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State of Washington

Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013

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Executive Summary

This report provides a summary of Washington's greenhouse gas emissions from the 1990 baseline through 2013. The information in this report is used to evaluate Washington's greenhouse gas emissions, where the emissions are coming from, and whether they are increasing or decreasing over time.

Key findings are:

- Washington's 2013 total greenhouse gas emissions were 94.4 million metric tons (MMT).
- Washington's 2013 total greenhouse gas emissions were 6 MMT higher than the 1990 baseline of 88.4 MMT.
- Washington's greenhouse gas emissions declined by about 2.8 percent from 2010 to 2013. However, 2013 greenhouse gas emissions increased by about 0.8 percent from 2012 levels.
- Compared to the nation, the electricity sector in Washington contributes significantly less due to the availability of hydropower.
- In 2013, Washington's largest contributors of greenhouse gases were:
    - Transportation sector at 42.8 percent.
    - Residential, commercial, and industrial sector at 22 percent.
    - Electricity sector at 19 percent.

Background Information

Greenhouse gases (GHGs) are substances that contribute to climate change by trapping heat in the atmosphere. The internationally-recognized greenhouse gases are:

- Carbon dioxide.
- Hydrofluorocarbons.
- Methane.
- Nitrogen trifluoride.
- Nitrous oxide.
- Perfluorocarbons.
- Sulfur hexafluoride.

Greenhouse gases are released during:

- *Stationary combustion*, which occurs at places that use equipment (such as boilers) to produce electricity, steam, heat, or power.
- *Mobile combustion*, which occurs when fuel is burned for transportation (such as in cars, trucks, ships, trains, and planes).
- *Industrial processes*, such as manufacturing cement, aluminum, ammonia, etc.
- *Fugitive releases* from the production, processing, transmission, or distribution of fossil fuels (such as methane emissions released via leakage and venting from pipelines)

Washington's greenhouse gas legislation

Passed in 2008, House Bill 2815 established limits for reducing greenhouse gas emissions in Washington, and included specific requirements for reporting greenhouse gas emissions. These reporting requirements are in RCW 70.235.020 (2):

> *By December 31st of each even-numbered year beginning in 2010, the department and the *department of community, trade, and economic development shall report to the governor and the appropriate committees of the senate and house of representatives the total emissions of greenhouse gases for the preceding two years, and totals in each major source sector…*
>
> * renamed Department of Commerce

Greenhouse gas emissions inventory

How the inventory was developed

To develop an inventory of Washington's greenhouse gas emissions, Ecology used a set of generally-accepted principles and made adjustments as needed to apply them to Washington. The inventory is based on aggregated data for each sector, not facility-specific emissions.

The data to develop this inventory is provided by U.S. Environmental Protection Agency's State Inventory and Projection Tool (SIT) designed specifically to help users develop State GHG inventories. Although the sector modules within SIT are updated periodically, the most recent data available is from 2013.

In addition, Washington State Department of Commerce annually provides greenhouse gas emissions for electricity calculated from fuel mix disclosure data.

Greenhouse gas sectors

Ecology categorized greenhouse gas emissions into the following sectors:

- Transportation.
- Electricity consumption.[1]
- Residential, commercial, and industrial.[2]
- Fossil fuel industry.[3]
- Waste management.
- Industrial processes.[4]
- Agriculture.

How greenhouse gas emissions are shown

In 1992, the United States signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC). Article 2 of the UNFCCC states:

> *…parties to the convention agreed develop, periodically update, and publish, national inventories of anthropogenic emissions. The emissions are to be reported by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies.*

The United States views EPA's national greenhouse gas inventory report as an opportunity to fulfill these commitments. The United States and other developed countries have also agreed to

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[1] Electricity consumption – greenhouse gas emissions associated with Washington's electricity demand
[2] Residential, commercial, and industrial - greenhouse gas emissions from fuels combusted to primarily produce space heating and/or process heating
[3] Fossil fuel industry – greenhouse gas emissions known as fugitive emissions from leaking or venting in processing or distribution systems
[4] Industrial processes - non-combustion sources of greenhouse gas emissions from industrial processes

submit to the UNFCCC annual inventories starting with 2013 emission data, based on the use of Intergovernmental Panel on Climate Change (IPCC) Assessment Report 4 global warming potential values.[5] Washington follows this guidance and methodology to develop this annual greenhouse gas inventory.

Carbon dioxide equivalent: The emission inventory shows greenhouse gas emissions in million metric tons (MMT) of carbon dioxide equivalent (CO_2e). Using carbon dioxide equivalent as a measurement allows us to capture the cumulative impacts of all greenhouse gases in one number.

Global Warming Potential: Greenhouse gas emissions in this report use the global warming potential values from the Intergovernmental Panel on Climate Change's (IPCC) Assessment Report 4, the international authority on greenhouse gas emissions. A greenhouse gas global warming potential is the ratio of its heat-trapping ability to that of carbon dioxide. For example, the global warming potential of nitrous oxide is 298 because one metric ton of nitrous oxide has 298 times more ability to trap heat in the atmosphere than one metric ton of carbon dioxide.

Greenhouse gases included in the inventory

Washington's greenhouse gas emissions inventory includes the greenhouse gases also found in the U.S. Greenhouse Gas Emissions Inventory in Table 1. As stated previously, both inventories now use the global warming potential from the IPCC Assessment Report 4.[6]

Table 1: Global Warming Potential Factors for Greenhouse Gases

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
Hydrofluorocarbons (HFCs)	12 – 14,800
Perfluorocarbons (PFCs)	7,390 – 12,200
Sulfur hexafluoride (SF_6)	22,800
Nitrogen trifluoride (NF_3)	17,200

[5] http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Chapter-Executive-Summary.pdf
[6] This 2013 inventory is the first time that U.S. greenhouse gas emissions are reported using the Assessment Report 4 global warming potential values. https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Annex-6-Additional-Information.pdf

Findings: Inventory Results

As seen in Table 2, total greenhouse gas emissions for 2013 are estimated at 94.4 MMT CO_2e. This represents an approximate 0.8 MMT increase from 2012 greenhouse gas emissions.

Table 2: Washington State Total Annual GHG Emissions (MMT CO_2e)

Million Metric Tons CO_2e	1990	2010	2011	2012	2013
Electricity, Net Consumption-Based	**16.9**	**20.8**	**15.7**	**15.2**	**18.2**
Coal	16.8	15.83	12.80	12.10	13.34
Natural gas	0.1	4.84	2.80	3.00	4.81
Petroleum	0.0	0.10	0.10	0.10	0.07
Biomass and waste (CH_4 and N_2O)	0.0	0.01	0.01	0.01	0.01
Residential/Commercial/Industrial (RCI)	**18.6**	**19.7**	**21.1**	**20.7**	**21.0**
Coal	0.6	0.25	0.17	0.20	0.19
Natural gas	8.6	10.79	11.91	11.55	12.04
Oil	9.1	8.39	8.73	8.64	8.47
Wood (CH_4 and N_2O)	0.2	0.30	0.30	0.30	0.31
Transportation	**37.5**	**42.1**	**41.9**	**42.5**	**40.4**
On-road gasoline	20.4	21.78	21.31	21.20	21.71
On-road diesel	4.1	7.97	7.99	7.38	7.01
Marine vessels	2.6	2.98	3.32	4.12	3.36
Jet fuel and aviation gasoline	9.1	8.11	7.62	8.02	6.57
Rail	0.8	0.53	0.97	0.97	0.86
Natural gas, LPG	0.6	0.69	0.64	0.76	0.84
Fossil Fuel Industry	**0.5**	**0.8**	**0.8**	**0.8**	**0.8**
Natural gas industry (CH_4)	0.5	0.81	0.81	0.82	0.83
Coal mining (CH_4)	0.0	0.00	0.00	0.00	0.00
Oil industry (CH_4)	0.0	0.00	0.00	0.00	0.00
Industrial Processes	**7.0**	**4.5**	**4.6**	**4.6**	**4.8**
Cement manufacture (CO_2)	0.2	0.28	0.25	0.26	0.33
Aluminum production (CO_2, PFC)	5.9	0.77	0.77	0.67	0.67
Limestone and dolomite use (CO_2)	0.0	0.00	0.00	0.00	0.01
Soda ash	0.1	0.05	0.05	0.05	0.05
ODS substitutes (HFC, PFC)	0.0	3.15	3.25	3.37	3.50
Semiconductor manufacturing (HFC, PFC, SF_6, NF_3)	0.0	0.05	0.07	0.06	0.06
Electric power T & D (SF_6)	0.8	0.17	0.17	0.14	0.13
Waste Management	**1.5**	**3.1**	**3.1**	**3.2**	**3.3**
Solid waste management	1.0	2.34	2.38	2.46	2.54
Wastewater management	0.5	0.75	0.76	0.77	0.78
Agriculture	**6.4**	**6.2**	**6.5**	**6.6**	**5.9**
Enteric fermentation	2.0	2.33	2.42	2.47	2.29
Manure management	0.7	1.27	1.30	1.34	1.34
Agriculture soils	3.7	2.59	2.73	2.81	2.28
Total Gross Emissions	**88.4**	**97.2**[7]	**93.7**	**93.6**	**94.4**

[7] Data variability from previous reports primarily due to revised GWPs released in IPCC's AR4.

Washington's Greenhouse Gas Emissions Trends

Trends by sector, 1990 – 2013

Figure 1 shows greenhouse gas emissions from 1990 to 2013 by sector. There was a significant decrease in emissions between 2000 and 2002, mainly due to changes in the aluminum industry in Washington. Due to an error in the EPA State Inventory Tool module for Washington aluminum emissions, these emissions starting in 2008 have been adjusted.[8] This data variation is also reflected in the reported total annual emissions.

Total greenhouse gas emissions in 2013 were 94.4 MMT CO_2e, compared to 93.6 MMT CO_2e for 2012.

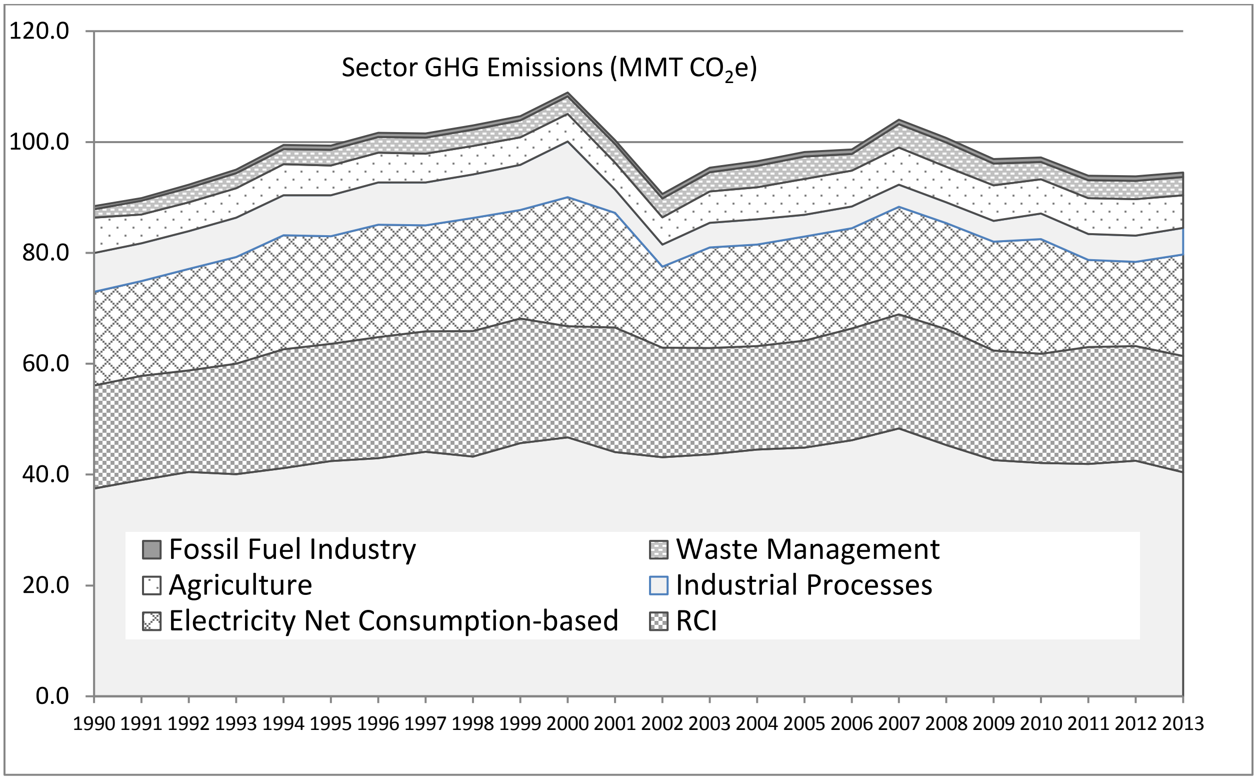

Figure 1: Total Annual Greenhouse Gas Emissions (MMT CO_2e) by Sector from 1990 – 2013

[8] The SIT module develops an estimate of aluminum emissions. This is calculated using a ratio of state capacity to total production. The state capacity was wrong because the capacity of a Washington facility had been left out.

Trends by sector, 2010 – 2013

Figure 2 compares total 2010 – 2013 greenhouse gas emissions from the electricity, residential, commercial, and industrial (RCI), and transportation sectors.

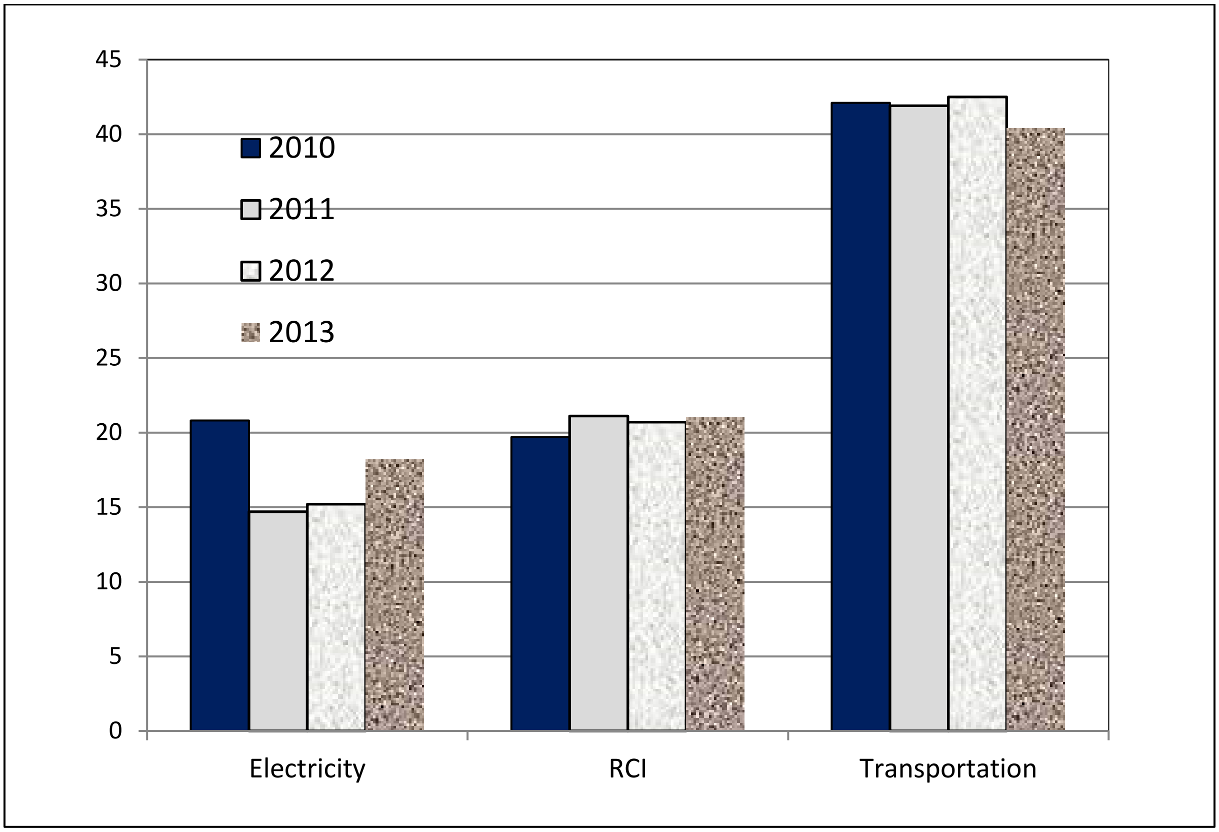

Figure 2: Total Greenhouse Gas Emissions (MMT Co_2e) by Sector for 2010 – 2013

Trends by sector, Washington and U.S.

Nationally, the electricity sector is the largest contributor of greenhouse gases (Figure 3). Since Washington uses hydropower for much of its electricity, the electricity sector is less significant in Washington. The transportation sector is Washington's most significant contributor of greenhouse gases.

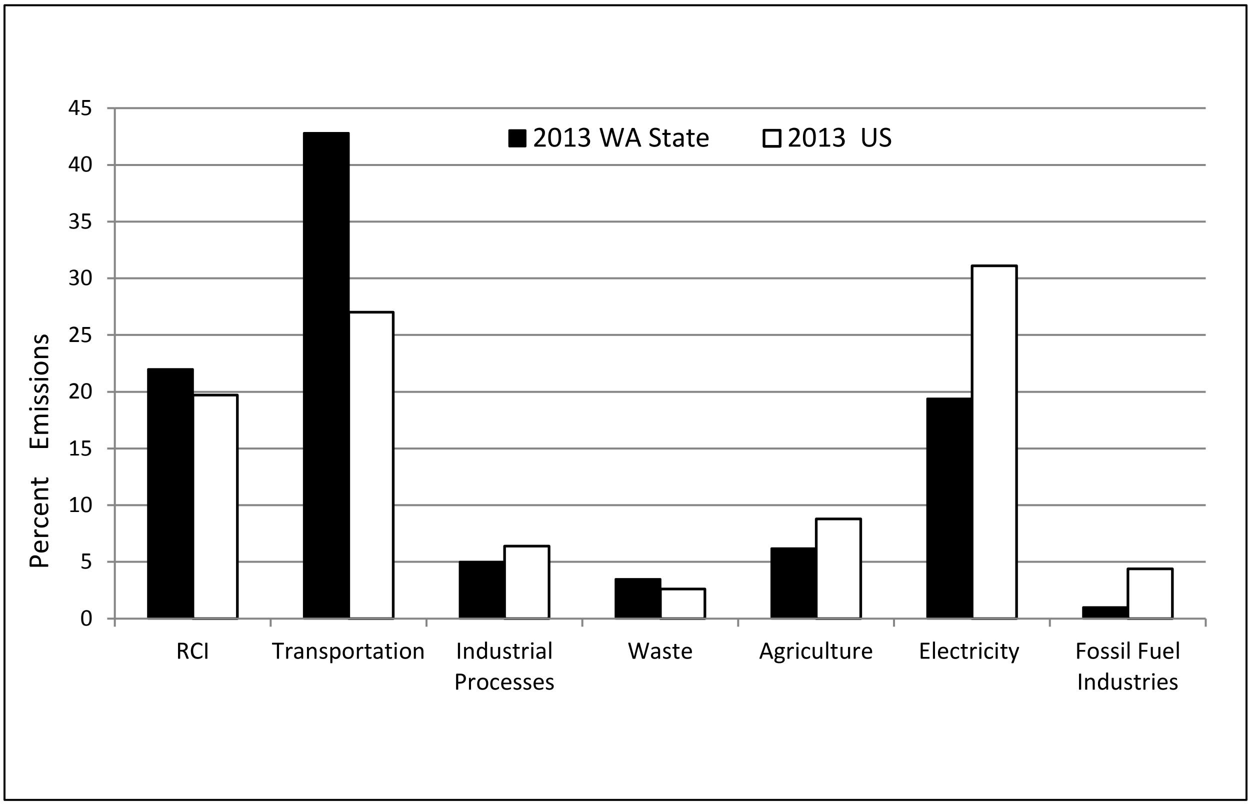

Figure 3: Percent Greenhouse Gas Emissions by Sector – 2013, Washington and U.S.[9]

[9] Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2013, https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Main-Text.pdf, Table ES-2

Summary of results by sector

Transportation sector

Transportation is Washington's largest greenhouse gas emissions contributor, while electricity is the largest contributor nationally. However, on a per capita basis, Washington produces less on-road motor gasoline and diesel greenhouse gas emissions than the U.S. average (Table 3).

Washington greenhouse gas emissions from the transportation sector have been fairly constant for several years, with a slight decrease in aviation emissions.

Table 3: On-Road Greenhouse Gas Emissions Per Capita, 2013

2013	Population	MMT CO_2e Motor Gasoline	MMT CO_2e On-Road Diesel	MMT CO_2e On-Road Motor Gasoline	MMT CO_2e On-Road Diesel
U.S.	316,128,839[10]	1,097[11]	595	3.47	1.9
WA	6,971,406	21.7	7.0	3.11	1.0

[10] Population data: https://www.census.gov/popest/data/historical/2010s/vintage_2013/index.html Go to national tables, annual population estimates, American Fact Finder

[11] Annex 2.1 Table A-11: http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Annexes.pdf

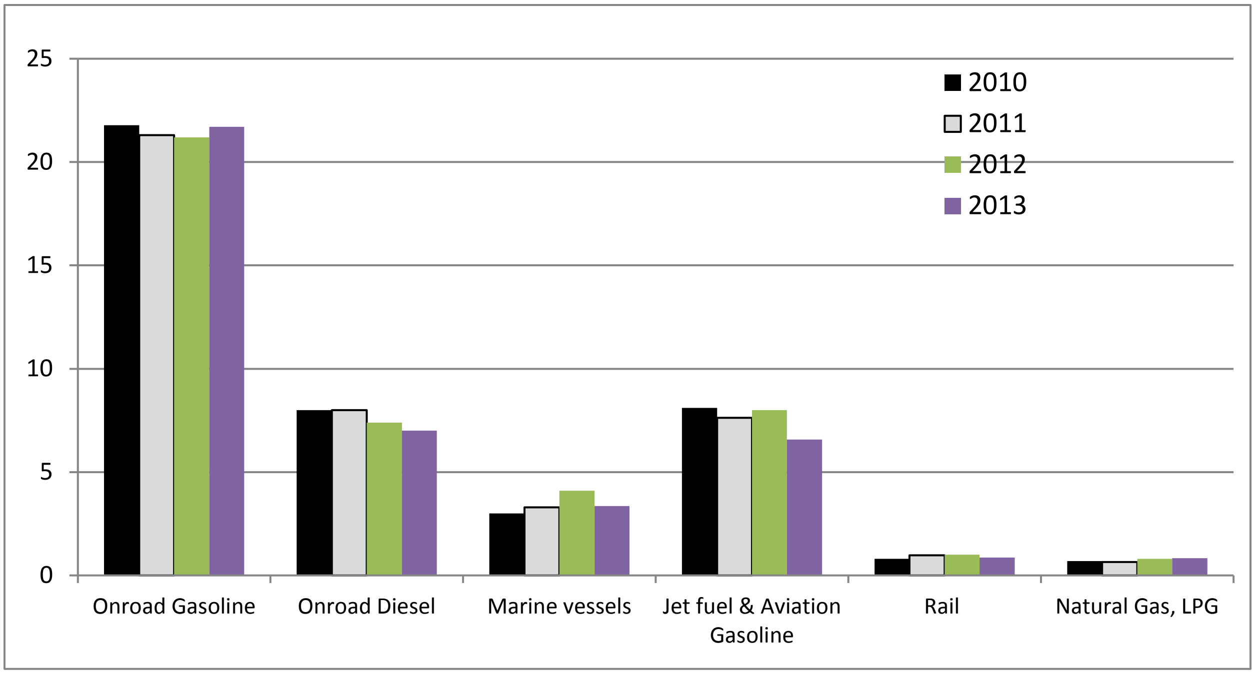

Figure 4: 2010 – 2013 Greenhouse Gas Emissions (MMT CO_2e) from the Transportation Sector

Electricity consumption-based sector

Despite the availability of hydroelectricity, Washington also uses electricity from coal and natural gas that is produced in Washington and imported from other states. Figure 1 shows Washington's greenhouse gas emissions from electricity on a consumption-based (or "load-based") approach. In other words, emissions are calculated based on sources that deliver electricity to Washington, regardless of where those sources are located.

Emissions have increased from 2012 to 2013 due to:

- Increase in natural gas and coal consumed to generate electricity.
- Less water available for hydro electricity production.

Residential, commercial, and industrial (RCI) sector

Greenhouse gas emissions from energy consumption in this sector occur when fuels are combusted to provide heat, including space heating and process heating (heating necessary for production processes or other applications).

This sector is another large source of greenhouse gas emissions in Washington. In 2013:

- 11.89 MMT CO_2e came from the industrial sector.
- 5.26 MMT CO_2e came from the residential sector.
- 3.84 MMT CO_2e came from the commercial sector.

Fossil fuel industry sector

This sector includes fugitive greenhouse gas emissions that are released during the production, processing, transmission, and distribution of fossil fuels. These emissions are typically fugitive methane due to leakage and venting from natural gas pipelines, petroleum systems, and coal mining.

In 2013, these emissions were about 0.8 percent of Washington's greenhouse gas emissions.

Waste management sector

This sector includes greenhouse gas emissions from landfills and wastewater treatment facilities. This inventory does not include waste exported from Washington to other states for disposal.

Washington's 2013 greenhouse gas emissions from this sector are estimated at 3.5 percent of the total emissions.

Industrial processes sector

This sector includes greenhouse gas emissions from industry-specific processes such as aluminum or cement manufacturing, or fugitive emissions such as sulfur hexafluoride (SF_6) releases from electric power transmission and distribution systems.

In 2013, greenhouse gas emissions from this sector contributed 5 percent of Washington's total greenhouse gas emissions.

Aluminum production is one of several industrial processes that release greenhouse gas emissions as a product of manufacturing the commodity and separate from the combustion of fuel. The historical emissions data for Washington State managed by EPA contained an error that was in 2008. Specifically, the EPA State Inventory Tool module develops an estimate of aluminum emissions. This estimate is calculated using a ratio of state production capacity to total production. The state capacity was wrong because the capacity of a Washington facility had been left out. This was corrected starting in 2008.

Washington's Mandatory Greenhouse Gas Reporting Program provided an estimate of annual nitrogen trifluoride emissions.

Washington produces small amounts of lime and nitric acid. Although these processes emit greenhouse gases, they are expected to have relatively low emissions due to their low levels of production. This greenhouse gas inventory excludes estimates for these processes.

Agriculture sector

Agricultural activities such as manure management, fertilizer use, and livestock digestion process (enteric fermentation) result in methane and nitrous oxide emissions.

In 2013, these emissions accounted for about 6.25 percent of Washington's greenhouse gas emissions.

Next Steps

An annual Washington greenhouse gas inventory will be completed for 2014 and 2015 as EPA releases the State Inventory Tool modules for these years. The next legislative report on Washington Greenhouse Gas Inventory will be issued in December 2018.

Conclusion

This inventory summarizes the greenhouse gas emissions from specific sectors in Washington from the 1990 baseline through 2013.

Key points are:

- Washington's 2013 total greenhouse gas emissions were 94.4 million metric tons (MMT).
- Washington's 2013 total greenhouse gas emissions were 6 MMT higher than the 1990 baseline of 88.4 MMT.
- Washington's greenhouse gas emissions declined by about 2.8 percent from 2010 to 2013. However, 2013 greenhouse gas emissions increased by 0.8 percent from 2012 levels.
- Compared to the nation, the electricity sector in Washington contributes significantly less because of the availability of hydropower.
- In 2013, Washington's largest contributors of greenhouse gases were:
    - Transportation sector at 42.8 percent.
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