Washington State Greenhouse Gas Emissions Inventory 2009-2010

December 2012
Publication no. 12-02-034 (Revised September 2013)

Publication and Contact Information

This report is available on the Department of Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/1202034.html .

For more information contact:

Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6600

Washington State Department of Ecology - www.ecy.wa.gov

o Headquarters, Olympia	360-407-6000
o Northwest Regional Office, Bellevue	425-649-7000
o Southwest Regional Office, Olympia	360-407-6300
o Central Regional Office, Yakima	509-575-2490
o Eastern Regional Office, Spokane	509-329-3400

f you need this document in a format for the visually impaired, call the Air Quality Program at 360-407-6800. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Washington State
Greenhouse Gas Emissions Inventory
2009-2010

by
Gail Sandlin

Air Quality Program
Washington State Department of Ecology
Olympia, Washington

Ecology is responsible for completing three legislatively-mandated reports related to greenhouse gases per state law. The reports are:

- *Washington State Greenhouse Gas Emissions Inventory 1990-2010* - This report provides a summary of Washington's greenhouse gas emissions for the years 1990, 2000, and 2005 through 2010. The information in this report shows where Washington's greenhouse gas emissions are coming from by economic sector and whether they are increasing or decreasing over time. State law requires this report every two years.
- *Effectiveness of Chapter 80.80 Revised Code of Washington - Greenhouse Gas Emission Performance Standards* - The purpose of this report is to present the Department of Ecology's review of the law's need, applicability, and effectiveness. State law requires this report every five years.
- *Reducing Greenhouse Gas Emissions in Washington State Government* - The second biennial progress report on greenhouse gas emissions from state agency operations is required under the State Agency Climate Leadership Act. The report, required every two years, provides an update on the progress of about 120 state agencies in reducing GHG emissions. It summarizes:
    - State agency greenhouse gas emission levels for 2005, 2010, and 2011.
    - Actions taken by agencies since 2010 to reduce greenhouse gas emissions and meet the statutory greenhouse gas reduction targets.
    - Recommendations from agencies on budgetary and other incentives to help agencies meet their reduction targets.

Table of Contents

List of Figures and Tables vi
Figures vi
Tables vi
Background Information 1
Washington's Greenhouse Gas Legislation 1
Purpose of This Report 1
GHG Emission Inventory 2
How the inventory was developed 2
GHG sectors 2
How GHG emissions are shown 2
GHGs included in the inventory 3
Inventory results ..... **Error! Bookmark not defined.**
Washington's GHG Emissions Trends 5
Trends by sector, 1990-2010 5
Trends by sector, 2008-2010 6
Trends by sector, Washington and U.S. 7
Summary of Results by Sector 8
Transportation Sector 8
Electricity Consumption-Based Sector 10
Residential, Commercial and Industrial (RCI) Sector 10
Fossil Fuel Industry Sector 10
Waste Management Sector 10
Industrial Processes Sector 10
Agriculture Sector 11
Conclusions 12

List of Figures and Tables

Page

Figures

Figure 1: Total annual GHG emissions (MMt CO2e) by sector from 1990 – 2010 5
Figure 2: Total GHG emissions (MMt CO_2e) by Sector for 2008-2010 6
Figure 3: Percent GHG Emissions by Sector - 2010, Washington State and U.S. 7
Figure 4: 2008 & 2010 GHG Emissions (MMtCO_2e) from the Transportation Sector 8

Tables

Table 1: Global Warming Potential Factors for Greenhouse Gases 3
Table 2: Washington State Total Annual GHG Emissions (MMtCO_2e) 4
Table 3: On Road GHG Emissions Per Capita, 2010 7

Background Information

Greenhouse gases (GHGs) are substances that contribute to climate change by trapping heat in the atmosphere. There are six internationally-recognized greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and 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).
- "Production processes," such as the manufacturing of cement, aluminum, ammonia, etc.
- "Fugitive releases" from the production, processing, transmission, storage, or use of fuels and other substances that do not pass through a stack, chimney, vent, or exhaust pipe (for example, the release of sulfur hexafluoride from electrical equipment).

Washington's Greenhouse Gas Legislation

In 2008, the Washington Legislature enacted House Bill 2815. It established limits for reducing GHG emissions in Washington, and included specific requirements for reporting GHG emissions. These reporting requirements are in the Revised Code of Washington, 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…."

Purpose of This Report

This report provides a summary of Washington's greenhouse gas emissions for the years 1990, 2000, and 2005 through 2010. The information in this report will be used to evaluate Washington's greenhouse gas emissions to determine where the emissions are coming from and whether they are increasing or decreasing over time.

GHG Emission Inventory

How the inventory was developed

To develop an inventory of Washington's GHG emissions, Ecology used a set of generally-accepted principles and guidelines, and made adjustments as needed to apply them specifically to Washington.

GHG sectors

Ecology categorized GHG emissions into the following sectors:

- Transportation,
- Residential / Commercial and Industrial (RCI),
- Electricity Consumption,
- Industrial Processes,
- Agriculture,
- Waste Management, and
- the Fossil Fuel Industry.

How GHG emissions are shown

- **Carbon dioxide equivalent:** The emission inventory shows GHG emissions in million metric tons (MMt) of carbon dioxide equivalent (CO_2e). Using carbon dioxide equivalent as a measurement allows us to compare the global warming potential (GWP) of different GHGs more easily.

- **GWP:** A greenhouse gas GWP is the ratio of its heat-trapping ability to that of carbon dioxide. For example, the global warming potential of nitrous oxide is 310 because one metric ton of nitrous oxide has 310 times more ability to trap heat in the atmosphere than one metric ton of carbon dioxide.

GHGs included in the inventory

Washington's GHG emissions inventory includes the six greenhouse gases also found in the U.S. Greenhouse Gas Emissions Inventory. Both inventories use the GWPs from the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR). See Table 1.

Table 1: Global Warming Potential Factors for Greenhouse Gases

Greenhouse Gas	**Global Warming Potential**
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	12-11,700
Perfluorocarbons (PFCs)	6,500-9,200
Sulfur hexafluoride (SF_6).	23,900

Table 2: Washington State Total Annual GHG Emissions ($MMtCO_2e$)

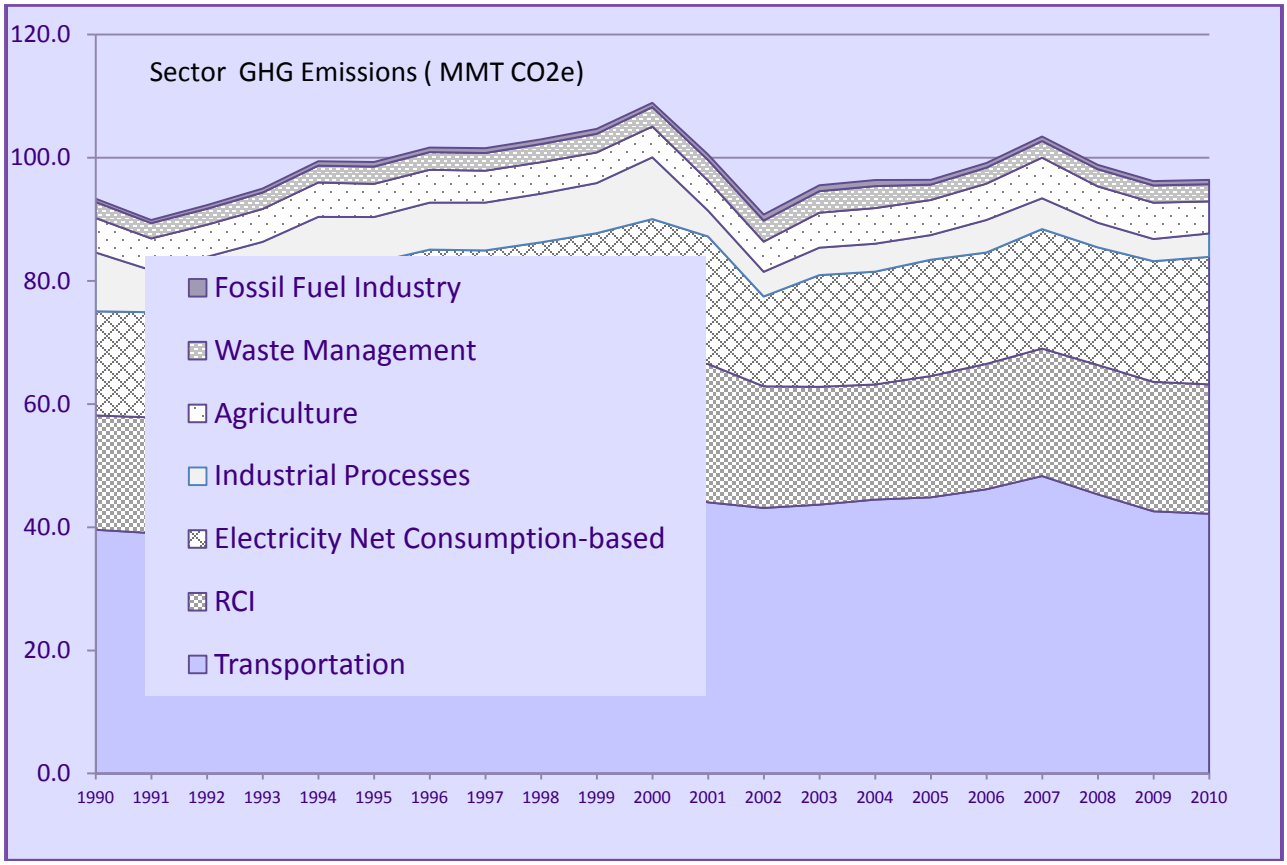
Million Metric Tons CO2e	1990	2005	2006	2007	2008	2009	2010
Electricity, Net Consumption-based	**16.9**	**18.8**	**18.1**	**19.4**	**19.1**	**19.6**	**20.7**
Coal	16.8	15.2	14.7	15.2	15.1	14.7	15.8
Natural Gas	0.1	3.6	3.3	4.1	3.9	4.8	4.8
Petroleum	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Biomass and Waste (CH4 and N2O)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential/Commercial/Industrial (RCI)	**18.6**	**19.3**	**20.2**	**20.6**	**20.9**	**19.8**	**19.7**
Coal	0.6	0.1	0.2	0.3	0.3	0.3	0.3
Natural Gas	8.6	10.3	10.7	11.2	11.7	11.4	10.8
Oil	9.1	8.7	9.1	8.9	8.7	7.9	8.4
Wood (CH4 and N2O)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Transportation	**37.5**	**44.0**	**45.6**	**47.6**	**45.2**	**42.6**	**42.2**
Onroad Gasoline	20.4	23.9	24.1	24.1	22.6	22.6	21.9
Onroad Diesel	4.1	7.1	9.2	9.4	9.6	8.2	8.0
Marine Vessels	2.6	3.3	3.0	3.8	3.0	2.9	3.0
Jet Fuel and Aviation Gasoline	9.1	7.7	7.7	8.5	8.5	7.7	8.1
Rail	0.8	1.3	1.0	1.1	0.8	0.6	0.5
Natural Gas, LPG	0.6	0.7	0.6	0.7	0.7	0.6	0.7
Fossil Fuel Industry	**0.5**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**
Natural Gas Industry(CH4)	0.5	0.7	0.7	0.7	0.7	0.7	0.7
Coal Mining (CH4)	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Oil Industry (CH4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industrial Processes	**7.0**	**3.8**	**3.9**	**4.0**	**3.9**	**3.6**	**3.8**
Cement Manufacture (CO2)	0.2	0.4	0.5	0.5	0.3	0.3	0.3
Aluminum Production (CO2, PFC)	5.9	0.8	0.7	0.8	0.9	0.5	0.5
Limestone and Dolomite Use (CO2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soda Ash	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ODS Substitutes (HFC, PFC and SF6)	0.0	2.1	2.2	2.2	2.2	2.3	2.5
Semiconductor Manufacturing (HFC, PFC, SF6)	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Electric Power T&D (SF6)	0.8	0.3	0.3	0.3	0.3	0.3	0.3
Waste Management	**1.5**	**2.5**	**2.6**	**2.7**	**2.8**	**2.8**	**3.8**
Solid Waste Management	1.0	1.9	2.0	2.0	2.1	2.1	3.1
Wastewater Management	0.5	0.6	0.7	0.7	0.7	0.7	0.7
Agriculture	**6.4**	**5.7**	**5.9**	**6.6**	**5.9**	**5.9**	**5.2**
Enteric Fermentation	2.0	2.1	2.1	2.2	2.1	2.1	2.0
Manure Management	0.7	1.1	1.1	1.1	1.1	1.1	1.1
Agriculture Soils	3.7	2.5	2.7	3.3	2.7	2.7	2.1
Total Gross Emissions	**88.4**	**94.9**	**98.0**	**101.6**	**98.5**	**95.0**	**96.1**

Washington's GHG Emissions Trends

Trends by sector, 1990-2010

Figure 1 shows greenhouse gas emissions from 1990 to 2010 by sector. There is a significant decrease in emissions occurring between 2000 and 2002, mainly due to changes in the aluminum industry in Washington.

Figure 1: Total annual GHG emissions (MMt CO2e) by sector from 1990 – 2010

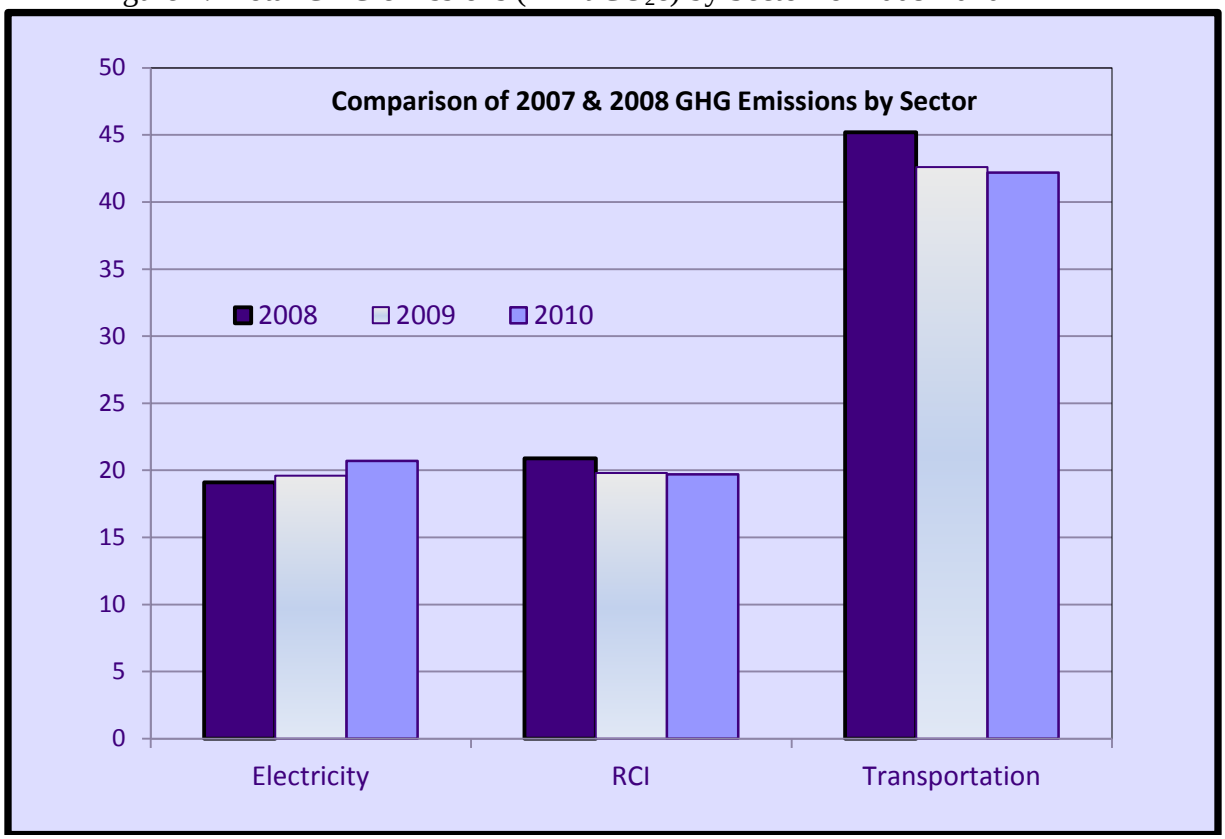


Total GHG emissions in 2009 were 95.0 MMt CO_2e, compared to 96.1 MMt CO_2e for 2010.

Trends by sector, 2008-2010

Figure 2 compares total 2008, 2009 and 2010 GHG emissions from the Electricity, RCI and Transportation Sectors. The most significant change is a 6.6 percent decrease in emissions from the Transportation Sector.

Figure 2: Total GHG emissions (MMt CO_2e) by Sector for 2008-2010

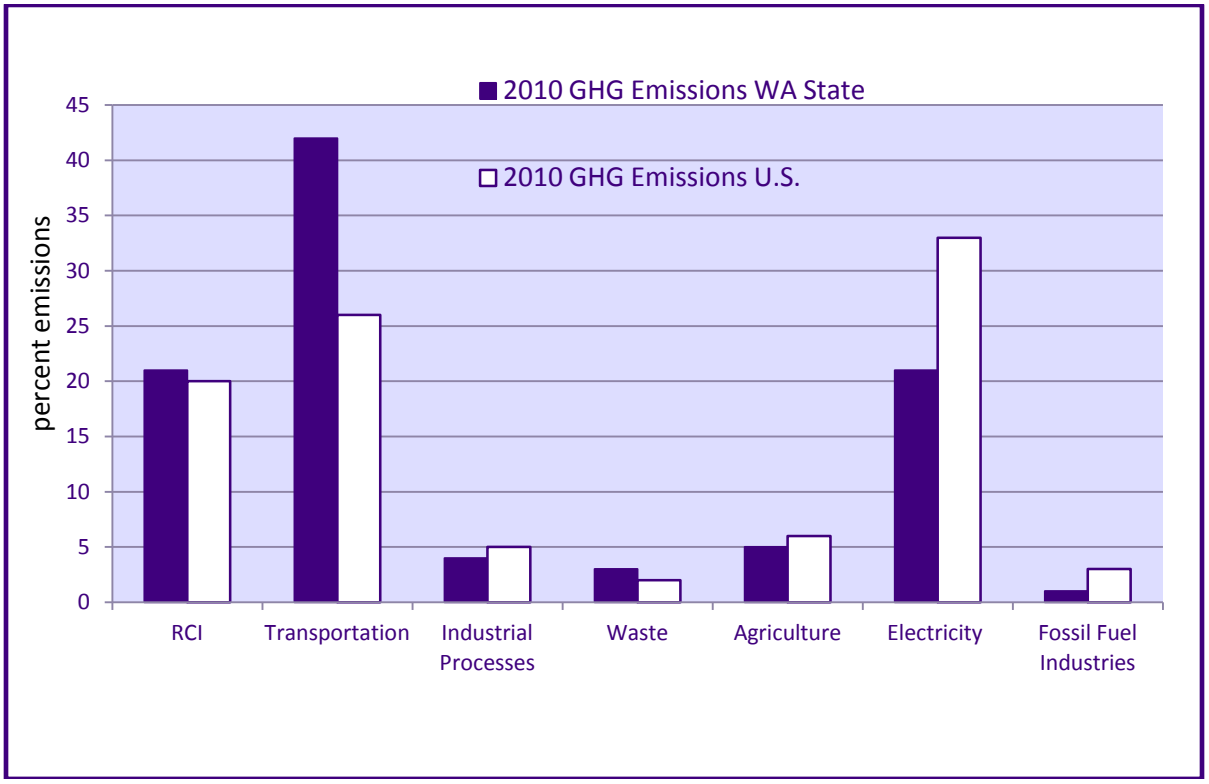


Trends by sector, Washington and U.S.

On a national scale, the Electricity Sector is the largest contributor to greenhouse gases (see Figure 3). Because 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.

It is also important to note that Washington's GHG emissions per capita are significantly lower than U.S. emissions per capita. Washington's 2010 per capita emissions are 14.2 Mt CO_2e, while U.S. per capita emissions are 22.1 Mt CO_2e.

Figure 3: Percent GHG Emissions by Sector - 2010, Washington State and U.S.



Summary of Results by Sector

Transportation Sector

As stated previously, transportation is Washington's largest GHG emissions contributor, while electricity is the largest contributor for the U.S. as a whole. However, on a per capita basis, Washington produces slightly less on-road motor gasoline GHG emissions as the US average (see Table 3). Per capita on-road diesel emissions for 2010 were also slightly less for Washington as compared to the U.S. average.

Table 3: On Road GHG Emissions, 2010

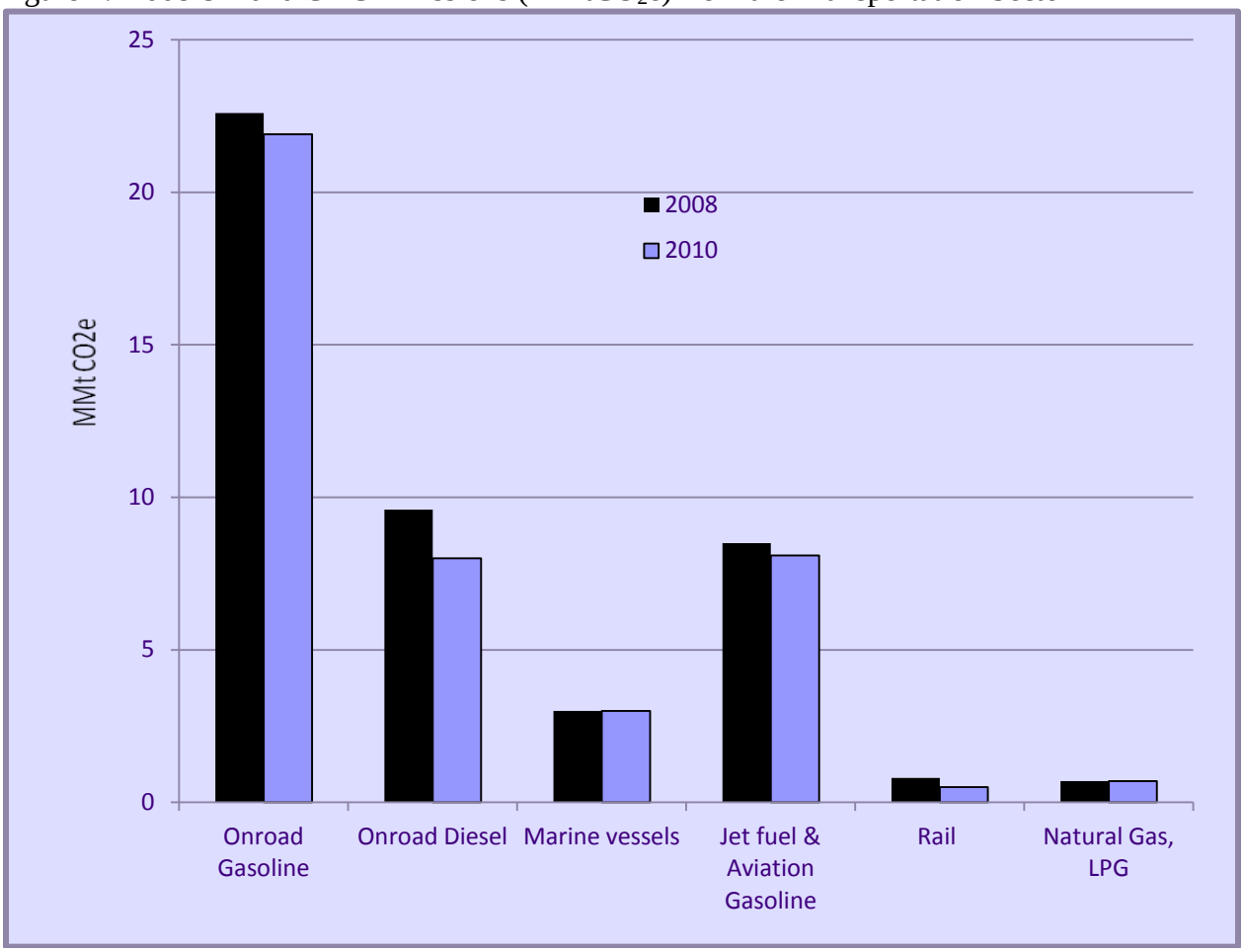
2010	Population	MMt CO_2e Motor Gasoline	MMtCO2e On road Diesel	Mt CO_2e On Road Motor Gasoline per capita	Mt CO_2e On Road Diesel per capita
US	308,745,538	1,110*	414.5	3.6	1.3
WA state	6,724,540	21.8	8.0	3.2	1.2

* http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html Annex 3

Washington's most significant decrease in GHG emissions from 2008 to 2010 was in the Transportation Sector. This decrease was specifically from on-road gasoline, on-road diesel, and jet fuel (see Figure 4). According to the recent EPA inventory report, on a national level "the more recent trend for transportation has shown a general decline in emissions, due to recent slow growth in economic activity, higher fuel prices, and an associated decrease in the demand for passenger transportation"[1]. Decreases in GHG emissions from the transportation sector in Washington State seem to align with this national trend.

[1] Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2011, EPA 430-R-13-001, Pg ES-11 http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf

Figure 4: 2008 & 2010 GHG Emissions ($MMtCO_2e$) from the Transportation Sector



Electricity Consumption-Based Sector

Despite the availability of hydroelectricity, Washingtonians also use electricity from coal and natural gas that is both produced in Washington and imported from other states.
Figure 1 shows Washington's GHG emissions from electricity on a consumption-based (or "load-based") approach (emissions of sources that deliver electricity to Washington consumers, regardless of where those sources are located). The 2010 increase in emissions from coal is due to drought conditions thus less hydro electricity available. This is reversed in 2011 with a 19% reduction of greenhouse gas emissions from consumed coal-produced electricity.

Residential, Commercial and Industrial (RCI) Sector

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

This sector is another large source of greenhouse gas emissions in Washington. In 2010, 10.4 MMt CO_2e came from the Industrial Sector, 5.1 MMt CO_2e came from the Residential Sector, and 3.8 MMt CO_2e came from the Commercial Sector.

Fossil Fuel Industry Sector

This sector includes fugitive GHG 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 2010, these emissions were about 0.7 % of Washington's GHG emissions. This is no change from 2009 emissions.

Waste Management Sector

This sector includes GHG emissions from landfills and wastewater treatment facilities.

Washington's 2010 GHG emissions from this sector are estimated at 3.8 MMt. This inventory does not include waste exported from Washington to other states for disposal.

Industrial Processes Sector

This sector includes GHG emissions from industry-specific processes such as aluminum or cement manufacturing; or fugitive emissions such as sulfur hexafluoride (SF6) releases from Electric Power Transmission and Distribution systems.

GHG emissions from this sector contributed 4.0 % of Washington's total GHG emissions in 2010.

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

Future mandatory reporting of GHG emissions from this sector will provide more complete information.

Agriculture Sector

Agricultural activities such as manure management, fertilizer use, and livestock (enteric fermentation) result in methane and nitrous oxide emissions. These emissions accounted for ~ 5.5 % of Washington‘s GHG emissions in 2010. This is a slight decrease from 2009 emissions.

Conclusions

This inventory summarizes the greenhouse gas emissions from specific sectors in Washington from 1990 to 2010. Key points are:

- There is a noticeable decreasing trend since 2007 in greenhouse gas emissions (Figure 1)
- The Transportation Sector has been the largest contributor of GHG's in Washington, and in 2010 accounted for 44% of the total statewide emissions.
- The RCI and Electricity Sectors accounted for 21 percent and 21.5 percent of statewide GHG emissions, respectively.
- Compared to the nationwide GHG emissions inventory, emissions from the Electricity Sector in Washington are significantly less due to the availability of hydropower.

One of the purposes of the Washington State GHG inventory is to evaluate emissions trends from the various sectors. Future methodology improvements and data from the mandatory GHG reporting requirements will improve our understanding of Washington State GHG emissions sources and trends.