020-06967.pdf
[53] 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
[54] U.S. DOT and EPA Put Safety and American Families First with Final Rule on Fuel Economy Standards. EPA Press Office. 2020 Mar 31. [accessed 2020 Oct 15]. https://www.epa.gov/newsreleases/us-dot-and-epa-put-safety-and-american-families-first-final-rule-fuel-economy-standards
[55] As mentioned in Section 3.2, GHG emissions associated with motor gasoline are the same as was reported in NDEP's 2019 report.
[56] Phase 2 fuel economy standards as they pertain to truck trailers were stayed by the United States Court of Appeals on September 29, 2020.

vehicles, where no significant changes to Reference case assumptions were made by the EIA, the AEO provides more details on the transportation sector Reference case and the key factors driving transportation projections:

- "Increases in fuel economy standards temper growth in U.S. motor gasoline consumption, which decreases by 26% between 2018 and 2050.
- "Increases in fuel economy standards result in heavy-duty vehicle energy consumption and related diesel use remaining at approximately the same level in 2050 as in 2018, despite rising economic activity that increases the demand of freight truck travel.
- "Excluding electricity (which starts from a comparatively low base), jet fuel consumption grows more than any other transportation fuel during the projection period, rising 35% from 2018 to 2050. This growth arises from increases in air transportation outpacing increases in aircraft fuel efficiency.
- "Motor gasoline and distillate fuel oil's combined share of total transportation energy consumption decreases from 84% in 2018 to 74% in 2050 as the use of alternative fuels increases.
- "Continued growth of on-road travel increases energy use later in the projection period because current fuel economy and greenhouse gas standards require no additional efficiency increases for new light-duty vehicles after 2025 and for new heavy-duty vehicles after 2027."

Based on the above assumptions, the pre-COVID dataset, and with no change in current laws and regulations included in the modeling tools currently used by NDEP, transportation GHG emissions would have been projected to peak in Nevada in 2020 at 16.329 MMTCO2e emissions. Emissions in 2025 are projected to be 15.653 MMTCO2e, emissions in 2030 are projected to be 15.280 MMTCO2e, and emissions in 2040 are projected to be 14.502 MMTCO2e. Figure 3-5 illustrates transportation sector GHG emissions projections in Nevada by fuel type for 2018 through 2040.

Figure 3-5: Transportation Sector Projected GHG Emissions and Emissions by Fuel Type, 2018–2040



Electricity Generation

Figure 4-1: Nevada Net GHG Emissions with Electricity Generation Sector Emissions Emphasized and Updated Projections Beginning in 2018, 1990–2040

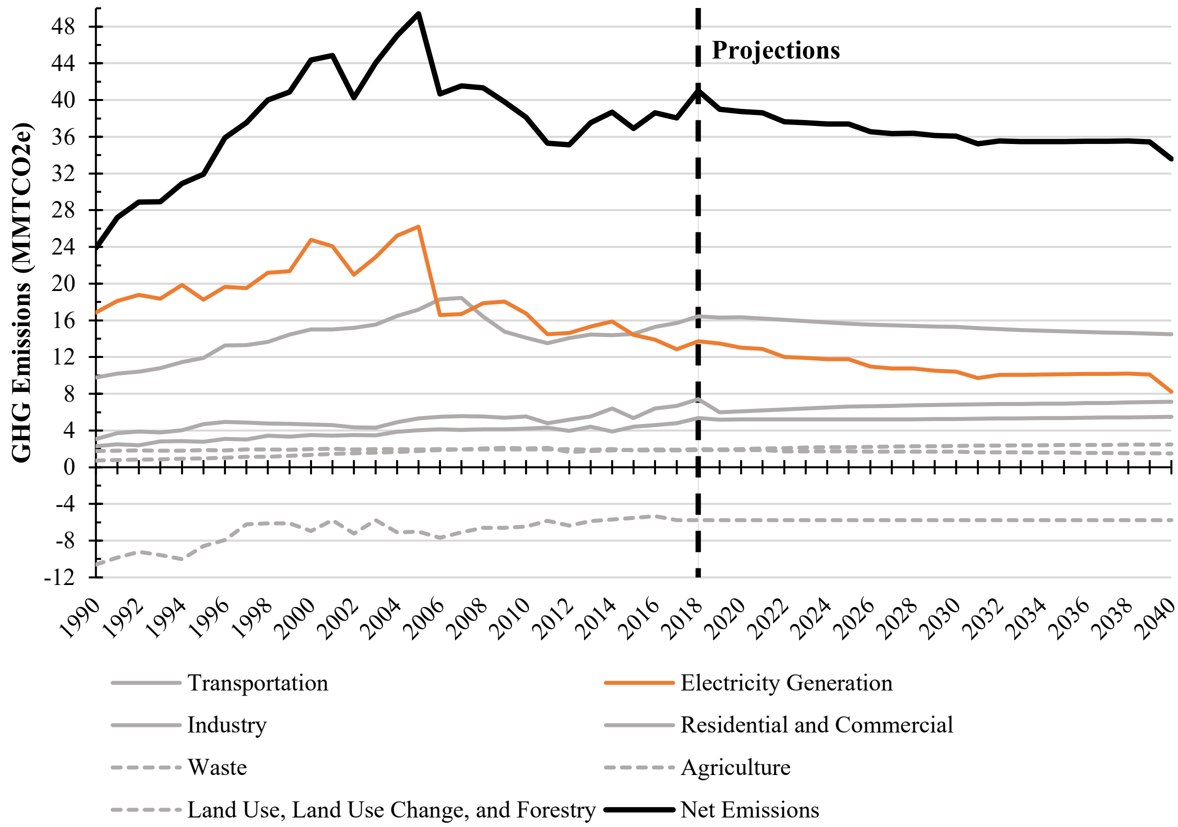
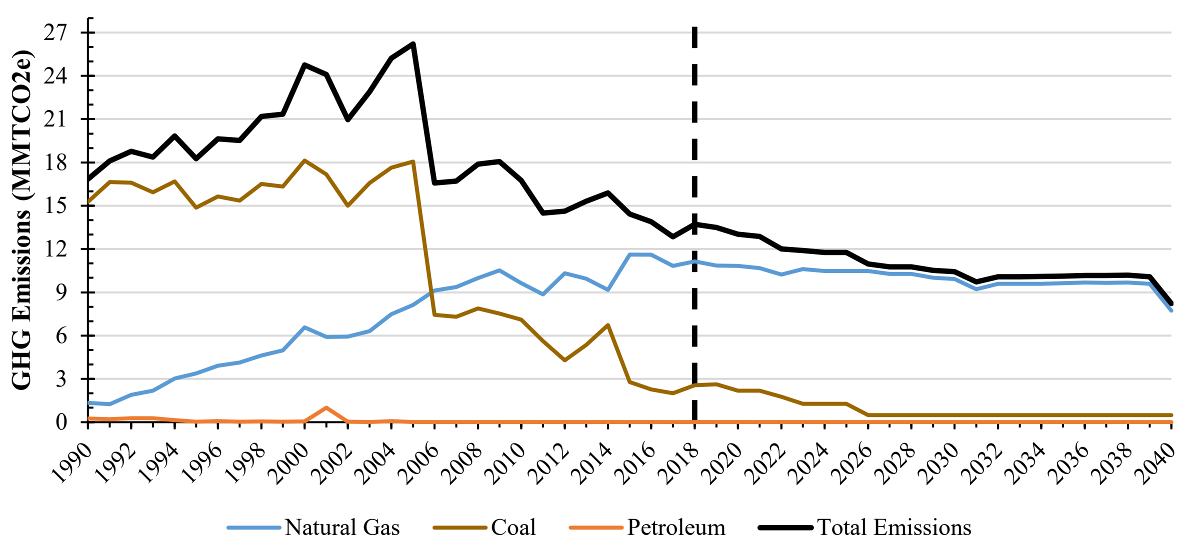


Figure 4-2: Electricity Generation Sector GHG Emissions and Emissions by Fuel Type with Projections Beginning in 2018, 1990–2040



4.1 Overview

Electricity generation has historically been Nevada's largest sector of GHG emissions, but the retirements of two coal-fired power plants (Mohave Generating Station in 2005 and Reid Gardner Generating Station's last unit in 2017) and their partial replacement with natural gas-fired power plants and the adoption of renewable energy have led to significant emissions reductions. This change in fuel type results in a less carbon intense emissions profile for the electricity generated in Nevada. From the EPA's 2020 GHG Inventory, "[c]arbon dioxide emissions also depend on the source of energy and its carbon (C) intensity. The amount of C in fuels varies significantly by fuel type. For example, coal contains the highest amount of C per unit of useful energy. Petroleum has roughly 75 percent of the C per unit of energy as coal, and natural gas has only about 55 percent."[57]

In 2017, it is estimated that 12.858 MMTCO2e emissions attributed to electricity generation were emitted in Nevada, that's more than 29% of the State's gross GHG emissions. Based on the pre-COVID datasets used to prepare this report, it is projected that by 2040, emissions from electricity generation will be just 1.092 MMTCO2e more than industrial sector emissions, 8.225 MMTCO2e. 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), the recently 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, and that there are currently no plans filed with the Public Utilities Commission of Nevada (PUCN) nor any other regulatory body for new, utility-scale fossil fuel-fired electric generating units (EGUs) in Nevada through 2040. Total electricity generation sector emissions by fuel type for 1990 through 2040 are illustrated in Figure 4-2. Electricity generation sector emissions were 26.211 MMTCO2e in 2005, and (using pre-COVID data) are projected to be 11.765 MMTCO2e and 10.423 MMTCO2e in 2025 and 2030, respectively.

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 more accurate of the actual GHG emissions for the State, as emissions are estimated through reported fuel usage at the generating unit level. In 2017, there were an estimated 1.984 MMTCO2e emissions associated with electricity transmitted out-of-state.

4.2 Methodology

Electricity generation sector GHG emissions are the result of fossil fuel combustion and (to a much lesser extent) the byproducts (CH_4 and N_2O) of fossil fuel combustion. Historical emissions are quantified using two SIT modules. The *CO_2 from Fossil Fuel Combustion* module estimates CO_2 emissions using annual fuel consumption data (provided by the EIA), combustion efficiency (IPCC guidelines recommend assuming 100% combustion efficiency for all fuel types), and the carbon content of the fuels. CO_2

[57] U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. U.S. Environmental Protection Agency; released 2020 Apr 13. Washington D.C. EPA 430-R-20-002. [accessed 2020 Dec 23]. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018

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, distillate fuel/petroleum, and natural gas) to annual fuel consumption (provided by the EIA). CH_4 and N_2O emissions vary with the type of fuel burned, the size and age of the combustion technology, the maintenance and operating conditions of the combustion equipment, and the types of pollution control technologies installed.

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

The SIT's *Greenhouse Gas Projection Tool* is not used for projecting electricity generation sector emissions. Because the projection tool depends on the EIA's AEO, it neither considers the most recent Integrated Resource Plans (IRPs) filed by the utilities considered in this report, nor does it account for Nevada's updated Renewable Portfolio Standard (RPS) specified in NRS 704.7821. CO_2 emissions from coal- and natural gas-fired EGUs are projected using a method developed by NDEP that depends on historical, unit-level electricity generation and emissions data as well as the existing policies and regulations affecting the future of those units.[58,59] Information was gathered from the following sources:

- EIA Form 923[60] and EIA Form 860[61] for unit level net generation, fuel consumption, reported retirements, and nameplate capacity;

[58] CH_4 and N_2O emissions are projected by considering projected CO_2 emissions against the historical CO_2, CH_4, and N_2O emissions. CH_4 and N_2O emissions accounted for less than 0.2% of sector emissions in 2017.
[59] CO_2 emissions associated with the combustion of petroleum products was projected using a linear trend of 2008 through 2016 historical emissions. Petroleum-based CO_2 emissions accounted for less than 0.07% of sector emissions in 2017.
[60] Form EIA-923. U.S. Energy Information Administration. [accessed 2019 Oct 2]. https://www.eia.gov/electricity/data/eia923/
[61] Form EIA-860. U.S. Energy Information Administration. [accessed 2019 Oct 2]. https://www.eia.gov/electricity/data/eia860/

- EPA Air Markets Program Data (AMPD)[62] and the Emissions and Generation Resource Integrated Database (eGRID)[63] for CO_2 emissions, gross generation, heat input, and EGU nameplate capacity;
- NV Energy's 2019-2038 IRP[64] submitted to the PUCN for sales projections, power purchase agreements, supply side plans, and reported remaining useful lives of their fossil fuel-fired fleet[65];
- Idaho Power's 2019 IRP[66] for information on North Valmy Generating Station[67]; 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. In the case of Idaho Power's 2019 IRP, they plan to cease "participation in North Valmy Unit 1 at year-end 2019 and Unit 2 no later than year-end 2025."[68]

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.[69] When this happens, NDEP simulates fossil fuel peaker and intermediate load units (as identified by NV Energy in their IRP) being curtailed until generation is equal to projected demand by reducing generation from these types of units. Reduced emissions due to the reduced generation are estimated using the utility's average emission rates for SPPC and NPC peaker and intermediate load units. For years when projected demand is greater than projected generation, it is assumed that the wholesale market (that is, generally, electricity generated outside of Nevada) is used to provide coverage.

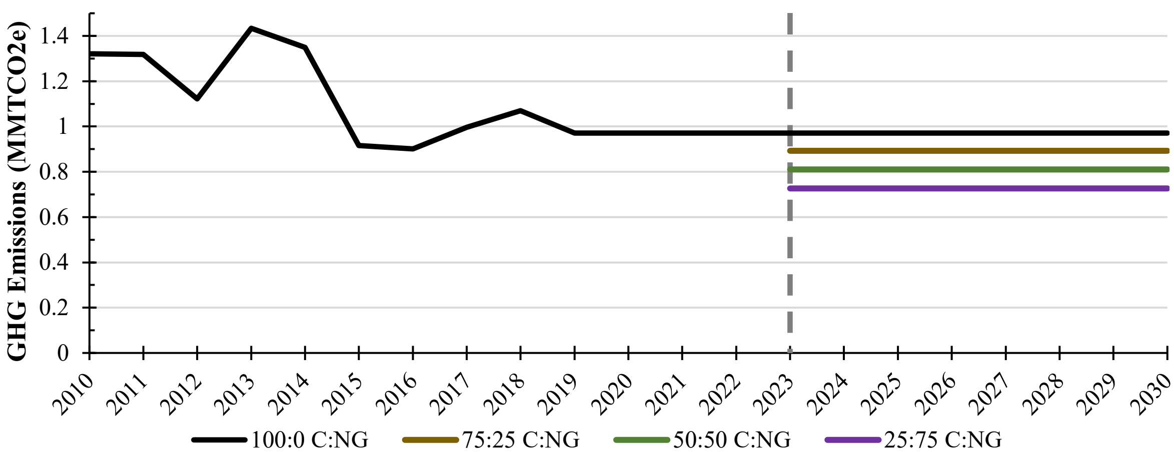
[62] Air Markets Program Data. U.S. Environmental Protection Agency. [accessed 2019 Oct 2]. https://ampd.epa.gov/ampd/
[63] Emissions and Generation Resource Integrated Database. U.S. Environmental Protection Agency; 2018 Feb 15. [accessed 2019 Aug 1]. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[64] Nevada Power Company d/b/a NV Energy and Sierra Pacific Power Company d/b/a NV Energy. Joint 2019-2038 Integrated Resource Plan, for the three year Action Plan period 2019-2021, and the Energy Supply Plan period 2019-2021. Public Utilities Commission of Nevada. 2018 Jun 1; Docket 18-06003, Original Filing. [accessed 2019 Oct 2]. http://puc.nv.gov/
[65] In considering retirement dates for Nevada's existing fossil fuel-fired EGUs, the analysis looked at planned retirement dates (as submitted to the EIA), depreciation-based retirement dates (as included in the utility IRP and approved by the PUCN), and the remaining useful life of the EGUs (as determined using an historical average of similarly sized and operated EGUs when the first two options are unavailable).
[66] Idaho Power Company. Idaho Power Integrated Resource Plan 2019. 2019 Jun. [accessed 2019 Oct 2]. https://www.idahopower.com/energy-environment/energy/planning-and-electrical-projects/our-twenty-year-plan/
[67] North Valmy Generating Station is co-owned by NV Energy and Idaho Power.
[68] Idaho Power Integrated Resource Plan 2019, p79.
[69] 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.

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, Nevada Gold Mines LLC has begun a plan to convert the power plant from a strictly coal-fired facility to a dual fueled, coal- and natural gas-fired facility. The company has the stated goal of having the work completed in the second quarter of 2022.[70] While a representative of the company has been reported saying that the "conversion to natural gas would save 650,000 metric tons of carbon dioxide emissions a year,"[71] if the facility is operated to minimize fuel costs, emissions reductions will likely be more modest (coal is generally cheaper than natural gas in the winter while natural gas is generally cheaper than coal in the summer). To determine potential emissions reductions from a dual fuel TS Power, NDEP examined three possible operating scenarios for TS Power based on the facility's historical emissions from 2015 through 2018 and the emissions profile of a similarly sized natural gas-fired boiler.

Scenario 1 assumes that in an average year the facility operates 75% of the time on coal (January through June and October through December) and 25% of the time on natural gas (July through September); scenario 2 assumes a 50:50 ratio of time in an average year spent operating with coal (January through April and November and December) to natural gas (May through October); and scenario 3 assumes a 25:75 ratio of time in an average year spent operating with coal (December through February) to natural gas (March through November). Emissions from these three scenarios, as well as a scenario that assumes the facility continues to operate exclusively on coal, are illustrated in Figure 4-3.

Figure 4-3: TS Power Plant Historical Emissions and Projected Emissions Scenarios of Coal (C) to Natural Gas (NG) Utilization, 2010-2030



[70] Conversion of NGM's TS Power Plant Aligns with Nevada's Carbon Reduction Ambitions. Barrick. 2020 Feb 24. [accessed 2020 Oct 5]. https://www.barrick.com/English/news/news-details/2020/Conversion-of-NGMs-TS-Power-Plant-aligns-with-Nevadas-carbon-reduction-ambitions/default.aspx
[71] Harding A. NGM converting power plant to reduce carbon emissions. Elko Daily Free Press. 2020 Jun 3. [accessed 2020 Oct 5]. https://elkodaily.com/mining/ngm-converting-power-plant-to-reduce-carbon-emissions/article_ec74a148-da17-5016-a31d-3819877145fe.html

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.

4.3 GHG Emissions, 1990-2017

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 84% of 2017 emissions, 10.841 MMTCO2e), and an ever-increasing reliance on renewable electricity (that is, hydroelectric, solar thermal and photovoltaic, wind, and geothermal resources). Figure 4-4 shows electricity generation sector GHG emissions in Nevada from 1990 through 2017 by fuel type and Table 4-1 lists electricity generation sector GHG emissions in Nevada for select years.

Figure 4-4: Electricity Generation Sector GHG Emissions by Fuel Type, 1990–2017

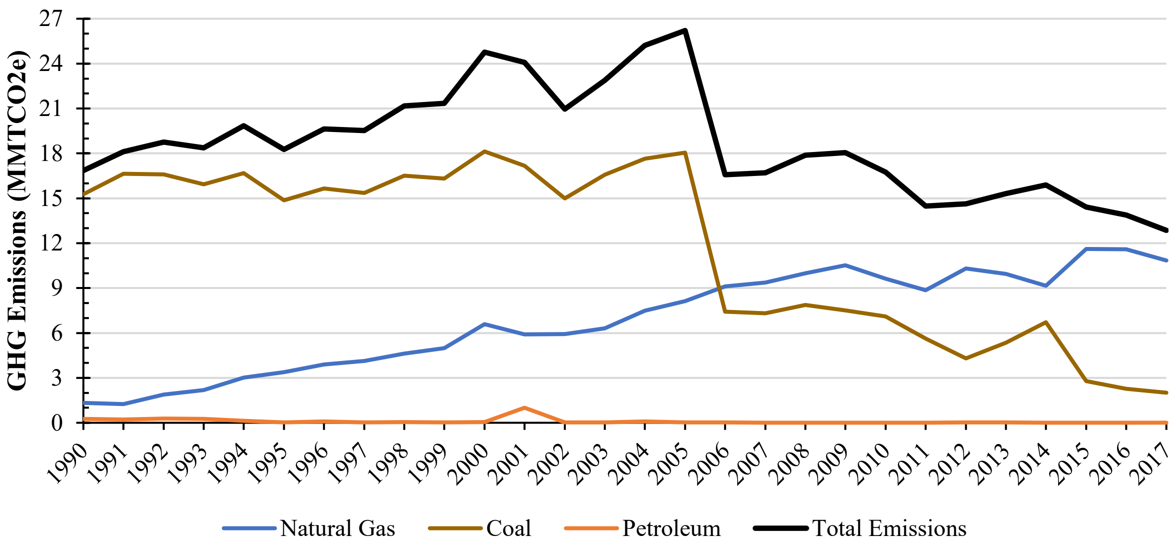


Table 4-1: Electricity Generation Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2013	2014	2015	2016	2017
Natural Gas	1.333	3.380	6.581	8.133	9.953	9.158	11.614	11.604	10.841
Coal	15.266	14.859	18.132	18.059	5.352	6.722	2.787	2.273	2.009
Petroleum	0.250	0.024	0.055	0.019	0.015	0.012	0.013	0.009	0.008
Total Emissions	**16.849**	**18.263**	**24.768**	**26.211**	**15.320**	**15.893**	**14.415**	**13.887**	**12.858**

Large changes to the State's GHG emissions are often driven by the opening or closing of EGUs (for example, emissions in 2005 versus 2006 clearly show the impact of the Mohave Generating Station shutting down). Smaller inter-annual variability is likely associated with factors such as weather variability and the economy. An especially hot summer could mean higher demand for air conditioning, which would not be otherwise utilized in cooler conditions, resulting in an increase in emissions. Annual changes in electricity generation sector GHG emissions by fuel from 2012 through 2017 are listed in Table 4-2.

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

Fuel Type	2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017	
Natural Gas	-0.359	-3.48%	-0.794	-7.98%	2.456	26.82%	-0.010	-0.09%	-0.763	-6.57%
Coal	1.059	24.66%	1.370	25.60%	-3.935	-58.54%	-0.514	-18.43%	-0.264	-11.62%
Petroleum	-0.003	-15.32%	-0.002	-16.08%	0.001	7.19%	-0.004	-30.73%	-0.001	-12.90%
All Fuel Types	**0.697**	**4.77%**	**0.573**	**3.74%**	**-1.478**	**-9.30%**	**-0.528**	**-3.67%**	**-1.028**	**-7.40%**

Using EIA data, Figure 4-5 shows the amount of electricity generated in Nevada from 1990 through 2018 by source, in terawatt-hours (TWh)[72].[73] Table 4-3 shows the amount of electricity generated in Nevada for select years by source, in TWh. While emissions from the electricity generation sector have reduced by nearly half, the amount of electricity generated has remained largely unchanged. A benefit of viewing the sector in this way is that all sources of electricity are considered, not just the ones that emit GHGs. It also shows that renewable energy has long been a part of Nevada's diverse generation mixture. The generation of electricity via hydroelectric dams and geothermal deposits was present before 1990 and the relatively recent introduction of solar and wind demonstrates that renewable energy has become a relied upon portion of the state's generation mix. Renewable energy accounted for 26% of the electricity generated in Nevada in 2018; that percent is expected to rise as the RPS increases and new renewable energy projects are constructed.

[72] For reference, 1 TWh is the same as 1,000,000 megawatts-hours (MWh).
[73] U.S. Energy Information Administration Electricity Generation Data. [released 2020 Jun 26; accessed 2020 Sep 30]. https://www.eia.gov/state/seds/

Figure 4-5: Amount of Electricity Generated in Nevada by Source, 1990-2019, TWh

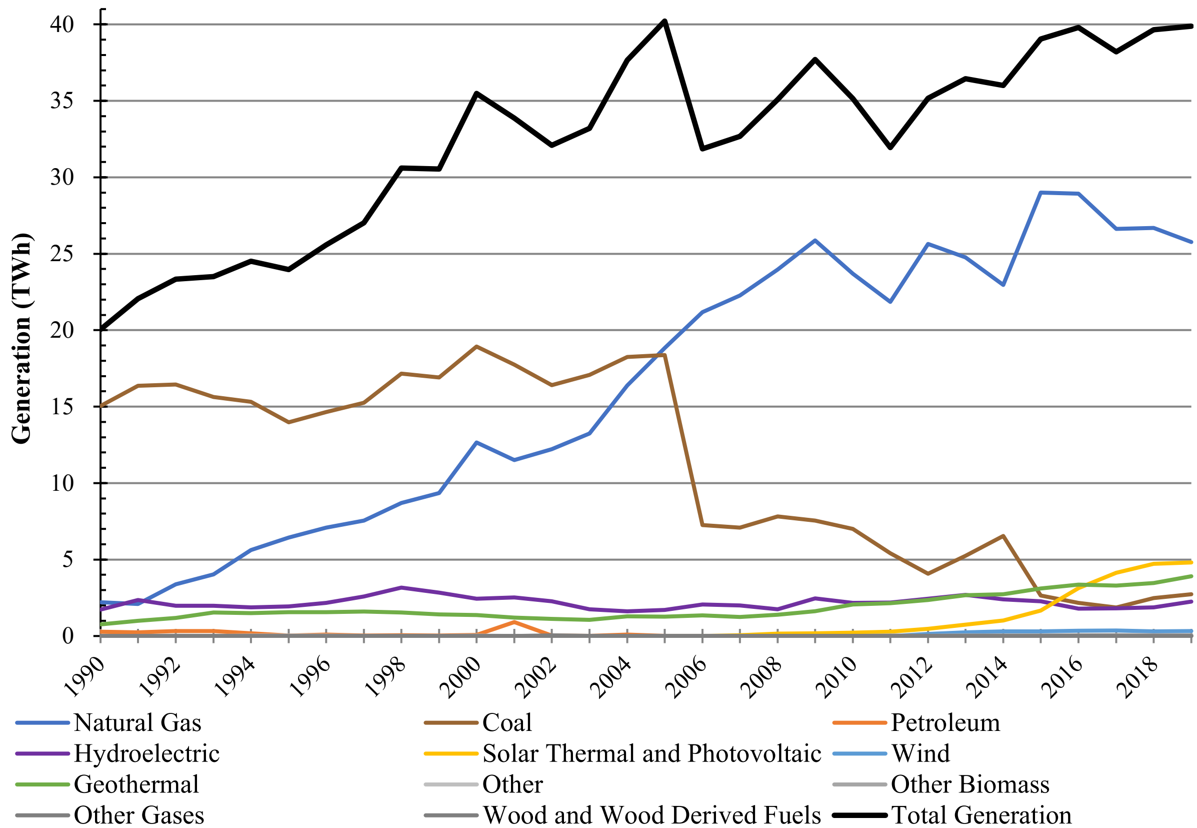


Table 4-3: Electricity Generated in Nevada by Source, Select Years (TWh)

Source	2005	2010	2014	2015	2016	2017	2018	2019
Natural Gas	18.836	23.688	22.961	29.000	28.922	26.626	26.689	25.775
Coal	18.384	6.997	6.548	2.657	2.167	1.866	2.485	2.735
Petroleum	0.021	0.011	0.015	0.016	0.011	0.009	0.010	0.012
Hydroelectric	1.702	2.157	2.389	2.264	1.789	1.813	1.881	2.242
Solar Thermal and Photovoltaic	0.000	0.217	1.014	1.657	3.124	4.146	4.719	4.811
Wind	0.000	0.000	0.300	0.310	0.344	0.361	0.312	0.329
Geothermal	1.263	2.070	2.729	3.111	3.353	3.292	3.462	3.909
Other	0.000	0.000	0.015	0.001	0.021	0.032	0.029	0.022
Other Biomass	0.000	0.000	0.025	0.026	0.055	0.058	0.053	0.054
Other Gases	0.008	0.006	0.005	0.006	0.001	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
Total Generation	**40.214**	**35.146**	**36.001**	**39.047**	**39.787**	**38.201**	**39.640**	**39.890**

4.4 Projected Emissions, 2018-2040

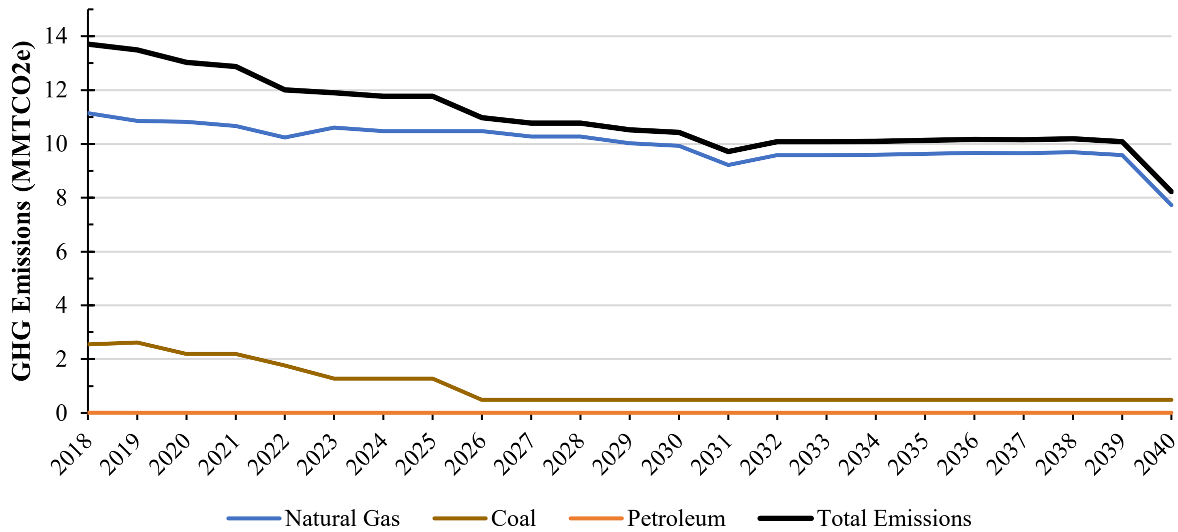
In 2018, there were 19 fossil fuel-fired power plants — 17 natural gas-fired and two coal-fired — operating in Nevada. Of these 19, three are transmitting some or all of their electricity out-of-state. Table 4-4 provides some information for these power plants. These power plants, in addition to the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

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

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

Without any additional changes to Nevada's RPS, electricity generation sector GHG emissions are expected to fall below 10 MMTCO2e by 2040 with emissions in 2025 projected to be 11.765 MMTCO2e, and emissions in 2030 projected to be 10.423 MMTCO2e. Emissions reductions are largely associated with the expected retirement of the North Valmy Generating Station (although there is uncertainty regarding whether the facility will retire on its current, voluntary schedule) and the lack of published/filed plans for new fossil fuel fired EGUs through 2040. Figure 4-6 shows electricity generation sector GHG emissions in Nevada by fuel type projected for 2018 through 2040. From 2039 to 2040, there is a significant reduction in sector emissions. The Las Vegas Generating Facility Units 2 & 3 (297.6 MW), Silverhawk (664 MW), and the Walter Higgins Generating Station (688 MW) all reach their depreciation-based retirement dates at the end of 2039 according to NV Energy filings. The method of projecting emissions (explained in Section 4.2) assumes the closure of these facilities and that wholesale electricity will be purchased to meet any demand in 2040 not met by in-state generation.

Figure 4-6: Electricity Generation Sector Projected GHG Emissions and Emissions by Fuel Type, 1990–2040



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, for years when projected demand is greater than projected generation, it is assumed that the wholesale market is used to provide coverage. When projected generation is greater than projected demand, the analysis only assumes that EGUs are curtailed until projected generation is equal to projected demand. It is likely however, that wholesale purchases of electricity will sometimes be more cost effective than operating peaker and intermediate load units.

Industry

Figure 5-1: Nevada Net GHG Emissions with Industry Emissions Emphasized and Updated Projections Beginning in 2018, 1990–2040

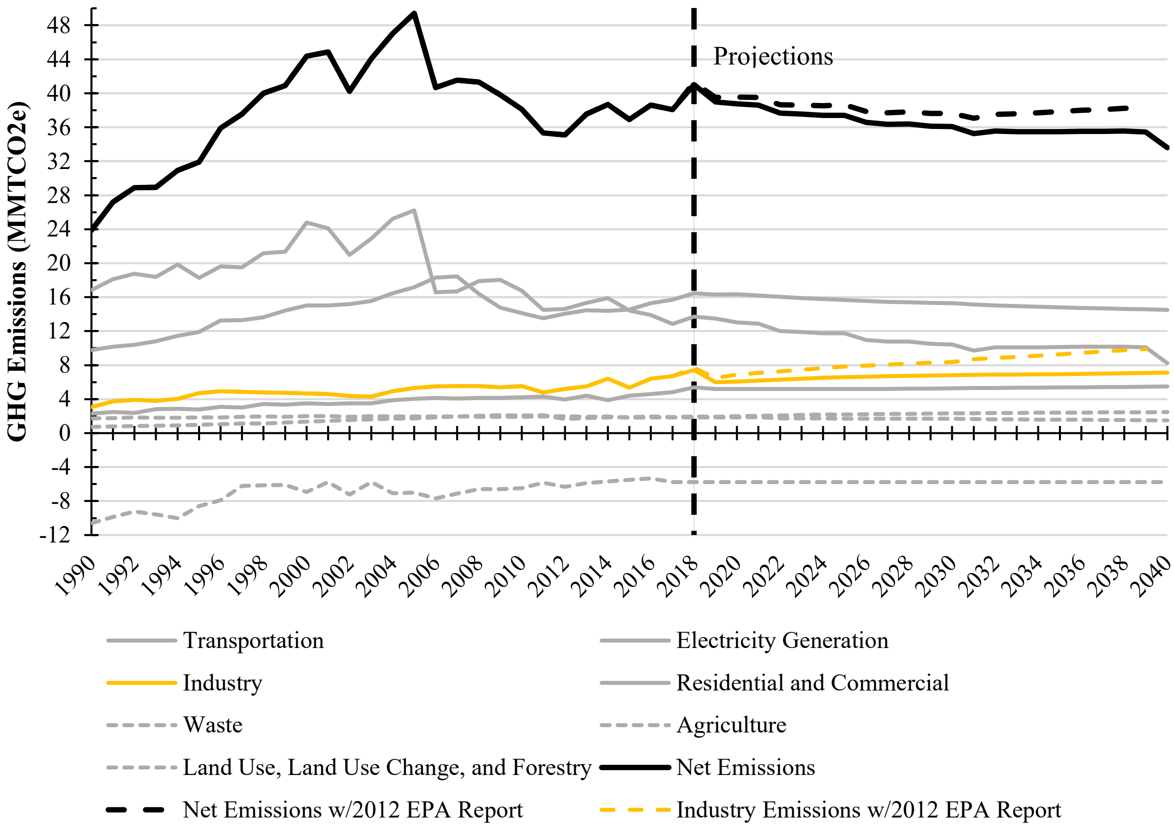
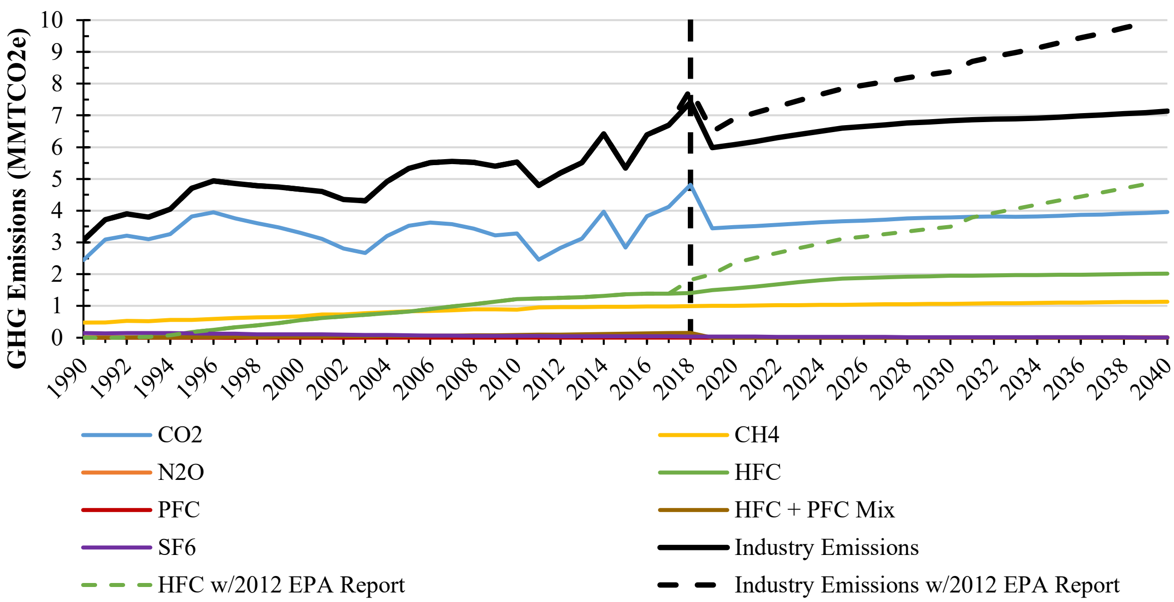


Figure 5-2: Industry GHG Emissions and Emissions by GHG with Projections Beginning in 2018, 1990–2040



5.1 Overview

5.1.1 Uncertainties in Ozone Depleting Substance (ODS) Substitute Emissions

An increasingly significant percentage of industry emissions (nearly 23% of sector emissions in 2017) are the result of ODS substitute emissions. ODS substitutes, or classes of hydrofluorocarbons (HFCs) and perfluorocarbons (PFC), are used as alternatives to several classes of ODSs that are being phased out under the Montreal Protocol (an international agreement to restore and protect the Earth's ozone layer) and the Clean Air Act Amendments of 1990. ODS substitutes are used as replacements in a variety of residential, commercial, and industrial applications, including refrigeration and air conditioning equipment, aerosols, solvent cleaning, fire extinguishing, foam production, and sterilization. While ODS substitutes are not harmful to the ozone layer, they are potent GHGs with high GWPs. ODS substitutes can be emitted into the atmosphere at the point of manufacture, throughout the equipment's usage life through leakage and evaporation (refrigeration and air conditioning), when the product is used (aerosols, solvent cleaning, fire extinguishing, foam production, and sterilization), or when a piece of equipment is taken offline and the ODS substitutes are not properly disposed.

In previous versions of this report, ODS substitute emissions were projected using data from the SIT, which used projections from the EPA's 2012 report, *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030.*[74] EPA's 2012 report presented, in 5 year intervals, U.S. historical emissions from 1990 to 2005 and projected emissions from 2010 to 2030. For this report, U.S. projections from the EPA's 2019 report, *Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation: 2015-2050*[75], are used to estimate ODS substitute emissions projections for Nevada. U.S. and Nevada population are used to apportion U.S. emissions to Nevada. However, in the EPA's 2019 report, the model used to project U.S. emissions under existing policy only (that is, a business as usual model) incorporates transitions to low-cost, low-GWP alternatives to reflect compliance with rules finalized through the Significant New Alternatives Policy (SNAP) Program.

While the projections in the EPA's 2019 report show a significant reduction in ODS substitute emissions compared to the EPA's 2012 report, there is uncertainty in these reductions. In August of 2017 and April of 2019, that is, after work on the EPA's 2019 report had begun and the business as usual modelling effort had commenced, the U.S. Court of Appeals for the District of Columbia Circuit vacated SNAP Program Rule 20 and Rule 21, respectively. These rules would have prohibited the use of certain high-GWP HFCs that are used as ODS substitutes. The court's decision to limit the EPA's authority regarding the banning of ODS substitutes has not stopped the SNAP Program from continuing its work (Rule 23 was proposed in June 2020), but it does limit their ability to directly address high-GWP compounds and creates uncertainty with regard to the EPA's 2019 report projections. The spending appropriation bill, which was

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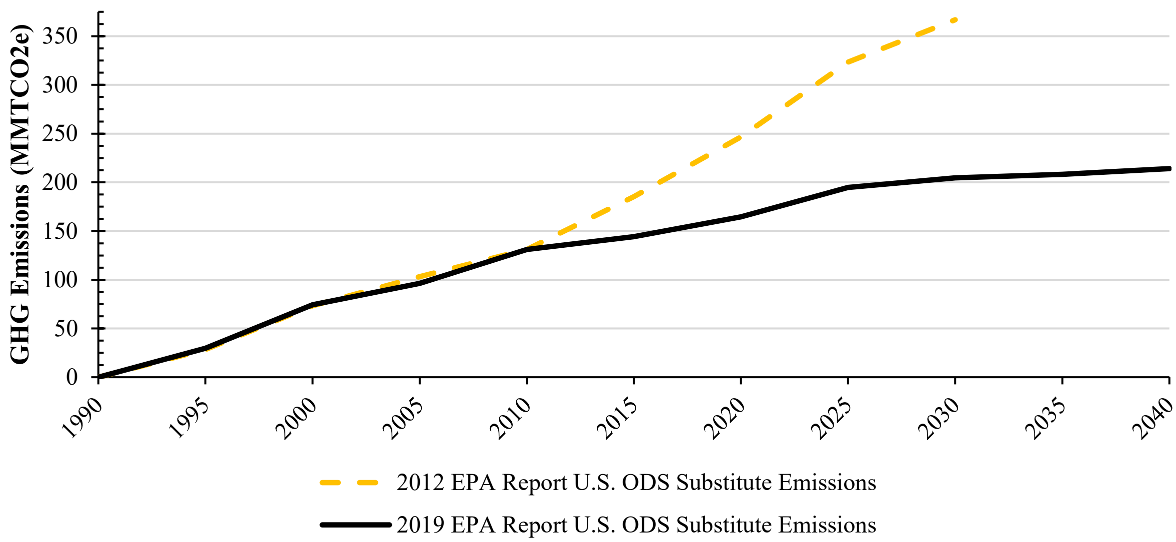
[74] U.S. Environmental Protection Agency. Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2030. U.S. Environmental Protection Agency Office of Atmospheric Programs; released 2012 Dec. Washington D.C. EPA 430-R-12-006. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-ghg-emissions-1990-2030

[75] 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. https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-non-co2-greenhouse-gas-emission-projections

passed by the U.S. Congress on December 21, 2020, included a provision for a phasedown of HFCs at the national level and provided the EPA with the authority to regulate such process. NDEP was not able to assess the specific effects of this legislation on anticipated HFC use projections in Nevada.

Considering that, both the projections from NDEP's 2019 report as well as the updated emissions projections used throughout the rest of this report are illustrated in this section. Furthermore, to better illustrate the stark contrast in ODS substitute emissions the two EPA reports present, Figure 5-3 shows historical and projected U.S. ODS substitute GHG emissions from the 2012 and 2019 reports; projected emissions for 2030 differ by more than 160 MMTCO2e. Throughout this report, we adopt the emission projections from the EPA's 2019 report; while affected by the uncertainty in regulatory framework, this report still represents the most recent and accurate dataset available.

Figure 5-3: U.S. ODS Substitute Historical and Projected Emissions Estimates from Two EPA Reports



Again, the methodology used for historical and projected ODS substitute emissions in Nevada is the same as in previous versions of this report. That is, U.S. ODS substitute emissions are apportioned to Nevada using national and state population estimates; the only difference being that U.S. ODS substitute emissions projections are coming from the EPA's 2019 report. While these updated projections show — compared to the NDEP's 2019 report — a lower rate of increasing ODS substitute emissions, it is important to note that the usage of ODS substitutes is expected to increase until alternatives become commonplace and high-GWP compounds are phased out entirely.

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 ways than other parts of the country (leading to a higher frequency of weather extremes, including heatwaves), using national estimates to apportion emissions is likely leading to underestimates of both

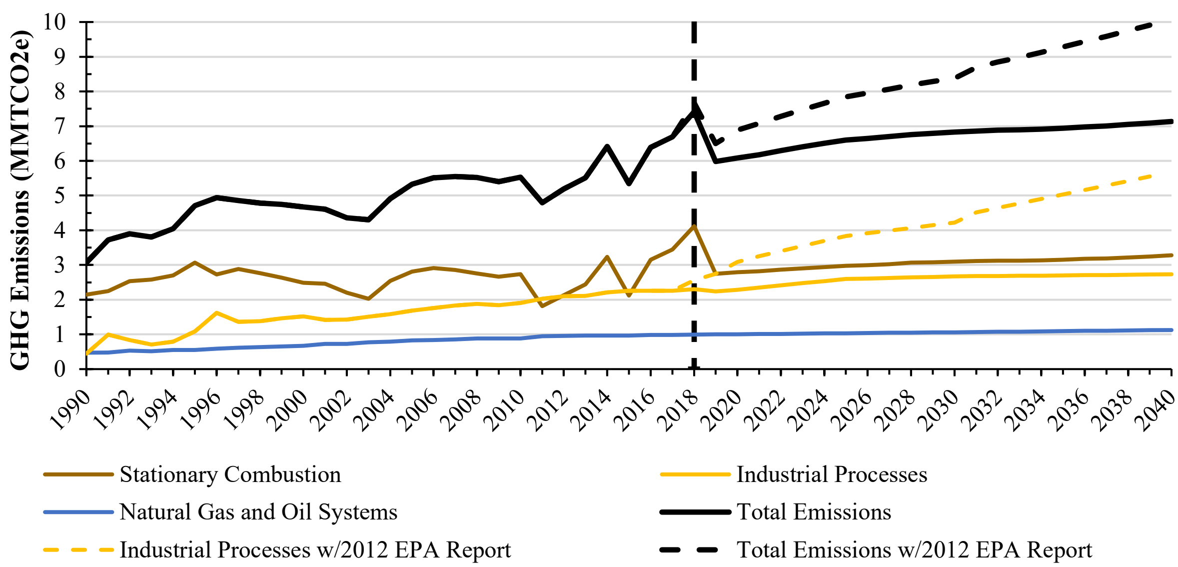
ODS substitute usage and the associated emissions. More accurately estimating these emissions will require efforts to further characterize the presence and usage of ODS substitutes in Nevada.

5.1.2 General Considerations

Industrial sector GHG emissions for 2017 are estimated to be 6.542 MMTCO2e and accounted for nearly 15% 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 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, HFCs, PFCs, and SF_6.[76]

Total industry emissions are illustrated by GHG for 1990 through 2040 in Figure 5-2 and Figure 5-3 shows the relative contributions of the three sub-sectors on total industry GHG emissions for 1990 through 2040. Based on the updated ODS substitute emissions, stationary combustion was still the largest sub-sector of industry emissions in 2017, and — given the pre-COVID datasets — are projected to remain that way through 2040. Emissions from this sector were 5.227 MMTCO2e in 2005, and are projected to be 6.602 MMTCO2e in 2025 and 6.828 MMTCO2e in 2030. As a whole, industry will account for more than 17% of the gross GHG emissions in Nevada in 2040.

Figure 5-4: Industry GHG Emissions and Emissions by Sub-Sector with Projections Beginning in 2018, 1990-2040



Emissions from the stationary combustion of fossil fuels by industry includes the combustion of natural gas, coal, and petroleum products. There were 3.449 MMTCO2e emissions attributable to this sub-sector in 2017. The SIT also considers in this sub-sector some industrial processes (examples include, road

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

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 the SIT.

Table 5-1: Industrial Stationary Combustion Sub-Sector Fuels Consumed[77]

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.[78] Emissions from the industrial process sub-sector accounted for 2.112 MMTCO2e emissions in 2017. The sources of emissions from individual industrial processes are listed in Table 5-2.

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[77] 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

[78] 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.

Table 5-2: Industrial Process Emissions Sources Detailed[79]

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 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.[80] 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.[81] Natural gas and oil systems in Nevada accounted for 0.981 MMTCO2e emissions in 2017.

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

[80] 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.

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

5.2 Methodology

5.2.1 Industry Emissions from Stationary Combustion

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

The *CH_4 and N_2O Emissions from Stationary Combustion* module estimates CH_4 and N_2O emissions (the byproducts of fossil fuel consumption) by applying emission factors for the individual fuel types (examples include coal, natural gas, and petroleum products) to annual fuel consumption (provided by the EIA). CH_4 and N_2O emissions vary with the type of fuel burned, the size and age of the combustion technology, the maintenance and operating conditions of the combustion equipment, and the types of pollution control technologies installed. This module also considers the quantity of fossil fuels used for non-energy consumption in a manner that permanently stores the final product with no emissions into the atmosphere. The emissions that would be associated with these fossil fuels are considered sequestered emissions and are subtracted from the sub-sector total. Examples include the use of 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 SIT's *Energy Consumption Projections Tool* from 2018 through 2040. The projection tool uses EIA State Energy Data and the EIA AEO Reference Case in order to estimate state level fuel consumption. Fuel consumption estimates are then subjected to the same quantification method as the *CO_2 from Fossil Fuel Combustion* and *CH_4 and N_2O Emissions from Stationary Combustion* modules.

5.2.2 Industry Emissions from Industrial Processes

Generally, the *Industrial Processes* module estimates GHG emissions by either (1) considering the amount of a material produced (produced materials in Nevada being cement, lime, limestone, 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.[82]

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

For usage/consumption-based industrial process GHG emissions, 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 from 2018 through 2040. For ODS substitutes and electric power transmission and distribution systems, the 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. These updated projections are apportioned to Nevada using projected U.S. and Nevada population estimates (refer to Section 5.1.1 above for more information regarding the uncertainty in ODS substitute estimates).

5.2.3 Industry Emissions from Natural Gas and Oil Systems

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

Projections for natural gas and oil systems emissions use a modified version of the projection tool's methods to project emissions through 2040. That is, a linear trend of only post-recession emissions is used to project future emissions rather than a linear trend of the entirety of the historical dataset. This change in method results in more accurate near-term emissions estimates.

[82] 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.

5.3 GHG Emissions, 1990-2017

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 5.227 MMTCO2e for 2005 and 6.542 MMTCO2e for 2017. Figure 5-4 shows industry emissions in Nevada by GHG from 1990 through 2017 and Table 5-3 lists industry GHG emissions in Nevada for select years.

Figure 5-5: Industry GHG Emissions in Nevada by GHG, 1990-2017

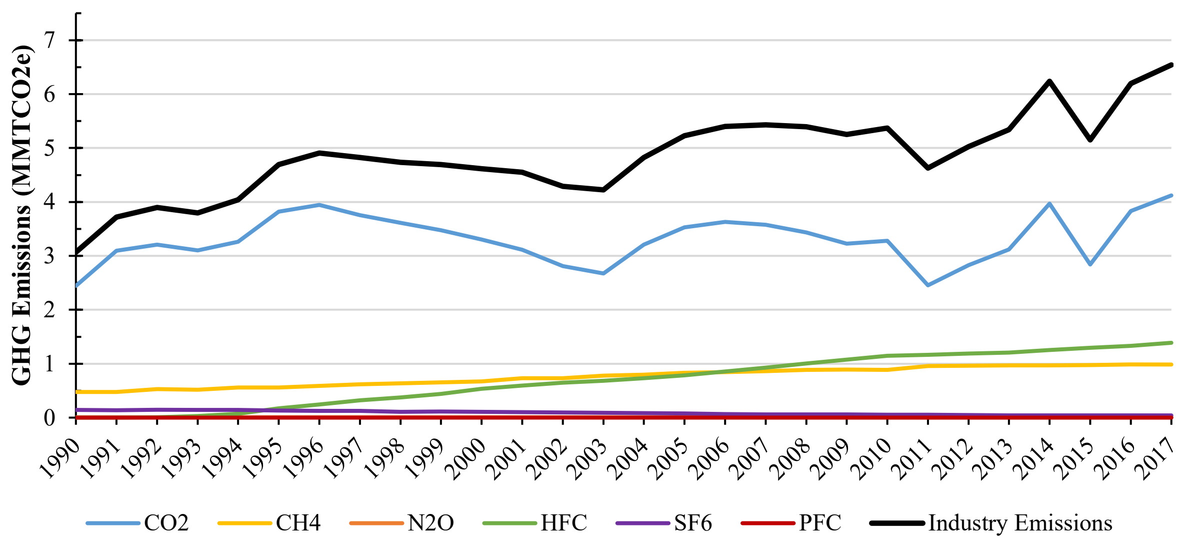


Table 5-3: Industry GHG Emissions in Nevada by GHG, Select Years (MMTCO2e)

GHG	1990	1995	2000	2005	2010	2014	2015	2016	2017
CO_2	2.444	3.822	3.304	3.529	3.281	3.966	2.837	3.831	4.121
CH_4	0.476	0.559	0.670	0.834	0.884	0.968	0.972	0.984	0.985
N_2O	0.005	0.007	0.005	0.006	0.006	0.007	0.004	0.006	0.007
HFCs	0.000	0.172	0.532	0.782	1.146	1.252	1.296	1.329	1.388
SF_6	0.144	0.131	0.106	0.076	0.055	0.045	0.042	0.043	0.041
PFCs	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
HFC + PFC Mix	0.001	0.010	0.034	0.059	0.087	0.111	0.125	0.136	0.146
Total Emissions	**3.069**	**4.691**	**4.619**	**5.267**	**5.441**	**6.305**	**5.220**	**6.249**	**6.544**

5.3.1 Industry Emissions from Stationary Combustion

The stationary combustion of fossil fuels has been the largest sub-sector of industry emissions since 1990. Figure 5-5 illustrates stationary combustion sub-sector GHG emissions in Nevada by fuel type and Table 5-4 lists stationary combustion sub-sector GHG emissions in Nevada by fuel type for select years. Petroleum-related usage is both the largest contributor of sub-sector emissions and also the most prone to significant year-to-year variability in emissions as shown in Table 5-5, which lists the annual changes in stationary combustion GHG emissions by fuel type from 2012 through 2017.

Figure 5-6: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 1990-2017 (MMTCO2e)

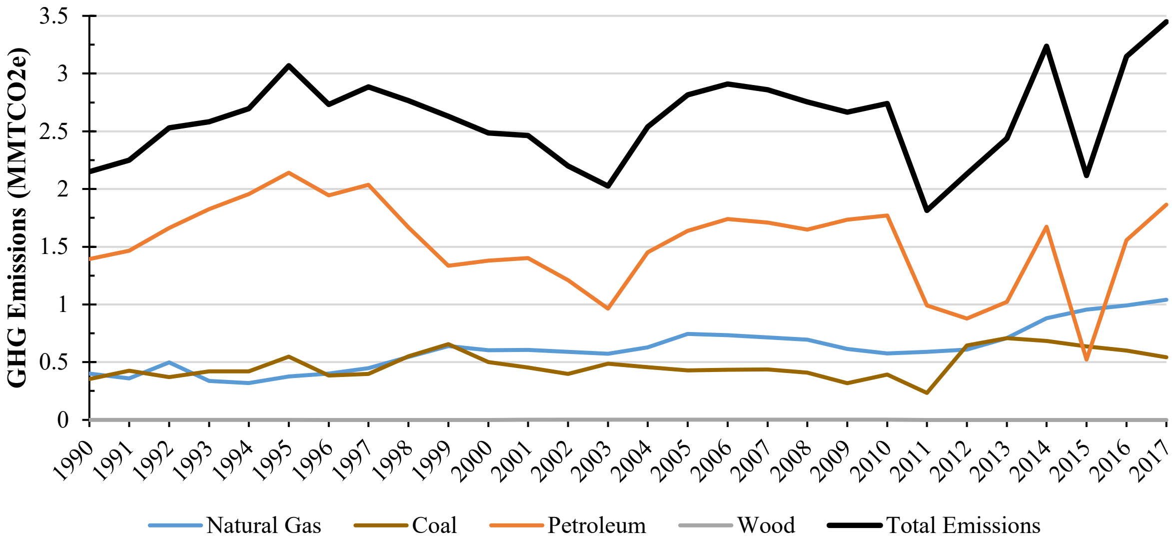


Table 5-4: Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, Select Years (MMTCO2e)

Fuel Type	1990	1995	2000	2005	2010	2014	2015	2016	2017
Natural Gas	0.402	0.377	0.603	0.746	0.577	0.881	0.957	0.991	1.041
Coal	0.353	0.549	0.502	0.429	0.391	0.684	0.637	0.602	0.542
Petroleum	1.394	2.141	1.379	1.638	1.770	1.672	0.522	1.556	1.866
Wood	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000
Total Emissions	**2.149**	**3.067**	**2.485**	**2.814**	**2.740**	**3.238**	**2.116**	**3.149**	**3.449**

Table 5-5: Annual Change in Stationary Combustion Sub-Sector GHG Emissions in Nevada by Fuel Type, 2012-2017 (MMTCO2e and Percent)

Fuel Type	2012-2013		2013-2014		2014-2015		2015-2016		2016-2017	
Natural Gas	0.102	16.83%	0.171	24.14%	0.075	8.52%	0.034	3.57%	0.050	5.05%
Coal	0.062	9.55%	-0.025	-3.47%	-0.047	-6.83%	-0.035	-5.50%	-0.060	-9.98%
Petroleum	0.145	16.48%	0.651	63.73%	-1.150	-68.76%	1.034	197.82%	0.310	19.92%
Wood	0.000	0.00%	0.000	2.65%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Totals	**0.308**	**14.47%**	**0.798**	**32.70%**	**-1.122**	**-34.64%**	**1.033**	**48.80%**	**0.300**	**9.52%**

5.3.2 Industry Emissions from Industrial Processes

Industrial process sub-sector GHG emissions were estimated to be 2.112 MMTCO2e in 2017. Figure 5-6 illustrates individual industrial process sub-sector GHG emissions in Nevada for 1990 through 2017 and Table 5-6 lists individual industrial process sub-sector GHG emissions in Nevada for select years. As Nevada's population and economy grows, industrial process emissions have continued to grow with it. There is no immediate substitute for the final products — cement, lime, and air conditioning and refrigeration — of these industrial processes nor for the ways in which these materials are processed/produced. Until there is, emissions are expected to continue to increase in Nevada and across the country.

Figure 5-7: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, 1990-2017 (MMTCO2e)

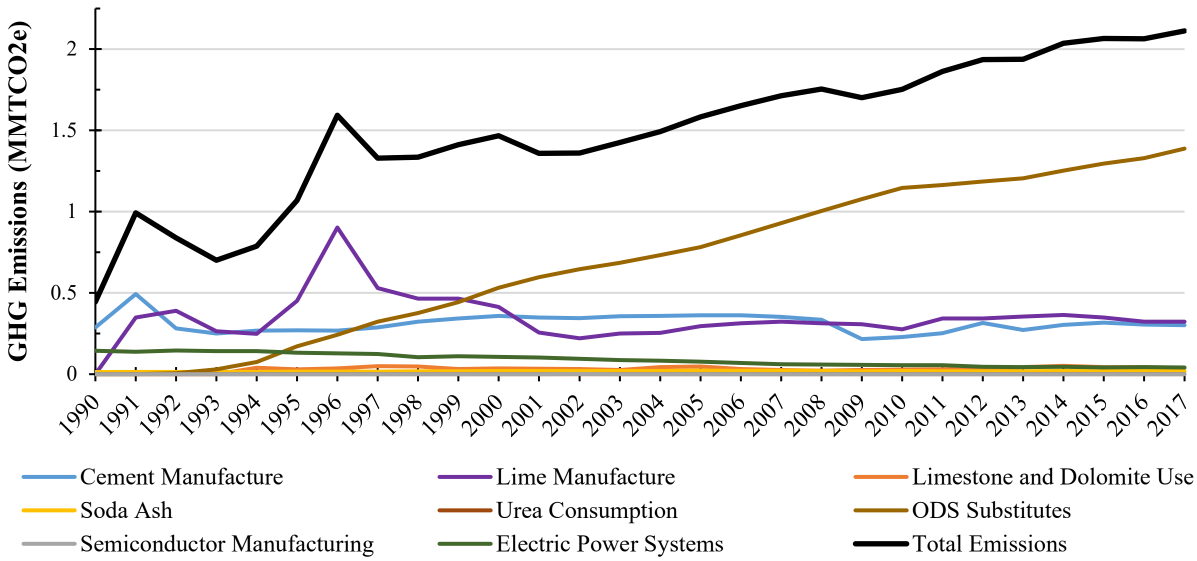


Table 5-6: Industrial Process Sub-Sector GHG Emissions in Nevada by Process, Select Years (MMTCO2e)

Process	1990	1995	2000	2005	2010	2014	2015	2016	2017
Cement Manufacture	0.288	0.270	0.359	0.362	0.229	0.304	0.316	0.306	0.302
Lime Manufacture	0.000	0.451	0.414	0.295	0.276	0.365	0.350	0.323	0.323
Limestone and Dolomite Use	0.000	0.029	0.036	0.047	0.027	0.051	0.044	0.044	0.040
Soda Ash	0.013	0.016	0.019	0.021	0.019	0.019	0.018	0.019	0.019
Urea Consumption	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ODS Substitutes	0.001	0.187	0.585	0.881	1.303	1.430	1.489	1.521	1.536
Aerosols	*0.000*	*0.053*	*0.085*	*0.079*	*0.134*	*0.166*	*0.174*	*0.162*	*0.151*
Fire Extinguishers	*0.000*	*0.000*	*0.001*	*0.003*	*0.005*	*0.007*	*0.008*	*0.008*	*0.009*
Foams	*0.000*	*0.000*	*0.002*	*0.012*	*0.042*	*0.057*	*0.062*	*0.064*	*0.064*
Refrigerators and Air Conditioners	*0.000*	*0.124*	*0.464*	*0.729*	*1.034*	*1.089*	*1.121*	*1.150*	*1.167*
*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*	*0.059*	*0.087*	*0.111*	*0.125*	*0.136*	*0.146*
Semiconductor Manufacturing	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Electric Power Transmission and Distribution Systems	0.144	0.131	0.106	0.076	0.055	0.045	0.042	0.043	0.041
Total Emissions	**0.446**	**1.085**	**1.520**	**1.682**	**1.909**	**2.215**	**2.259**	**2.256**	**2.260**

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

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 2012 through 2017.

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

Process	2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017	
Cement Manufacture	-0.044	-13.96%	0.033	12.03%	0.012	4.03%	-0.010	-3.26%	-0.004	-1.44%
Lime Manufacture	0.012	3.39%	0.010	2.86%	-0.015	-4.14%	-0.027	-7.66%	0.000	0.00%
Limestone and Dolomite Use	0.018	68.60%	0.007	15.93%	-0.008	-15.42%	0.001	2.12%	-0.005	-10.41%
Soda Ash	0.000	1.45%	0.000	1.76%	0.000	-2.55%	0.001	3.81%	-0.001	-2.96%
Urea Consumption	0.000	-2.22%	0.000	29.75%	0.000	-15.98%	0.000	0.16%	0.000	-1.77%
ODS Substitutes	0.025	1.83%	0.052	3.76%	0.059	4.10%	0.032	2.12%	0.016	1.02%
Aerosols	*0.007*	*4.70%*	*0.009*	*5.51%*	*0.008*	*4.76%*	*-0.012*	*-6.84%*	*-0.011*	*-7.05%*
Fire Extinguishers	*0.001*	*8.87%*	*0.001*	*8.77%*	*0.001*	*8.53%*	*0.001*	*8.30%*	*0.001*	*8.03%*
Foams	*0.004*	*8.04%*	*0.004*	*7.97%*	*0.005*	*7.91%*	*0.003*	*4.09%*	*-0.001*	*-1.16%*
Refrigerators and Air Conditioners	*0.007*	*0.70%*	*0.032*	*3.00%*	*0.032*	*2.90%*	*0.029*	*2.62%*	*0.017*	*1.49%*
*Solvents**	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*
Other Applications	*0.006*	*5.96%*	*0.007*	*6.39%*	*0.014*	*12.63%*	*0.011*	*8.75%*	*0.010*	*7.29%*
Semiconductor Manufacturing	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Electric Power Transmission and Distribution Systems	-0.003	-5.63%	0.001	3.07%	-0.003	-5.66%	0.001	1.60%	-0.002	-3.93%
Totals	**0.008**	**0.38%**	**0.103**	**4.90%**	**0.045**	**2.02%**	**-0.003**	**-0.14%**	**0.004**	**0.19%**

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

5.3.3 Industry Emissions from Natural Gas and Oil Systems

Natural gas and oil systems sub-sector GHG emissions were estimated to be 0.981 MMTCO2e in 2017. Due to the absence of a coal industry in Nevada and the limited natural gas and oil production that does take place, fugitive emissions from natural gas and oil systems represent a small portion of total GHG emissions. Transmission and distribution of natural gas are the major sources of GHG emissions in this sub-sector. Nevada is both a net importer of natural gas (and oil) as well as a "throughway" for natural gas passing through Nevada from where it is produced to where it is used. Table 5-8 shows natural gas and oil systems sub-sector GHG emissions in Nevada by fuel type for select years and Table 5-9 shows the annual change in natural gas and oil systems GHG emissions by fuel type from 2012 through 2017.

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

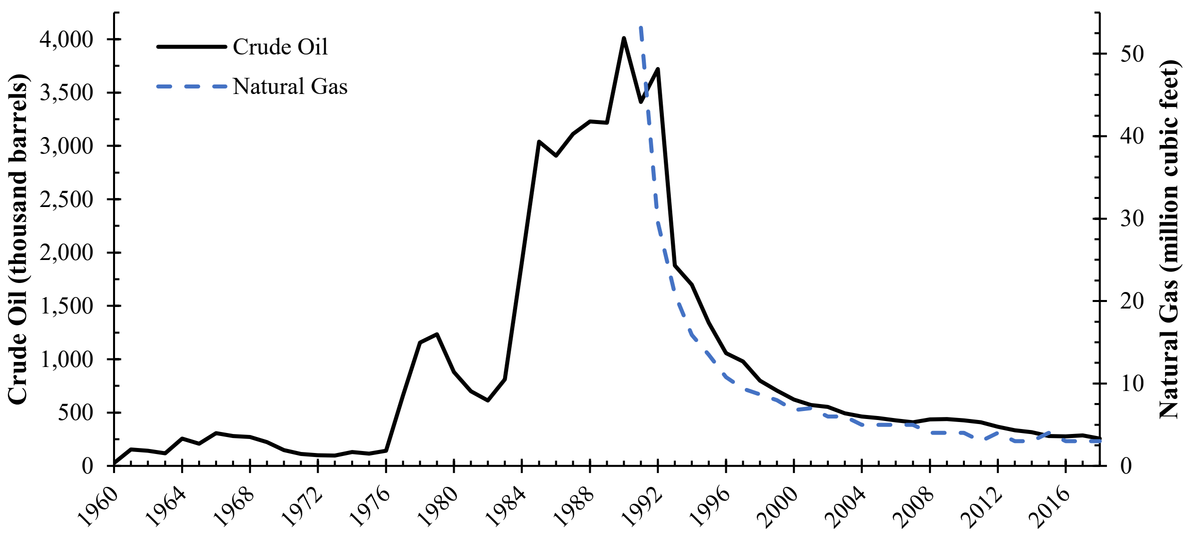
Fuel Type	1990	1995	2000	2005	2010	2014	2015	2016	2017
Natural Gas	0.409	0.532	0.656	0.821	0.872	0.960	0.966	0.977	0.977
Production	*0.000*	*0.000*	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Transmission	*0.231*	*0.291*	*0.321*	*0.396*	*0.371*	*0.448*	*0.448*	*0.456*	*0.450*
Distribution	*0.177*	*0.241*	*0.333*	*0.424*	*0.501*	*0.512*	*0.517*	*0.521*	*0.527*
Oil	0.065	0.022	0.011	0.008	0.007	0.004	0.003	0.003	0.003
Total Emissions	0.473	0.554	0.667	0.830	0.880	0.964	0.969	0.980	0.981

Table 5-9: Annual Change in Natural Gas and Oil Systems Sub-Sector GHG Emissions in Nevada by Fuel Type, 2012-2017 (MMTCO2e and Percent)

Fuel Type	2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017	
Natural Gas	0.007	0.78%	0.000	0.02%	0.006	0.62%	0.011	1.11%	0.000	0.04%
Production	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*	*0.000*	*0.00%*
Transmission	*0.005*	*1.21%*	*-0.002*	*-0.35%*	*0.001*	*0.15%*	*0.007*	*1.63%*	*-0.006*	*-1.24%*
Distribution	*0.002*	*0.40%*	*0.001*	*0.28%*	*0.005*	*1.04%*	*0.003*	*0.66%*	*0.006*	*1.17%*
Oil	-0.001	-10.82%	-0.001	-14.80%	-0.001	-17.07%	0.000	2.60%	0.000	0.05%
Totals	**0.007**	**0.71%**	**-0.001**	**-0.06%**	**0.005**	**0.55%**	**0.011**	**1.12%**	**0.000**	**0.04%**

The production of natural gas and oil in Nevada peaked in the early 1990's. Natural Gas production peaked in 1991, the EIA's first year of recorded commercial production estimates, at 53 million cubic feet and oil production in Nevada peaked in 1990 when the state produced just more than 4 million barrels. From 2011 through 2017 production in the industry has been relatively stagnant with natural gas production averaging roughly 9,300 cubic feet per day and oil production averaging roughly 936 barrels per day. Figure 5-7 shows EIA historical production estimates of natural gas and oil in Nevada from 1960 through 2018.[83]

Figure 5-8: EIA Historical Natural Gas and Oil Production Estimates for Nevada, 1960-2018



5.4 Projected Emissions, 2018-2040

Industry GHG emissions in Nevada — given pre-COVID data — are projected to continue to increase through 2040 with emissions in 2025 projected to be 6.602 MMTCO2e, emissions in 2030 projected to be 6.828 MMTCO2e, and emissions in 2040 projected to reach 7.133 MMTCO2e. Figure 5-8 illustrates industry GHG emissions projections in Nevada by GHG from 2018 through 2040. Figure 5-9 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.

[83] U.S. Energy Information Administration State Energy Data System [accessed 2020 Oct 20]. https://www.eia.gov/state/seds/

It's also important to note the uncertainty surrounding future natural gas and oil systems emissions. While a relatively minor source of GHG emissions in Nevada, with projections from the sub-sector staying between 1 and 1.1 MMTCO2e from 2018 through 2040 (Figure 5-9), the projections provided in this report depend on the EIA AEO, which assumes the 2012 and 2016 air quality new source performance standards (NSPS) for natural gas and oil systems will remain in effect; which, when finalized, were intended to reduce leakage of CH_4 and other GHGs in the oil and gas industry through better maintenance practices. The EPA finalized a rollback of these standards in September 2020.[84] This will result in an increase of GHG emissions in the sub-sector and in Nevada.

Figure 5-9: Industry GHG Emissions Projections in Nevada by GHG, 2018-2040

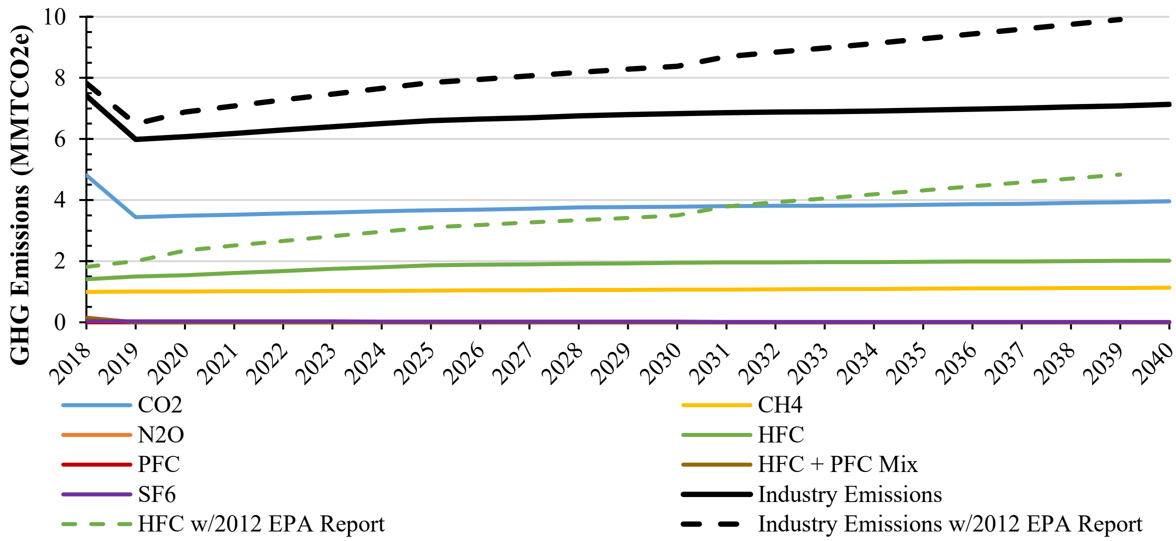
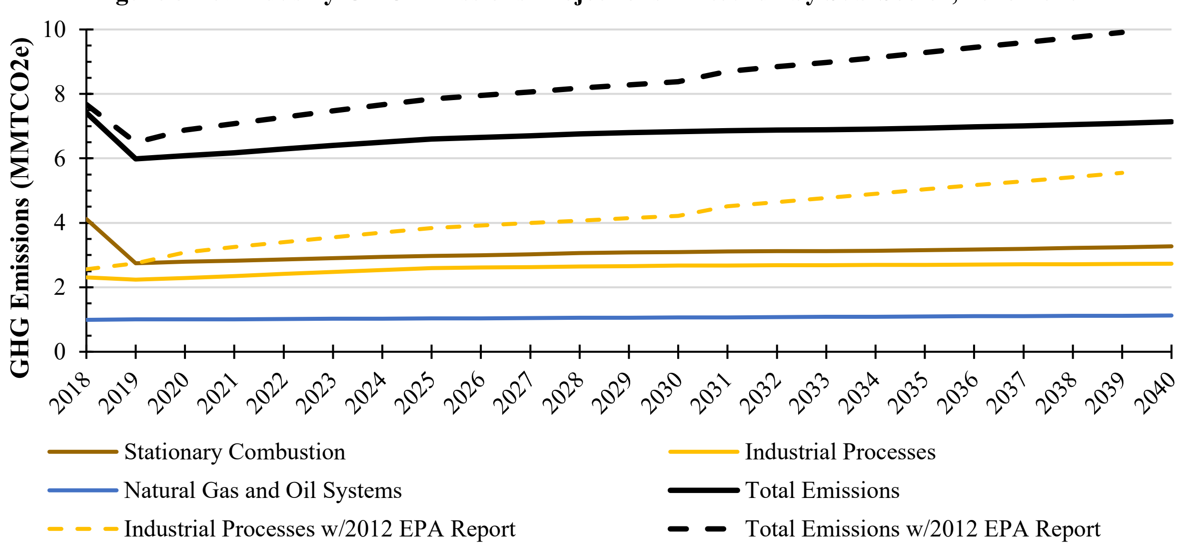


Figure 5-10: Industry GHG Emissions Projections in Nevada by Sub-Sector, 2018-2040



[84] U.S. Environmental Protection Agency. Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review. Federal Register. 2020 Sep 24; Vol. 85, No. 178, Rule, 57018. [accessed 2020 December 22]. https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-industry/epa-issues-final-policy-and-technical

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

NDEP references the reader to the following sections of the recently released *2020 State Climate Strategy* which includes further review of candidate policies from the NDEP's 2019 report:

- Climate Mitigation Policies: Lead by Example[85]
- Climate Mitigation Policy Analysis[86]
- Complex Climate Challenges for Nevada[87]

The following list references the initial identification of policies that could reduce Nevada's GHG emissions as included in the NDEP's 2019 report. A star symbol (*) preceding the policy name identifies those policies that were further analyzed in the *2020 State Climate Strategy*[88].

6.1 Transportation

<u>*Vehicle Emission Standards</u>

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

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

<u>Reduction of Vehicle Miles Travelled</u>

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

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

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

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85 https://climateaction.nv.gov/policies/lead-by-example/
86 https://climateaction.nv.gov/policies/policy-menu/
87 https://climateaction.nv.gov/policies/complex-challenges/
88 https://climateaction.nv.gov/policies/ndep-policies/

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

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

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

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

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

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

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

*<u>Exemption from Emissions Inspection for Certain Motor Vehicles</u>
Adopt one or more of the changes to the special license plate program that were recommended by the Advisory Committee on the Control of Emissions from Motor Vehicles in 2016 in order to require motor vehicles that would not normally be considered classic vehicles, but nevertheless meet the statutory requirements necessary to obtain special license plates (Classic Vehicles, Classic Rods, or Old Timer), to be treated in a manner similar to other motor vehicles in Nevada.[89,90] The recommendations included in the 2016 study were made in consideration of preserving the interests of owners of legitimate classic vehicles.

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

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

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

Provide outreach and education on the benefits of ZEV ownership.

Promote existing ZEV incentives and rebate programs.

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

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

6.2 Electricity Generation

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

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

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

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

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

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

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

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

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

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

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

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

6.3 Industry

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

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

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

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

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

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

6.4 Residential and Commercial

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

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

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

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

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

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

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

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

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

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

*Evaluate the effectiveness of adopting a statewide Residential PACE program.

*Reduce or Eliminate Fossil Fuel Use
Provide incentives for the conversion of fossil fuel dependent appliances to renewable energy sourced electric alternatives (examples include stoves, water heaters, and furnaces).

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

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

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

Infrastructure Improvements in Homes and Businesses to Facilitate Transition to Zero Emission Vehicles
Provide incentives for installation of charging infrastructures in existing facilities.

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

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

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

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

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

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

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

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

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

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

6.5 Waste

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

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

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

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

Promote or adopt practices that increase diversion of organic waste.

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

6.6 Agriculture

Agricultural Land Management Activities
Promote and provide incentives for the adoption of silvopasture practices.[91]

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

Promote practices to reduce emissions from enteric fermentation.

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

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

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

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

6.7 Land Use, Land Use Change, and Forestry

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

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

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

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

*Urban Forestry

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

Promote urban reforestation and management.

Adopt requirements for increased tree coverage when constructing residences and commercial buildings to increase canopy coverage and reduce heat-island effects in urban areas. Strictly enforced requirements will help reduce the urban-heat island effect as a driver of record-setting temperature increases in Las Vegas and Reno.[92,93]

Decrease Risk of Catastrophic Wildfire Events

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

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

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