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State of Washington

Washington State Greenhouse Gas Emissions Inventory 2010 – 2011

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This report is available on Ecology's website at www.ecy.wa.gov.

For more information, contact:

Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-6800

For special accommodations or documents in alternate format, call (360) 407-6800, 711 (relay service), or 877-833-6341 (TTY).

Washington State
Greenhouse Gas Emissions Inventory
2010 – 2011

by
Hedia Adelsman

Air Quality Program
Washington State Department of Ecology
Olympia, Washington

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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:** Occurs at places that use equipment like boilers to produce electricity, steam, heat, or power.
- **Mobile combustion:** When fuel is burned for transportation (i.e., cars, trucks, ships, trains, and planes).
- **Industrial processes:** Manufacturing of cement, aluminum, ammonia, etc.
- **Fugitive releases:** The production, processing, transmission, storage, or use of fuels and other substances that do not pass through a stack, chimney, vent, or exhaust pipe (i.e., the release of sulfur hexafluoride from electrical equipment).

Purpose of This Report

This report tracks the statewide annual greenhouse gas emissions by source and economic sector for the years 1990, and 2007 through 2011. It is submitted in accordance with the requirements 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…."

This report is an inventory of statewide greenhouse gas emissions. It provides a summary of historical greenhouse gas emissions for Washington. The information is used to analyze the trends in total statewide emissions of greenhouse gases and totals in each major sector. The inventory shows where emissions come from and whether they are increasing or decreasing over time.

***the** "department of community, trade, and economic development" was renamed the department of commerce

Greenhouse Gas Emission Inventory

How the inventory was developed

The inventory of Washington's greenhouse gas (GHG) emissions was developed by Ecology using a set of generally-accepted principles and guidelines. Ecology used the U.S. Environmental Protection Agency (EPA) State Inventory Tool (SIT)[1] and relied on Washington-specific data and input (i.e., for the electricity sector used the fuel mix disclosure data[2] provided by utilities to the Department of Commerce) and made modifications as needed.

The inventory estimated greenhouse gas emissions for the following sectors:

- Electricity consumption.
- Residential / Commercial and industrial (RCI).
- Transportation.
- Fossil Fuel Industry.
- Industrial processes.
- Waste management.
- Agriculture.

Since 2010 a number of large facilities in Washington have been reporting their emissions to both EPA and to Ecology. In addition, in 2011 smaller emitters began reporting their emissions just to Ecology. The information can be accessed through Ecology[3] or EPA websites.[4]

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 capture the cumulative impacts of all GHGs on the atmosphere in one number.

Greenhouse Gases included in the inventory

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

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[1] EPA's State Inventory Tool (SIT) is an interactive spreadsheet model designed to help states develop GHG emissions inventories, and provides a streamlined way to update an existing inventory or complete a new inventory.
[2] Beginning in 2000, Washington state began tracking the electricity sold to Washington consumers as a result of the Fuel Mix Disclosure Law, RCW 19.29A
http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/FuelMix.aspx
[3] http://www.ecy.wa.gov/programs/air/permit_register/ghg/ghg.html
[4] http://ghgdata.epa.gov/ghgp/main.do

This methodology follows the United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change Guidelines. The United Nations recently approved the use of the Fifth Assessment Report (AR5) Global Warming Potentials for national inventories, therefore, future inventory publications will use the AR5 Global Warming Potentials [5]

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

Global Warming Potential (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.

Inventory results

Table 2 provides a summary of historical GHG emissions for the years with published inventories[6]; 1990, 2007, 2008, 2009, 2010 and 2011. The information provides total statewide emissions, and emissions for sources.

Washington's total GHG emissions, while they fluctuate on a yearly basis, overall they are on a downward trend. The fluctuation is associated in large part with the electricity sector emissions and changes in state's hydropower output. For example, in 2011 the total emissions dropped by 3.8 % relative to 2010. In 2010 the state experienced a drought, which required utilities to purchase more coal and natural gas power (30 % in 2010 versus 20 % in 2011) to replace lost hydropower (60% hydropower consumed in 2010 versus 73% consumed in 2011). Although the state made significant progress in reducing greenhouse gas emissions, the total emissions continue to grow. In 2011 the total emissions were about 5 % more than the 1990 level (Figure 2 and Figure 1).

[5] For the purpose of official submissions of national GHG inventories under the UNFCCC, Annex I Parties are required to use the GWP values provided by the IPCC in its Second Assessment Report (SAR) based on the effects of GHGs over a 100-year time horizon, because it was so decided by the Conference of the Parties at its 5th session (See the UNFCCC document FCCC/CP/1999/7 for details). For the submissions of national GHG inventories from 2015, Annex I Parties shall use the GWP values provided in Table 2.14 of the errata to the IPCC WGI contribution to the Fourth Assessment Report (AR4), based on the effects of GHGs over a 100-year time horizon (Decision 15/CP.17) http://www.ipcc-nggip.iges.or.jp/faq/faq.html

[6] See http://www.ecy.wa.gov/climatechange/ghg_inventory.htm

Table 2: Washington State Total Annual GHG Emissions ($MMtCO_2e$) [1]

Million Metric Tons CO2e	1990	2007	2008	2009	2010	2011
Electricity, Net Consumption-based	**16.9**	**19.4**	**19.1**	**19.6**	**20.7**	**15.7**
Coal	16.8	15.2	15.1	14.7	15.8	12.8
Natural Gas	0.1	4.1	3.9	4.8	4.8	2.8
Petroleum	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
Residential/Commercial/Industrial (RCI)	**18.6**	**20.6**	**20.9**	**19.8**	**19.7**	**20.8**
Coal	0.6	0.3	0.3	0.3	0.3	0.2
Natural Gas	8.6	11.2	11.7	11.4	10.8	11.9
Oil	9.1	8.9	8.7	7.9	8.4	8.7
Wood (CH4 and N2O)	0.2	0.2	0.2	0.2	0.2	0.2
Transportation	**37.5**	**47.6**	**45.2**	**42.6**	**42.2**	**41.9**
Onroad Gasoline	20.4	24.1	22.6	22.6	21.9	21.3
Onroad Diesel	4.1	9.4	9.6	8.2	8.0	8.0
Marine Vessels	2.6	3.8	3.0	2.9	3.0	3.3
Jet Fuel and Aviation Gasoline	9.1	8.5	8.5	7.7	8.1	7.6
Rail	0.8	1.1	0.8	0.6	0.5	1.0
Natural Gas, LPG	0.6	0.7	0.7	0.6	0.7	0.6
Fossil Fuel Industry	**0.5**	**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
Coal Mining (CH4)	0.0	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
Industrial Processes	**7.0**	**4.0**	**3.9**	**3.6**	**3.8**	**3.7**
Cement Manufacture (CO2)	0.2	0.5	0.3	0.3	0.3	0.3
Aluminum Production (CO2, PFC)	5.9	0.8	0.9	0.5	0.5	0.5
Limestone and Dolomite Use (CO2)	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
ODS Substitutes (HFC, PFC and SF6)	0.0	2.2	2.2	2.3	2.5	2.6
Semiconductor Manufacturing (HFC, PFC, SF6)	0.0	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	0.2
Waste Management	**1.5**	**2.7**	**2.8**	**2.8**	**3.8**	**3.4**
Solid Waste Management	1.0	2.0	2.1	2.1	3.1	2.7
Wastewater Management	0.5	0.7	0.7	0.7	0.7	0.7
Agriculture	**6.4**	**6.6**	**5.9**	**5.9**	**5.2**	**5.5**
Enteric Fermentation	2.0	2.2	2.1	2.1	2.0	2.1
Manure Management	0.7	1.1	1.1	1.1	1.1	1.2
Agriculture Soils	3.7	3.3	2.7	2.7	2.1	2.2
Total Gross Emissions	**88.4**	**101.6**	**98.5**	**95.0**	**96.1**	**91.7**

[1] Independent rounding was used for totals and subtotals.

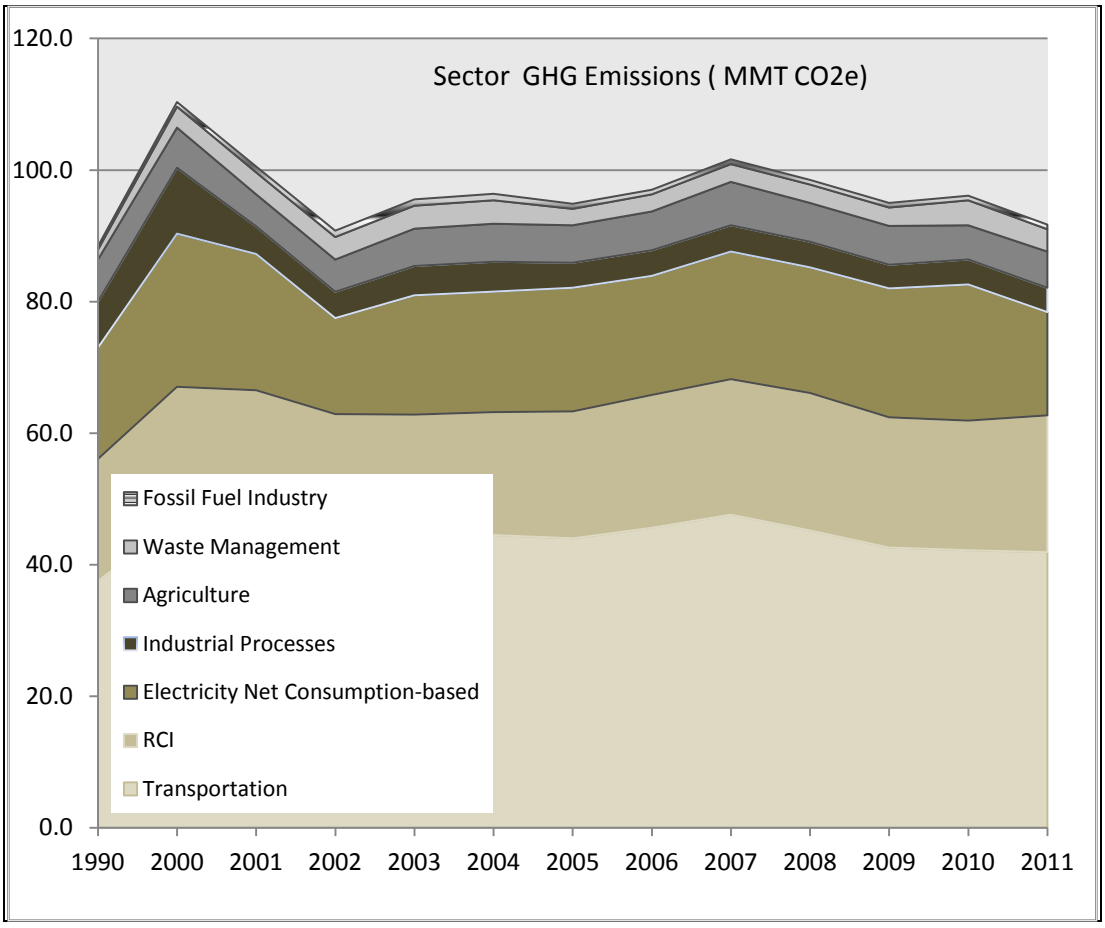
Washington's GHG Emissions Trends

Overall trend, 1990-2011

Figure 1 shows greenhouse gas emissions from 1990 to 2011 by sector. There is a significant decrease in emissions occurring between 2000 and 2002. This is mainly because of a drop in the aluminum industry in Washington. Several plants closed and therefore less GHG emissions were generated by this sector.

Washington state's GHG emissions profile differs from most states and the United States as a whole. Washington relies heavily on hydropower, which is dependent on the amount of snow and precipitation. The emissions from the electricity sector vary year to year depending on the amount of water available for hydropower production. Higher hydropower production and consumption result in lower state emissions from the electricity sector.

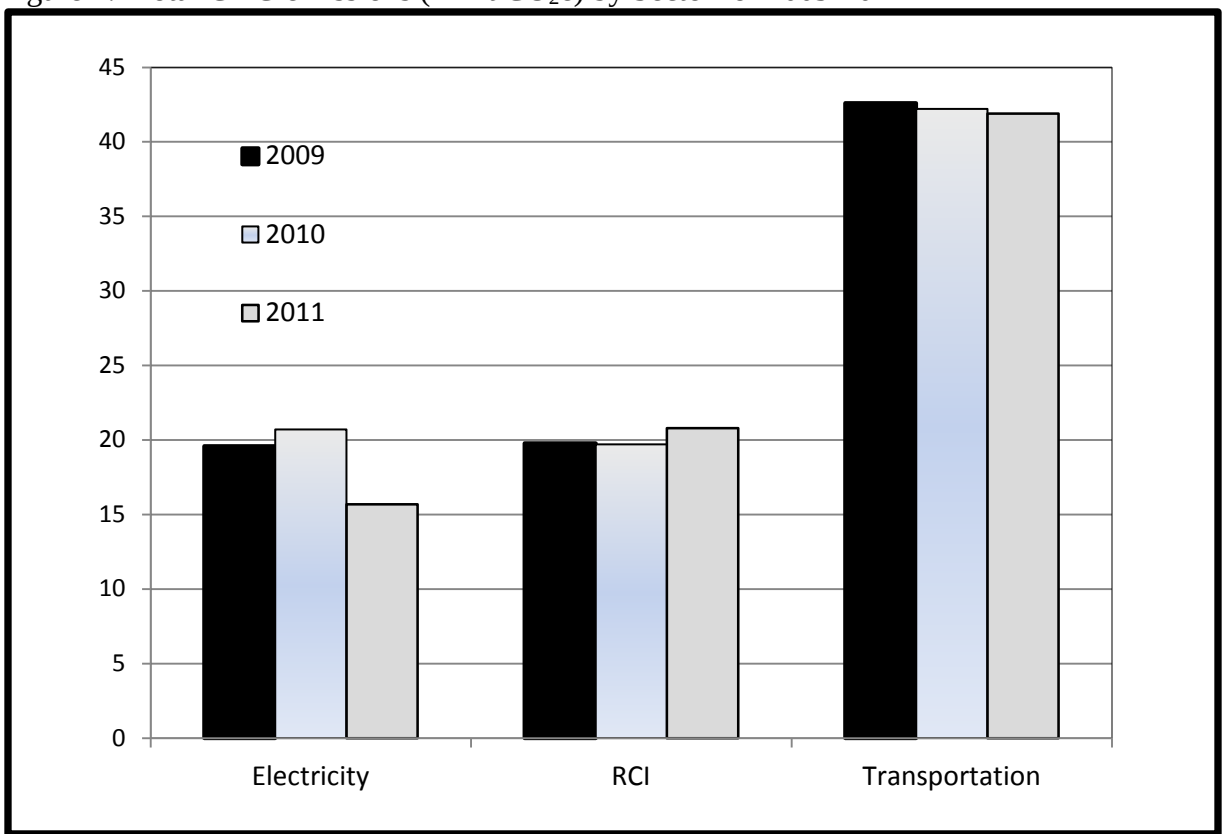
Figure 1: Total annual GHG emissions (MMt CO2e) by sector from 1990 – 2011



Trends by sector, 2009 - 2011

Figure 2 compares the total 2009 – 2011 GHG emissions from the electricity, RCI and transportation sectors.

Figure 2: Total GHG emissions (MMt CO_2e) by Sector for 2009-2011



Summary by Sector

Transportation sector

Transportation is Washington's largest GHG emissions contributor at 45.7 %. On a per capita basis, Washington produces slightly less on-road motor gasoline GHG emissions than the U.S. 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.

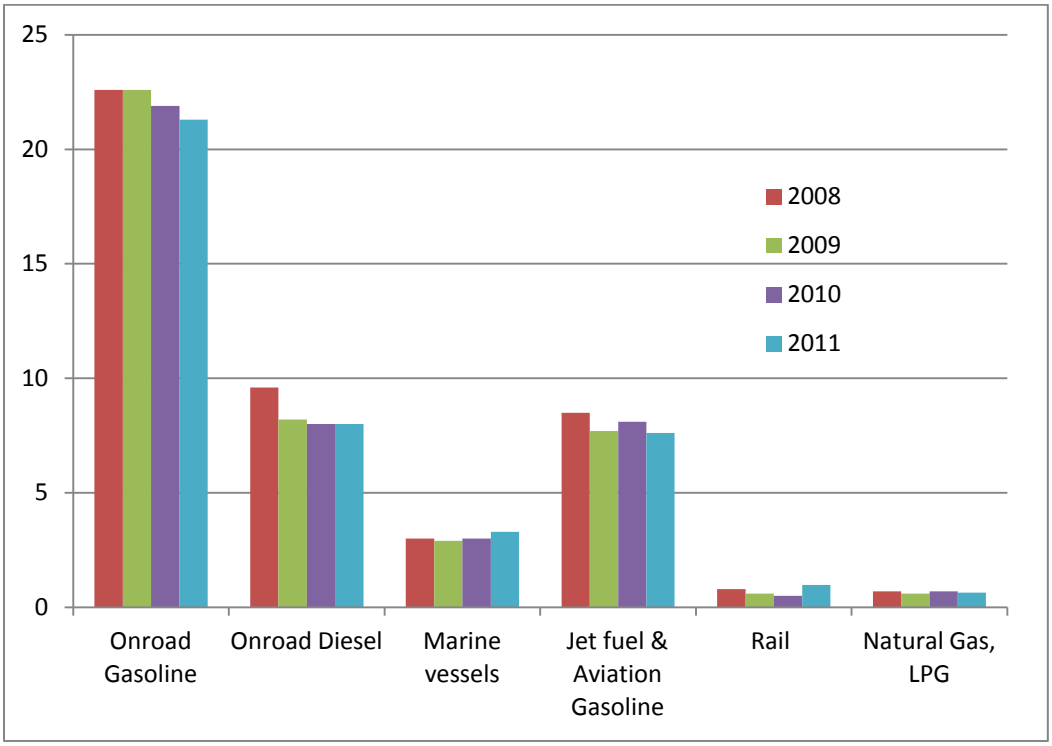
Table 3: On Road GHG Emissions, 2011

2011	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	311,591,917	1,100*	435	3.5	1.4
WA state	6,830,038	21.3	8.0	3.1	1.2

http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Annexes.pdf Annex 2.1 Table A-11

Washington's GHG emissions continue to decline in the transportation sector. This decline was specifically from on-road gasoline (see Figure 4). According to the 1990-2011 Environmental Protection Agency inventory report[7], the national trend in transportation was a general decline in emissions. This was because of slow growth in economic activity, higher fuel prices, and decrease in the demand for passenger transportation Decreases in GHG emissions from the transportation sector in Washington from 2008 to 2011 align with this national trend.

Figure 3: 2008-2011 GHG Emissions ($MMtCO_2e$) from the Transportation Sector



[7] 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

Electricity Consumption-based Sector

Washington state is a major producer and consumer of hydroelectricity, between 60 to 70 percent on average. 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 approach. A consumption-based approach includes emissions from electricity used by consumers in Washington. This includes electricity imported into Washington and does not include emissions from the electricity produced in Washington but used elsewhere.

Emissions decreased in 2011 compared to 2010. The main reason is the low production of hydropower caused by the 2010 drought. In 2010 the state's hydropower use was 60% of the total electricity consumed compared to 73% in 2011. To make up for the difference the state consumed about 30% of power from coal and natural gas in 2010 compared to 20% in 2011. The fuel mix in 2011 resulted in 24 percent lower GHG emissions than 2010.

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 2011, 11.4 MMt CO_2e came from the industrial sector, 5.6 MMt CO_2e came from the residential sector, and 3.8 MMt CO_2e came from the commercial sector. The slight increase was due to better economic conditions.

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 3.8 % of Washington's total GHG emissions in 2011.

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.

Fossil Fuel Industry Sector

This sector includes fugitive GHG emissions that are released during the production, processing, transmission and distribution of fossil fuels. Typically the emissions are fugitive methane from leakage and venting of:

- Natural gas pipelines.
- Petroleum systems.
- Coal mining.

In 2011, these emissions were about 0.8 % of Washington's GHG emissions.

Waste Management Sector

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

Washington's 2011 GHG emissions from this sector are estimated at 3.7 % of the total greenhouse gas emissions. This inventory does not include waste exported from Washington to other states for disposal.

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 ~ 6.0 % of Washington's GHG emissions in 2011.