2008 Seattle Community Greenhouse Gas Inventory

An inventory of the citywide greenhouse gas (GHG) emissions is our primary method of gauging progress toward Seattle's near-term and long-term goals of reducing climate pollution. The inventory measures the GHGs produced by Seattle's main emission sectors. It also helps us identify the sectors where emissions are declining, and where we need to take further action to reduce emissions.

This year, the Office of Sustainability & Environment completed an inventory of the Seattle's 2008 GHG emissions. The 2008 inventory is part of a commitment on the part of the City to measure the community's carbon footprint every three years. The last community inventory reported 2005 emissions, and this inventory follows the same methodology as 2005.

Overview of Citywide Emissions

Seattle's emissions are produced from three main sources: transportation, buildings, and industry. At 62%, the transportation sector is the largest source of emissions, and fully two-thirds of transportation emissions come from cars and trucks on Seattle streets. Energy use in Seattle's residential and commercial buildings is the second largest source of emissions and makes up 21% of total emissions. Industrial operations and processes make up the remaining 17% of emissions.

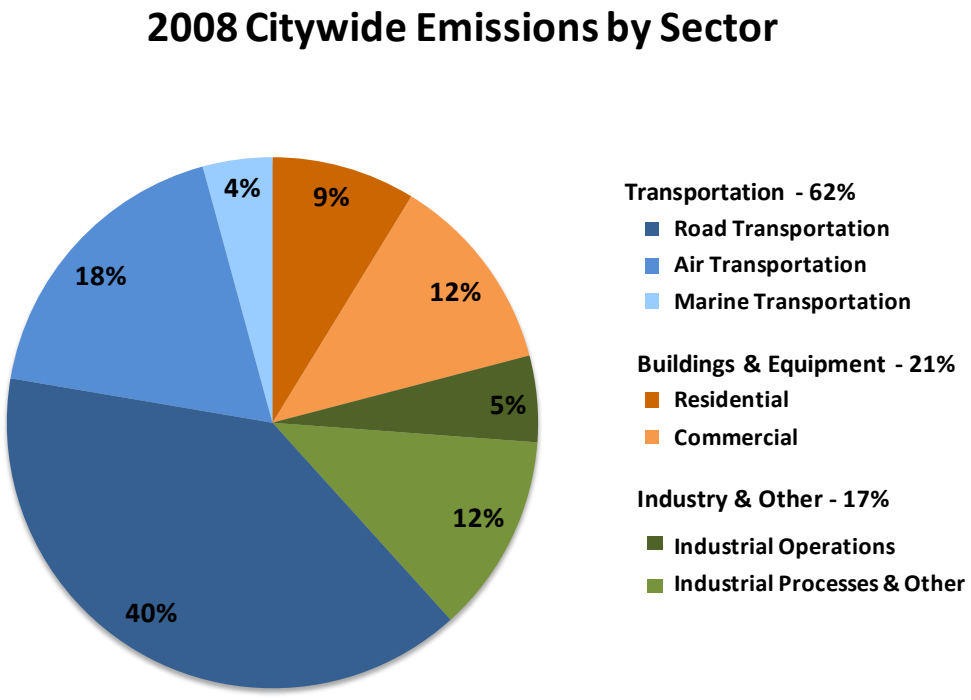


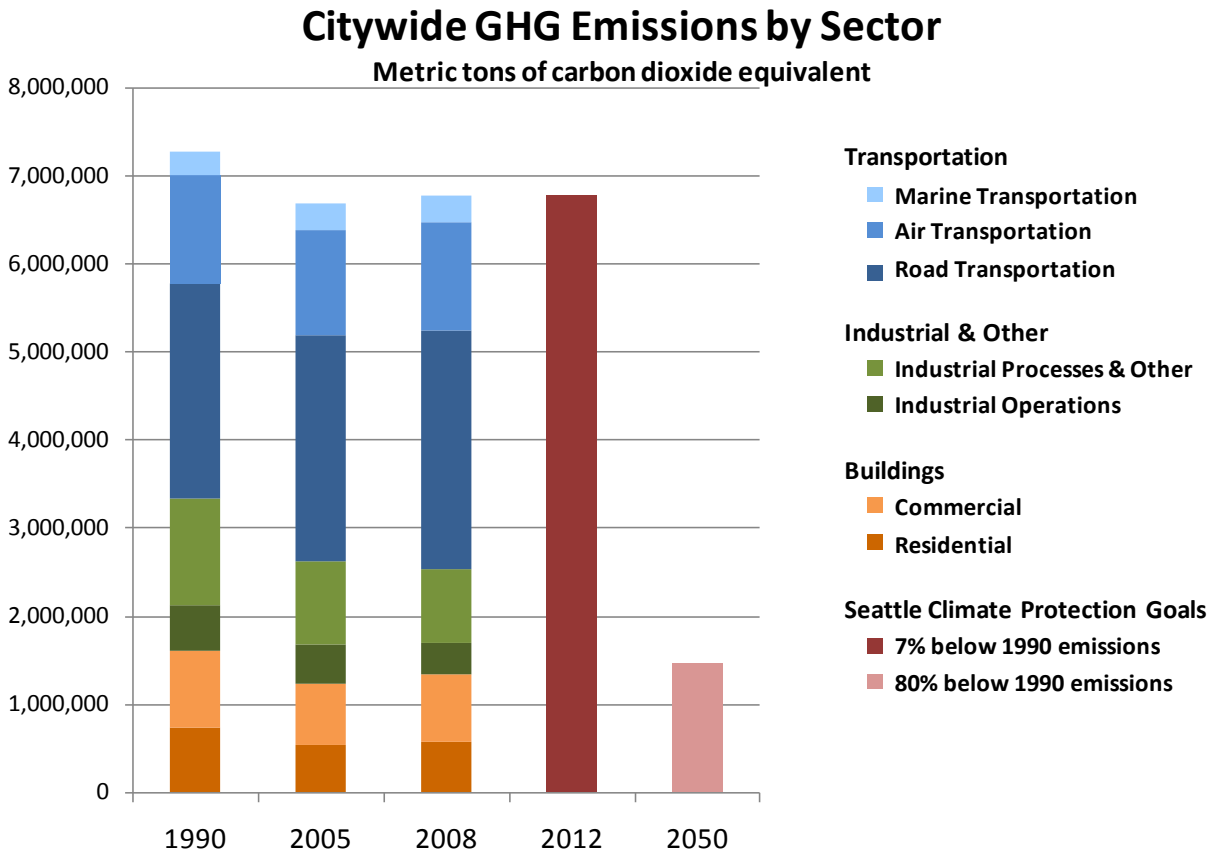
Table 1 – Citywide GHG Emissions by Sector*

	1990	2005	2008	% change 1990-2008
TRANSPORTATION	**3,947,000**	**4,062,000**	**4,242,000**	**7%**
Road	**2,440,000**	**2,566,000**	**2,707,000**	**11%**
Cars & Light Duty Trucks	*1,329,000*	*1,433,000*	*1,413,000*	*6%*
Trucks	*1,063,000*	*1,079,000*	*1,229,000*	*16%*
Buses & Vanpool	*47,000*	*54,000*	*65,000*	*38%*
Marine & Rail	**278,000**	**300,000**	**291,000**	**5%**
Ship & Boat Traffic	*178,000*	*194,000*	*194,000*	*9%*
WA State Ferries	*41,000*	*41,000*	*35,000*	*-15%*
Rail	*59,000*	*65,000*	*63,000*	*7%*
Air	**1,229,000**	**1,196,000**	**1,244,000**	**1%**
Sea-Tac Airport	*1,046,000*	*1,067,000*	*1,117,000*	*7%*
King County Airport	*184,000*	*129,000*	*128,000*	*-30%*
BUILDINGS	**1,609,000**	**1,411,000**	**1,470,000**	**-9%**
Residential	**735,000**	**606,000**	**613,000**	**-17%**
Electricity	*133,000*	*68,000*	*44,000*	*-67%*
Natural Gas	*259,000*	*370,000*	*430,000*	*66%*
Oil	*323,000*	*152,000*	*122,000*	*-62%*
Fuel for Yard Equipment	*20,000*	*16,000*	*17,000*	*-15%*
Commercial	**874,000**	**805,000**	**857,000**	**-2%**
Electricity	*169,000*	*102,000*	*82,000*	*-51%*
Natural Gas	*281,000*	*350,000*	*400,000*	*42%*
Oil	*139,000*	*56,000*	*56,000*	*-60%*
Steam	*152,000*	*161,000*	*176,000*	*16%*
Fuel for Building Equipment	*133,000*	*136,000*	*144,000*	*8%*
INDUSTRY & OTHER	**1,720,000**	**1,413,000**	**1,200,000**	**-30%**
Operations	**524,000**	**463,000**	**366,000**	**-30%**
Electricity	*62,000*	*26,000*	*17,000*	*-73%*
Natural Gas	*265,000*	*245,000*	*242,000*	*-9%*
Oil	*48,000*	*20,000*	*24,000*	*-50%*
Fuel for Building Equipment	*149,000*	*172,000*	*82,000*	*-45%*
Processes	**1,019,000**	**853,000**	**749,000**	**-26%**
Cement	*1,007,000*	*845,000*	*744,000*	*-26%*
Steel	*2,000*	*3,000*	*3,000*	*50%*
Fugitive Gases	10,000	5,000	2,000	-80%
Waste	**177,000**	**97,000**	**85,000**	**-52%**
Wastewater Treatment	*3,000*	*3,000*	*3,000*	*0%*
Closed Landfills	*174,000*	*94,000*	*82,000*	*-53%*
GHG OFFSETS		**-216,000**	**-143,000**	
City Light Offset Purchases		**-216,000**	**-143,000**	
TOTAL EMISSIONS	**7,280,000**	**6,670,000**	**6,770,000**	**-7%**

** Metric tons of carbon dioxide equivalent (CO2e) rounded to the nearest thousand; sums may not equal due to rounding*

2012 Goal - 7% below 1990:	**6,770,000**
2050 Goal - 80% below 1990:	**1,460,000**

In 2008, citywide emissions met the City's 2012 GHG reduction target. Our 2008 GHG emissions are 7% below 1990, and if emissions stay at the same level over the next three years, we will also achieve our 2012 goal. Holding emissions to 2008 levels will be challenging as our city continues to grow in population and bounces back from the economic downturn. As evidence of the challenge ahead, Seattle's emissions increased approximately 80,000 metric tons from 2005 to 2008, owing in large part to growth in population and building, stagnant transportation emissions, and a particularly cold winter.



Transportation emissions remain Seattle's biggest challenge. Transportation is the only sector in Seattle for which GHG emissions are still increasing, at roughly 7% above 1990 levels. Road, air, marine, and rail travel make up nearly two-thirds of Seattle's total 2008 emissions. The largest share of transportation emissions are from the cars and trucks on our roads, which comprise 64% of total transportation emissions. Although passenger vehicle fuel efficiency has increased approximately 9% since 1990, passenger vehicle miles traveled have outpaced our efficiency gains, rising roughly 16%. But there is promising news on per capita transportation emissions, as you'll see on the following page.

Seattle's buildings are continuing to move toward cleaner energy and fuels. Emissions from energy consumed by Seattle's residential and commercial buildings have decreased by 9% since 1990. The most significant reductions have come from residential buildings, in part because of a substantial shift from oil to natural gas as a home energy source. In addition, Seattle City Light's investments in energy conservation and electricity from renewable sources have helped the utility to move away from natural gas- and coal-derived electricity, significantly reducing the carbon intensity of Seattle's building energy. And City Light offsets its remaining electricity emissions by investing in carbon reduction projects, effectively zeroing out the carbon footprint of electricity in Seattle.

Since 1990, Seattle's population has grown roughly 16%, yet total emissions have dropped 7%. The combination of population growth and emissions reductions means that on a per person basis, we've made significant strides in lowering our carbon footprint. Seattle's per capita emissions—total emissions divided by total population—have declined 3% from 2005 and are now an impressive 20% below 1990 levels. On a per capita basis, every emission sector is now below 1990 levels. Buildings and industry have seen steep declines in per capita emissions with reductions of 21% and 40% respectively. Transportation saw a decline of 7%, and even per capita emissions from road transportation declined 4%.

Table 2 – Per Capita Emissions by Sector*

	1990	2005	2008	% change 1990-2008
TRANSPORTATION	**7.6**	**7.1**	**7.1**	**-7%**
Road	4.7	4.5	4.5	-4%
Marine & Rail	0.5	0.5	0.5	-10%
Air	2.4	2.1	2.1	-13%
BUILDINGS	**3.1**	**2.5**	**2.5**	**-21%**
Residential	1.4	1.1	1.0	-28%
Commercial	1.7	1.4	1.4	-15%
INDUSTRY & OTHER	**3.3**	**2.5**	**2.0**	**-40%**
Operations	1.0	0.8	0.6	-40%
Processes	2.0	1.5	1.3	-37%
Waste	0.3	0.2	0.1	-59%
TOTAL PER CAPITA	**14.1**	**11.7**	**11.3**	**-20%**

** metric tons of carbon dioxide equivalent (CO_2e)*

Methodology

This inventory is based primarily on a geographic approach, and so includes all emissions within a certain geographic boundary. All emissions in the inventory are from within the Seattle city limits, with the exception of air travel and energy production. Since there is no standard community inventory protocol, the City of Seattle's methodology is guided by the *IPCC Guidelines for the National Greenhouse Gas Inventories* and the *GHG Protocol (2004),* which was developed by both the World Business Council for Sustainable Development and the World Resources Institute.

Time Frame

The 2008 inventory reports greenhouse gas emissions produced between January 1, 2008 and December 31, 2008.

Greenhouse Gases

The community inventory includes six greenhouse gases, listed in the following table. The global warming potential indicates how potent the gas is in comparison to carbon dioxide. Sulfur hexafluoride (SF_6) is a gaseous insulator used in electrical switchgear. Although SF_6 is used in small quantities, it is included in the inventory because of its abnormally high global warming potential.

Table 3 - Greenhouse gases and associated global warming potential

Gas	Chemical Formula	Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310
Hydroflourocarbons	$C_xH_yF_z$	Various
Perfluorocarbons	C_yG_y	Various
Sulfur Hexafluoride	SF_6	23,900

For the emissions factors from fossil fuels used in the report, see Appendix B.

Units

In this report, greenhouse gas emissions are reported in metric tons of carbon dioxide equivalent. The consumption data associated with emissions is reported in United States units. The unit abbreviations used in the report are listed in the following table:

Abbreviation	Unit
Gal	Gallons
Ft^3	Feet cubed
$MgCO_2e$	Metric tons carbon dioxide equivalent
Mi	Miles
MWh	Megawatt Hours
Th	Therms
Ton	US tons

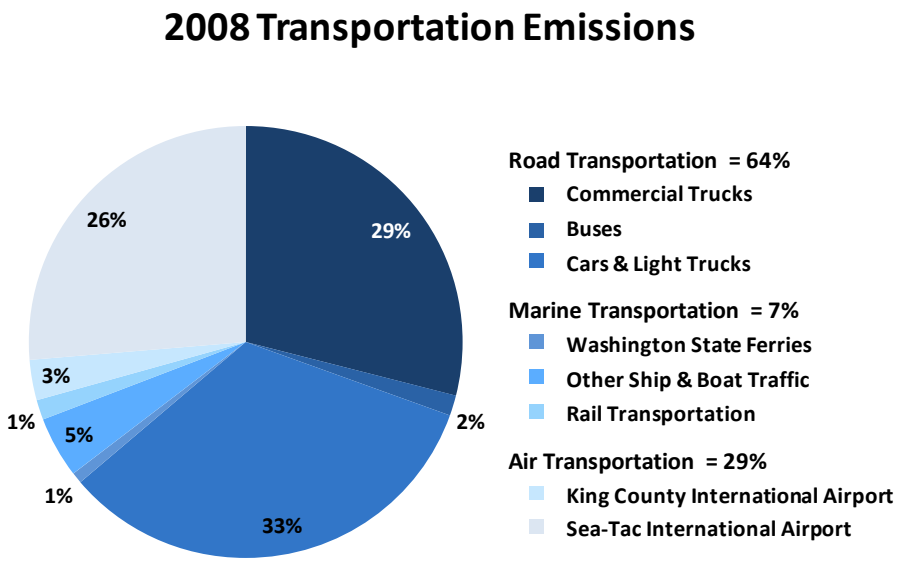
Note about rounding: With the exception of Table 1, the numbers in this report are not rounded. The unrounded numbers are not a true representation of the accuracy of the inventory.

Inventory Report

The City of Seattle inventory is divided into six sections: Transportation, Buildings, Industry, Waste, Greenhouse Gas Offsets, and Other Information. The appendix includes an index of source documents, emissions factors for fossil fuels, and population totals.

Transportation Sector

The transportation sector includes road, air, marine, and rail travel. Transportation is the only sector of emissions that is still above 1990 levels, at 7% above 1990. Within transportation, road travel is the largest source of emissions, accounting for nearly two-thirds of the sector's emissions.



ROAD TRANSPORTATION

Road transportation includes the emissions from passenger, commercial, and transit vehicles. Emissions are based on an estimate of vehicle miles traveled (VMT) on streets and highways within the city limits.

Table 4 – Road Transportation Emissions

	Vehicle Travel, Thousands of Miles				Emissions, $MgCO_2e$		
	1990	2005	2008		1990	2005	2008
Commercial Trucks	632,252	716,388	720,947		1,062,967	1,079,412	1,229,040
Buses	18,024	20.437	26,928		46,623	52,827	64,379
Cars & Light Trucks	2,846,915	3,225,764	3,292,031		1,329,473	1,433,116	1,412,791
Van Pool	876	986	1,205		479	488	587
Totals	**3,498,066**	**3,963,574**	**4,041,111**		**2,439,551**	**2,565,844**	**2,706,798**

Source Notes

Road transportation emissions were calculated from daily average vehicle miles traveled (DVMT) in the City of Seattle in calendar year 2008, provided by SDOT traffic modeler Zhong Wang in **08-11-16** for car (single and high occupancy 2 and 3), Metro VanPool, and commercial truck. The model estimates vehicle miles traveled on the roads and highways within the Seattle city limits. To calculate emissions, OSE multiplied annual VMT by the following emissions factors, derived from the fossil fuel emissions factors listed in Appendix B **(08-90-0 'Road Traffic')**:

	Emission Factor		
Vehicle	**1990**	**2005**	**2008**
Car	290 gCO_2/km	276 gCO_2/km	267gCO_2/km
Van	340 gCO_2/km	308 gCO_2/km	303 gCO_2/km
Truck	1,045 gCO_2/km	936 gCO_2/km	1,060 gCO_2/km

MARINE TRANSPORTATION

Marine transportation includes fuel used by boat traffic in the waters in and around Seattle. Boat traffic includes pleasure craft, Washington State Ferries, cruise ships, cargo vessels, and other commercial boat traffic, such as tug boats.

Table 5 – Maritime Emissions

	Fuel Consumption, Gallons				Emissions, $MgCO_2e$		
	1990	2005	2008		1990	2005	2008
Pleasure Craft, Diesel	318,035	90,261	94,135		843	906	945
Pleasure Craft, Gasoline	605,564	553,539	577,294		5,333	4,854	5,063
Washington State Ferries	No data	No data	No data		40,734	41,379	142,453
Other Ship & Boat Traffic	No data	No data	No data		125,488	136,722	142,453
Cruise Ships (hotelling)	No data	No data	No data		46,410	50,565	45,066
Totals					**278,184**	**299,117**	**291,054**

Source Notes
Pleasure craft: Fuel used by pleasure craft was estimated by scaling 2005 King County emissions by population growth (see Appendix C) and prorating by Seattle population **(08-90-0 'Marine Traffic')**. Fuel use was converted to emissions using the standard fuel-related emissions factors **(Appendix B)**. King County pleasure craft fuel use was estimated by Puget Sound Clean Air Agency using the NONROAD 2005 model.

Ferries: Emissions from Washington State Ferries were calculated from fuel consumed by ferries on Seattle routes, provided by Lucy Fullerton of WSDOT **(08-12-0).**

Ship & Boat Traffic (Cruise and other): 2008 emissions were calculated by scaling the 2005 ship and boat emissions reported in the *Puget Sound Maritime Air Emissions Inventory* by the number of non-electrified cruise ship calls, and the amount of Port cargo measured in twenty-foot containers, or TEUs.

RAIL TRANSPORTATION

Rail transportation includes the rail activity associated with the Port of Seattle.

Table 6 – Rail Transportation Emissions

	Fuel Consumption, Gallons				Emissions, $MgCO_2e$		
	1990	2005	2008		1990	2005	2008
Port of Seattle On-Terminal	No data	No data	No data		15,007	16,350	15,883
Port of Seattle Off-Terminal	No data	No data	No data		18,571	20,234	19,656
Other Freight	No data	No data	No data		25,797	28,107	27,304
Passenger	No data	No data	No data		No data	No data	No data
Totals					**59,375**	**64,691**	**62,842**

Source Notes
Rail emissions were estimated by scaling 2005 emissions by the change in cargo, measured in twenty-foot containers (TEUs) **(08-90-0 'Rail Traffic')**. From 2005 to 2008, TEUs at the Port of Seattle decreased by 3 percent (08-12-6).

AIR TRANSPORTATION

Air transportation includes take-offs and landings at the King County Airport and Seattle's share of flights out of Sea-Tac Airport. Seattle's share of Sea-Tac traffic (29%) is determined by a passenger survey administered by the Port of Seattle. Though emissions from the flights taken by these passengers do not occur within the city limits, the Mayor's Green Ribbon Commission decided to include emissions associated with air travel by Seattle's residents and businesses.

Table 7 – King County Airport and Sea-Tac Airport Emissions

	Fuel Consumption, Gallons				Emissions, $MgCO_2e$		
	1990	2005	2008		1990	2005	2008
King County International Airport	No data	No data	27,024,049		184,545	128,700	127,825
Sea-Tac International Airport	110,469,108	112,727,115	117,963,877		1,045,705	1,067,079	1,116,651
Totals					**1,229,250**	**1,195,779**	**1,244,475**

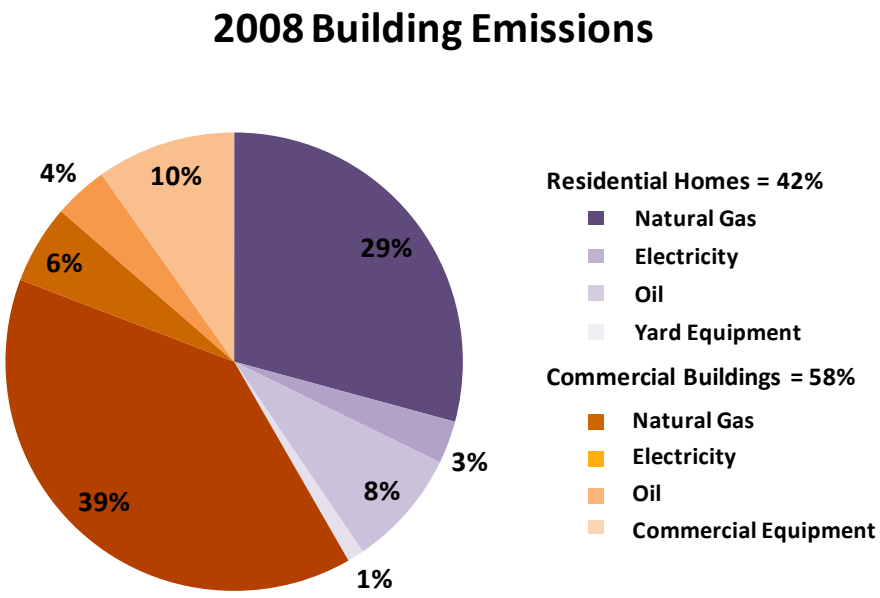
Source Notes

King County International Airport: 2008 emissions from King County International Airport were calculated from fuel used in grounds equipment and by jets during landing and take-off **(08-90-0 'Air Traffic')**. Fuel use was provided by Gary Molyneaux of KCIA (**08-14-08)** and the landing and take-off fraction (51%) of fuel burned was provided by the Puget Sound Clean Air Agency **(05-047)**.

Sea-Tac International Airport: The Seattle portion of Sea-Tac emissions is based on the percentage of Seattle passengers flying on domestic passenger flights **(08-90-0 'Air Traffic')**. The percentage of Seattle passengers is from a 2001 Port of Seattle passenger survey **(08-14-10)**, which was provided by Michael Drollinger of the Port of Seattle, and is the best available estimate of Seattle passengers. Total Jet A fuel consumed at Sea-Tac Airport (4.6 million gallons) was provided by Mike Hagan of Swissport **(08-14-13)**.

Building Sector

Building emissions include the energy consumed by Seattle's residential and commercial buildings for lighting, appliances, heat, hot water, and building equipment. Overall, 2008 emissions from residential buildings have decreased 11% from 1990. Residential buildings have seen the greatest emission reductions, fully 18% below 1990, whereas commercial buildings have seen only a modest decrease in emissions, now 2% below 1990.



RESIDENTIAL BUILDINGS

Residential building emissions are from single-family homes, apartment buildings, and other residential buildings in the City of Seattle. The vast majority of the building emissions are generated by the energy used for home heating, appliances, and hot water, but the emissions reported here also include fuel used for landscaping equipment like lawnmowers.

Table 8 – Emissions from single-family homes and other residential buildings

		Fuel Consumption, Gallons				Emissions, $MgCO_2e$		
	Units	1990	2005	2008		1990	2005	2008
Electricity	MWh	3,261,285	3,073,673	2,471,425		15,007	16,350	15,883
Direct Fuel Use								
Natural Gas	Th	69,642,333	70,043,708	81,484,393		258,698	369,512	429,866
Oil	Gal	32,222,257	15,164,200	12,148,591		323,406	152,199	121,932
Yard Equipment								
Gasoline	Gal	2,226,576	1,880,310	1,955,817		19,608	16,490	17,152
Diesel	Gal	5,492	5,900	6,137		55	59	62
Liquid Petroleum Gas	Gal	648	623	648		4	4	4
Totals						**734,881**	**612,665**	**613,414**

Source Notes

Residential Buildings: David Namura of Puget Sound Energy provided 2008 natural gas use by City of Seattle residences **(08-22-6, 08-90-0 'Residential Heat & Hot Water')**.

Oil: Seattle residential oil use is estimated from 2007 Washington State home oil use, which is reported by the U.S. Energy Information Administration **(08-22-2)**, according to the ratio of Seattle homes with oil heat to Washington State homes with oil heat. Seattle has 33,900 homes with oil heat, compared to 127,000 homes with oil heat in the state of Washington. The number of homes with oil heat is from the 2000 U.S. census, which is the most recent data available **(05-027)**. Calculations are completed in **08-90-0 'Residential Heat & Hot Water'**.

Electricity: Mary Winslow at Seattle City Light provided residential building electricity consumption **(08-90-0 'SCL Electricity')**. These emissions are offset by SCL and are not included in total emissions. See the *Greenhouse Gas Offsets* section on page 19.

Yard Equipment: OSE estimated yard equipment emissions by scaling 2005 emissions by Seattle population growth **(08-90-0 'Res-Garden & Rec')**. The Puget Sound Clean Air Agency calculated 2005 King County yard equipment emissions using the NONROAD model (**05-023)**. King County emissions were prorated to the City of Seattle by residential population (**05-901)**.

COMMERCIAL BUILDINGS

Commercial building emissions are from the energy consumed by businesses, office buildings, and institutional facilities (like government buildings and schools). Like residential building emissions, the majority of these emissions are generated by lighting, space heating, and hot water. Many downtown buildings are heated by steam generated by Seattle Steam Company, and the emissions associated with steam heat are reported on a separate line item. Commercial buildings also include emissions from small equipment associated with commercial operations.

Table 9 – Emissions from commercial buildings

		Energy/ Fuel Consumption				Emissions, $MgCO_2e$		
	Units	1990	2005	2008		1990	2005	2008
Electricity	MWh	3,289,806	4,651,850	4,554,983		169,089	112,602	81,829
Direct Fuel Use								
Natural Gas	Th	98,328,540	99,007,200	111,620,206		281,215	350,143	399,825
Oil	Gal	13,832,789	5,623,731	5,539,472		138,836	56,444	55,597
Commercial Equipment								
Gasoline	Gal	10,238,197	9,575,031	10,195,539		89,788	83,972	89,413
Diesel	Gal	2,286,083	3,454,372	3,678,233		28,726	34,671	36,917
LPG	Gal	474,141	663,633	706,640		2,707	3,789	4,034
CNG	Ft^3	524,680,295	569,865,381	618,524,233		11,802	12,819	13,650
Steam Plants								
Natural Gas	Th	25,872,685	30,205,025	33,243,000		136,571	159,345	175,372
Oil	Gal	1,433,978	131,425	54,000		15,581	1,534,	542
Totals						**874,314**	**815,318**	**857,179**

Source Notes

Natural Gas: Commercial natural gas emissions are from Seattle's steam plants and direct building consumption. PSCAA provided natural gas and back up oil use from the Seattle Steam and the University of Washington Steam Plant **(08-30-2)** and David Namura of Puget Sound Energy provided commercial building natural gas consumption **(08-30-0)**. Small source gas use was calculated by subtracting steam plant consumption **(08-30-1)** and CNG vehicle use from gross natural gas consumption **(08-90-0 'Commercial-Heat & Hot Water')**.

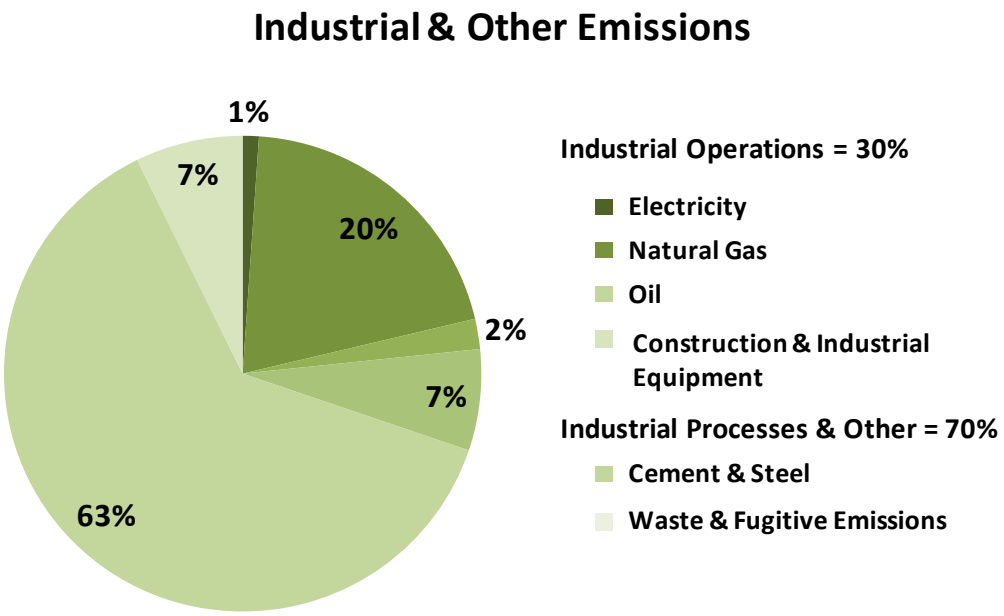
Oil: Commercial oil use is calculated by prorating 2007 Washington State commercial oil use, provided by the EIA, by the ratio of Seattle commercial employees to Washington State commercial employees **(08-22-2, 08-90-0 'Commercial Heat & Hot Water')**. Total 2007 Washington State oil consumption was 122 million liters and the ratio of commercial employees is .171.

Electricity: Mary Winslow and Corinne Grande of Seattle City Light provided the Seattle commercial electricity consumption and emission factors, respectively **(08-90-0 'SCL-Electricity')**.

Commercial Equipment: OSE estimated 2008 commercial equipment emissions by scaling 2005 emissions by the number of commercial employees in Seattle in **08-90-0 'Commercial-Equip'**. PSCAA calculated King County 2005 emissions equipment using a NONROAD model. Seattle emissions were calculated by prorating county emissions by the ratio of Seattle to Washington commercial employment **(05-023, 05-901, 05-903)**.

Industrial Sector

The industrial sector includes emissions from industrial operations, the manufacturing of cement and steel, and fugitive gases associated with industrial equipment. Virtually all sources of industrial emissions have decreased since 1990, and the sector as a whole dropped 31% since 1990. Cement production is the most GHG-intensive industry in Seattle, comprising more than 60% of all industrial emissions, and cement emissions are down 26% since 1990.



INDUSTRIAL OPERATIONS

Industrial operations include emissions from energy consumed by industrial facilities located in the City of Seattle. Unlike residential and commercial emissions, industrial operations are dominated by emissions from energy used to fuel manufacturing or other industrial equipment, rather than space heating and hot water. Industrial operations also include fuel use and greenhouse gas emissions from construction equipment, material handling, HVAC equipment, and other associated off-road machinery.

Table 10 – Energy-related emissions from industrial facilities

		Energy/ Fuel Consumption				Emissions, $MgCO_2e$		
	Units	1990	2005	2008		1990	2005	2008
Electricity	MWh	1,508,585	1,197,613	967,274		61,574	28,989	17,377
Direct Fuel Use								
Natural Gas	Th	50,266,407	53,569,159	52,827,225		265,335	245,217	241,812
Oil	Gal	4,802,405	1,983,058	2,416,750		48,254	19,903	24,255
Commercial Equipment								
Gasoline	Gal	692,149	487,565	233,787		6,070	4,276	2,050
Diesel	Gal	11,165,935	12,808,628	6,141,719		112,069	128,557	61,643
LPG	Gal	3,529,191	4,507,118	2,161,156		20,149	25,733	12,339
CNG	Ft^3	708,940,271	838,088,652	927,978,569		10,660	12,602	6,043
Totals						**524,111**	**465,277**	**365,518**

Source Notes

Point Source Natural Gas: Kathy Himes of PSCAA provided industrial point source natural gas and oil **(08-42-1, 08-42-3)**. Emissions calculations are in **08-90-0 'Ind-Operations'**.

Other Natural Gas: David Namura of PSE provided 2008 industrial natural gas use in the City of Seattle **(08-40-0)**. 2008 small source gas use was calculated by subtracting point source consumption and CNG vehicle use **(08-90-0 'Ind-Small Equip')** from total industrial natural gas**.** 2008 CNG vehicle use was calculated by scaling 2005 use by the change in Seattle industrial employees from 2005 to 2008.

Oil: Industrial oil use is calculated by prorating 2007 Washington State industrial oil, provided by the EIA, by the ratio of Seattle industrial employees to Washington industrial employees **(08-22-2)**. Total Washington State industrial oil use was 22.3 million gallons and the ratio of Seattle to Washington employees was .108 **(08-90-0 'Ind- Operations')**.

Industrial Equipment: 2008 equipment emissions were estimated by prorating 2005 emissions by .12, the ratio of Seattle to King County industrial employees **(08-90-0 'Ind-Equip')**. For 2005 construction and other small equipment, PSCAA calculated King County fuel with a NONROAD model **(05-023, 05-903)**. County-level, commercial fuel use was prorated to the City of Seattle using the industrial employment in **05-901**.

INDUSTRIAL PROCESSES

Industrial processes include greenhouse gases that are emitted directly from production of cement and steel, as well as the emissions from fugitive gases from electric switchgear equipment. With two cement plants in the City of Seattle, cement production is a significant contributor to the city's greenhouse gas emissions. Emissions from burning coal and tire-derived fuel for cement operations are included in the processes table below.

Table 11– Industrial processes emissions

		Fuel Consumption				Emissions, $MgCO_2e$		
	Units	1990	2005	2008		1990[1]	2005	2008
Process Emissions								
Cement								
Cement Manufacture						798,471	483,622	394,644
Coal	Ton	80,269	128,838	127,576		208,952	335,385	332,100
Tire-derived Fuel	Ton	-	9,214	6,130		-	25,746	17,128
Steel						1,824	3,217	3,175
Fugitive Gases						10,000	5,319	1,951
Totals						**1,019,248**	**853,288**	**748,998**

[1] **Includes baseline cement adjustment:**
Seattle's industrial sector includes two cement plants, which have operated in the city for many decades. One of Seattle's cement plants was temporarily closed from 1988 to 1992, meaning that 1990's cement production was significantly out of step with Seattle's historical emissions. Because cement production is roughly 13 percent of the community greenhouse gas inventory and because cement production is driven by regional—even national—demand, a meaningful comparison of community-wide progress in emission reductions from 1990 to other inventory years would benefit from either excluding cement from the community footprint or adjusting the 1990 baseline based on an estimate of what Seattle's cement production levels would have been had both plants been operating at the time.

A similar baseline adjustment is often used in corporate inventories to account for emissions from acquisitions and divestitures of facilities and operations that add or subtract at least 10 percent of the corporation's total footprint. Although the situation is not entirely analogous in the community footprint context, because there is no standard protocol for local communities, it is our best guide for how to control for atypical emission levels in the baseline year.

It is unclear whether the standard protocol for cities, which is currently under development, will call for exclusion of large point source emissions like cement or whether it will adopt the baseline adjustment approach. This inventory uses historical operating data to estimate the average emissions of the second cement plant: approximately 592,000 $MgCO_2e$/year. To protect proprietary data of the cement plant operator, source data for the baseline adjustment are not tabulated in this document.

Source Notes

Cement: Cement process emissions are calculated by multiplying tons of clinker produced by the calcinations factors **(08-90-0 'Ind-Process')**. Kathy Himes of PSCAA provided the tons of clinker produced **(08-42-3).** Margaret deGravelle of Lafarge and Jerry Brown of Ash Grove provided the calcinations factors (**08-41-0** and **05-134**) and tons of coal and tire-derived fuel burned at the cement plants **(08-41-0** and **08-41-1)**. Emissions from coal and tire-derived fuel burned to produce cement are included in the processes table **(08-90-0 'Ind-Operations')**.

Steel: The steel emissions are from Seattle's two manufacturers, Jorgensen and Nucor. Steve Van Slyke of PSCAA provided production data from the two plants **(08-40-1** and **08-42-1)**. To calculate emissions, the production data was multiplied by the nominal IPCC emission factor associated with electric arc furnaces, 1.25 $kgCO_2$/Mg steel. The manufacturers use entirely recycled stock, so there are no emissions associated with carbon lost from pig iron **(05-127**

Fugitive Gases: Corinne Grande of Seattle City Light provided fugitive SF_6 emissions (**08-60-2).**

Waste Sector

The waste sector includes emissions associated with in-city closed landfills and wastewater treatment. At less than 1% of emissions, in-city waste emissions from waste are not a significant source of emissions, and are combined with industrial emissions when reported in Table 1. Most emissions associated with waste generated in Seattle occur outside the city limits and are not included in the geographic inventory of emissions.

CLOSED LANDFILLS

Landfills continue to emit methane long after they have been closed, although emissions levels drop significantly over time. There are a number of closed landfills in Seattle, and the community inventory includes estimates of their methane emissions.

Table 12 – Emissions from closed landfills inside the City of Seattle

	Emissions, $MgCO_2e$		
	1990	2005	2008
Interbay	67,969	31,631	27,907
Genessee	64,570	30,050	26,512
Montlake	-	12,752	10,748
Judkins Park	11,555	5,377	4,744
South Park	24,716	11,502	10,148
West Seattle	4,806	2,237	2,069
Total	**173,616**	**93,549**	**82,127**

Source Notes

Landfills: Emissions from Interbay, Genessee, Judkins Park, and South Park landfills were estimated using Interbay monitoring data from the portion of the landfill that is under vacuum (7.2% of the landfill surface area). Min-Soon-Yim of Seattle Public Utilities provided the 2008 Interbay monitoring data **(08-50-1)**, which indicates that 3,876 $MgCO_2e$ of methane are emitted from the portion of the landfill under vacuum. These emissions are scaled to total emissions by ratio of total landfill surface area to surface area over the vacuum **(08-90-0 'Waste-Landfills')**.

Emissions estimates for Genessee, Judkins Park, and South Park were generated by multiplying Interbay's emissions by the volume ratios of each landfill's volume to Interbay's volume. Jeff Neuner of Seattle Public Utilities provided the landfill volume ratios **(05-066)** and confirmed that these ratios are still the best methodology to estimate emissions in 2008 **(08-90-37)**. Calculations are in **08-90-0 'Waste-Landfills'**.

Emissions from the Montlake landfill for 2008 were calculated using the landfill volume, mass, and the methane kinetics equation from the 2005 University of Washington greenhouse gas inventory **(05-158)**. The calculation steps were provided by Roel Hammerschlag of Stockholm Environment Institute **(08-50-5)**. The kinetics calculations were carried out in **08-90-0 'Waste-Landfills'**.

Emissions from the West Seattle landfill were calculated from Port of Seattle monitoring data provided by Hillary Ritenberg **(08-50-2)**.

WASTEWATER TREATMENT

King County operates a large wastewater treatment plant, West Point, located adjacent to Discovery Park within the Seattle city limits. Wastewater treatment emits methane and nitrous oxide.

Table 13 – Emissions from wastewater treatment inside the City of Seattle

	Emissions, $MgCO_2e$		
	1990	2005	2008
Emissions	2,294	3,250	3,389

Source Notes

Wastewater Treatment: 2008 wastewater treatment emissions were estimated by scaling 2005 wastewater emissions by Seattle population growth **(08-90-0 'Waste-Wastewater')**. 2005 emissions were from the King County 2003 greenhouse gas inventory **(05-806)**.

Greenhouse Gas Offsets

The majority of Seattle City Light's electricity is generated from hydro and wind power, but there are some emissions associated with the power City Light purchases on the market. Since 2005, City Light has invested in carbon reduction projects to offset the emissions associated with its electricity production.

Currently, City Light is purchasing most of its offsets from agricultural and landfill methane capture projects. These projects meet the standards of the Climate Action Reserve or the Voluntary Carbon Standard, two organizations that have established protocols for qualifying and verifying offsets. City Light is also buying a small number of offsets from a local project in which two cruise lines use electricity rather than their diesel engines when they are in port in Seattle.

City Light uses several criteria to evaluate offsets, and seeks projects that are local, verifiable, and reasonably priced. City Light pursues projects that reduce emissions beyond business as usual or regulatory requirements, can be replicated or adopted broadly, and have co-benefits to the environment and the economy. For more information on City Light's offset program, contact City Light's Environmental Affairs Division.

Table 14 – Electricity Offsets

	Emissions, $MgCO_2e$	
	1990	2005
Residential	74,401	44,398
Commercial	112,602	81,829
Industrial	28,989	17,377
Total	**215,993**	**143,604**

Source Notes

Electricity offsets: Corinne Grade of Seattle City Light provided a description of Seattle City Light's offset program **(08-90-70, 08-90-62, 08-90-0 'SCL Electricity')**.

Other Information

MUNICIPAL SOLID WASTE DISPOSAL

Emissions from municipal solid waste (MSW) disposal are considered "other emissions" and arise from three different sources: in-city collection, transfer and long-haul, and landfill emissions commitment.

In-city collection is simply the tailpipe emissions of the fleet of garbage trucks collecting Seattle garbage.

Seattle's MSW contractor disposes of the garbage in the Arlington landfill in eastern Oregon, so significant emissions are also induced by hauling Seattle's trash by rail to the landfill – hence, transfer and long-haul emissions. In Table 14, transfer and long-haul emissions are shown to have increased substantially, from about 3,400 $MgCO_2e$ in 1990 to 20,300 $MgCO_2e$ in 2008. This is because in 1990 the City of Seattle disposed of its garbage in the King County Cedar Hills landfill, which is much closer than the Arlington landfill.

Landfill emissions commitment is the total quantity of fugitive methane expected from the garbage disposed of in the inventory year, throughout its entire decay process in the landfill. The decay process takes many years, so the landfill emissions commitment is actually emitted only partly during the inventory year, and partly in future years. This line-item of the inventory is unique in this way, but recording emissions commitment associated with the waste reflects the global warming impact of the inventory year's policy choices much more accurately than the actual emissions of the landfill during that same year. This is especially true because the garbage in the landfill comes from other sources besides the City of Seattle.

Table 15 – Waste Management Emissions

	Emissions, $MgCO_2e$		
	1990	2005	2008
In-City Collection	8,283	8,293	7,538
Transfer & Long Haul	3,406	12,119	20,264
Landfill Emissions Commitment	109,925	103,491	100,845
Total	**121,614**	**123,903**	**128,647**

Source Notes

MSW Disposal: Jenny Bagby supplied all waste management emissions data **(08-50-0)**.

MSW-RELATED SEQUESTRATION

The majority of MSW consists of organic matter. When organic waste is buried in a landfill, a portion decays releasing methane and carbon dioxide, but the remaining portion remains buried in the landfill indefinitely. This remaining portion represents carbon sequestration, since the carbon in the waste was originally extracted from the atmosphere by means such as a food plant, garden vegetation, or a tree harvested for forest product. Table 16 lists the sequestration from waste disposed of in the Cedar Hills landfill in 1990 and in the Arlington landfill in 2005 and 2008.

Similarly to the methane commitment described above, the values in Table 15 are calculated for the waste disposed of in the listed calendar year, but represent the sequestration enduring only after that waste's decay is complete, many years in the future.

Table 16 – Sequestration associated with landfilling of Seattle's municipal solid waste

	Emissions, $MgCO_2e$		
	1990	2005	2008
Final anticipated sequestration	208,036	146,242	150,428
Total	**208,036**	**146,242**	**150,428**

In this table positive values represent metric tons of carbon sequestration.

Source Notes

MSW Sequestration: Jenny Bagby supplied all waste management emissions data **(08-50-0)**.

EMISSIONS AVOIDED FROM SEATTLE'S RECYCLING PROGRAM

Seattle Public Utilities' recycling program induces emissions from its operations, but also avoids emissions associated with disposal of MSW and manufacturing of new materials and products, as shown in Table 17.

The benefit of avoided materials manufacture overwhelms the emissions from recycling in Table 17, so that recycling yields a net GHG benefit of more than 545,000 $MgCO_2e$ of avoided emissions in 2008. This value represents the benefit of the entire recycling program, serving the entire city population.

Table 17- Emissions associated with Seattle's recycling program

	Emissions, $MgCO_2e$		
	1990	2005	2008
Emissions			
Collection	4,158	4,512	5,632
Processing	17,846	21,228	23,302
Foregone sequestration	197,424	205,357	213,275
Avoided emissions			
Disposal as MSW	(109,707)	(126,144)	(145,390)
Manufacturing of new materials	(548,635)	(585,921)	(642,248)
Total	**(438,914)**	**(480,968)**	**(545,429)**

Source Notes

Recycling: Jenny Bagby supplied all waste management emissions data **(08-50-0).**

URBAN FOREST SEQUESTRATION

About half of the dry mass of a typical tree consists of carbon that was separated from CO_2 by photosynthesis. As a tree grows, it destroys CO_2, releasing the oxygen but sequestering the carbon in the mass of its roots, trunk, branches and leaves. Table 17 estimates that during the calendar year 2008 trees growing within the City of Seattle sequestered about 59,000 metric tons of CO_2. This inventory does not attempt to account for the CO_2 releases associated with felled urban forest, so the gross sequestration values reported in Table 18 should be treated as maximum values of net sequestration, which is likely to be much smaller. There is no data for urban forest sequestration in 1990.

Table 18 – Annual carbon uptake (sequestration) in Seattle's urban forest

	Carbon Sequestration, $MgCO_2e$		
Zone Type	1990	2005	2008
Downtown	No data	363	181
Major Institutions	No data	544	635
Manufacturing/ Industrial	No data	2,359	1,270
Multi-family	No data	3,538	4,627
Neighborhood/Commercial	No data	1,724	2,087
Single Family	No data	16,329	23,587
Parks- Natural Area	No data	19,595	24,587
Parks- Developed Sites	No data	3,084	1,996
Total	**50,070**	**47,536**	**58,967**

Source Notes

Urban Forest Sequestration: Tracy Morgenstern, Office of Sustainability & Environment, provided data for 2008 urban forest sequestration **(08-80-3, 08-90-0 'Urban Forest')**.

Appendices

Appendix A

Source documentation

The formal inventory is a dataset consisting of electronic files and several paper files. The electronic data files are available on the Office of Sustainability & Environment (OSE) electronic file system and are divided into the following categories:

Index file – A single index file, <community dataset index 08.xls>, lists names and sources of all other files, electronic and paper alike, in the inventory.

Source files – These files are numbered 08-00-00 to 08-90-00. The files are organized by category in the following format:

08-00 Inventory Process and Policy Related Notes
08-09 Master Spreadsheets
08-10 Transportation
08-20 Residential
08-30 Commercial
08-40 Industrial
08-50 Waste
08-60 Electricity
08-70 Population and Employment
08-80 Urban Forestry
08-90 Communications

Reference files – These files have REF in the file title. Each is a copy of a formally published work that is used as a reference source for universal emissions factors or other constants. Filename extensions may be any one of the same set allowed for source files.

Calculation files – These files have WKBK in the file title. All calculation files are Microsoft Excel workbooks. The calculation files document the translation of source and reference data found in non-WKBK files into the final GHG emissions estimates published in this document. File 08-90-0 is the master calculation file for the geographic inventory, and includes at least the highest-level calculations for every datum reported in this document. Every table describing the geographic inventory in this document is duplicated from <08-90-0.xls>.

Every single datum in the calculation files is traceable to one of the source files through the 08-00-00 number provided in the "call no." column of most of the calculation files, or in a few instances to notes below the calculations.

Source Documents Index

Table 19- Source Documents

Call#	Subject	Ext.	Document title	Source
08-00-0	**Inventory Process and Policy**			
08-09-0	**Master WKBK**	xls	Master Spreadsheet	
08-10-0	**Transportation**			
08-11-0	**Road**	doc	2008 vmt memo for green house gas control	Zhong Wang, SDOT
08-11-1	**Road WKBK**	xls	VMT 2008	08-110
08-11-2	**Road**	xls	fleetsummary	Gary Prince, King County
08-11-3	**Road**	xls	Seattle Fleet Miles Traveled	Gary Prince, King County
08-11-4	**Road REF**	pdf	Annual Vehicle distance traveled.	Federal Hwy Administration
08-11-5	**Road**	mht	Table VM-1 - Highway Statistics 2007 - Highway Statistic Series - Policy Information - FHWA	Federal Hwy Administration (http://www.fhwa.dot.gov/policyinformation/statistics/2007/vm1.cfm)
08-11-6	**Road**	xls	Hwy Stats annual vehicle distance traveled vm1	Federal Hwy Administration
08-11-7	**Road WKBK**	xls	US Vehicle miles traveled WKBK	08-11-10
08-11-8	**Road**	xls	updated vehicle list	Gary Prince, King County
08-11-9	**Road**	mht	BTS Table 4-12 Other 2-Axle 4-Tire Vehicle Fuel Consumption and Travel	Federal Hwy Administration (http://www.bts.gov/publications/national_transportation_statistics/html/table_04_12.html)
08-11-10	**Road**	mht	BTS Table 4-11 Passenger Car and Motorcycle Fuel Consumption and Travel	Federal Hwy Administration (http://www.bts.gov/publications/national_transportation_statistics/html/table_04_11.html)
08-11-11	**Road**	xls	Energy Data Book Two-Axle Four-tire trucks Table4_02	Federal Hwy Administration (www.bts.gov)
08-11-12	**Road**	mht	BTS Table 4-14 Combination Truck Fuel Consumption and Travel (a)	Federal Hwy Administration (http://www.bts.gov/publications/national_transportation_statistics/html/table_04_14.html)
08-11-13	**Road**	xls	Single unit truck fuel consumption and travel table_04_13	Federal Hwy Administration
08-11-14	**Road**	xls	Combination truck fuel consumption and travel table_04_14	Federal Hwy Administration
08-11-15	**Road**	xls	2008_vol data from transporation survey.xlsx	SDOT, Vince Prince
08-12-0	**Marine**	.xls	08 vessels	Lucy Fullerton, WSDOT
08-12-1	**Marine**	.xls	CY2008 fuel	Lucy Fullerton, WSDOT
08-12-2	**Marine**	.xls	Ferry fuel allocated by boat 08	Lucy Fullerton, WSDOT
08-12-5	**Marine**	.pdf	Cargo by TEU by month	http://www.portseattle.org/seaport/statistics/
08-12-6	**Marine**	.mht	Port of Seattle 10 Year History Cargo volumes.mht	http://www.portseattle.org/seaport/statistics/
08-12-7	**Marine**	.xlsx	Port of Seattle Cruise Calls	Sarah Flagg, Port of Seattle
08-12-9	**Marine WKBK**	xls	2008 Marine Other-scaled by freight tonnage	08-120, 08-121, 08-122
08-12-10	**Marine**	.mht	Port of Seattle Vessel Calls	http://www.portseattle.org/seaport/statistics/vesselcalls.shtml
08-14-0	**Air**	pdf	KCIA 2007 CCX	Gary Molyneaux (King County), Kathy Himes (PSCAA)
08-14-1	**Air**	pdf	KCIA 2007 and historical aircraft activity	Gary Molyneaux (King County), Kathy Himes (PSCAA)
08-14-3	**Air**	.xls	Jet Fuel Sea-Tac 2008	Russ Simonson, Port of Seattle
08-14-4	**Air**	.doc	Jet Fuel Sea-Tac Airport	Russ Simonson, Port of Seattle
08-14-5	**Air**	.xls	Fuel King County International Airport	Gary Molyneaux (King County), Kathy Himes (PSCAA), 05-047
08-14-6	**Air**	.doc	2006 Sea Tac Survey	Russ Simonson, Port of Seattle
08-14-8	**Air**	pdf	2008 KCIA Fuel Purchase - all fuel	Gary Molyneaux (King County),
08-14-9	**Air**	pdf	SEA-01-164 Peak Week FINAL SUMMARY REPORT 2001	Michael Drollinger, Port of Seatle,
08-14-10	**Air**	pdf	2006 Enplaning Passenger Survey Summary.pdf	Michael Drollinger, Port of Seatle,
08-14-11	**Air**	doc	2006 enplaning survey data discrepancies	Michael Drollinger, Port of Seatle,

08-200	**Residential Buildings**			
08-21-0	**Natural Gas**	.xls	2008 Th UsageBillTaylor	Bill Taylor, PSE
08-22-0	**Oil**	.xls	Oil use washington excel.xls	http://tonto.eia.doe.gov/dnav/pet/pet_cons_
08-22-1	**Oil**	.mht	U_S_ Distillate Fuel Oil and Kerosene Sales by End Use	http://tonto.eia.doe.gov/dnav/pet/pet_cons_
08-22-2	**Oil**	.mht	Washington Distillate Fuel Oil and Kerosene Sales by End Use.mht	http://tonto.eia.doe.gov/dnav/pet/pet_cons_
08-22-3	**Oil**	pdf	eia821_refguide	
08-22-4	**Oil**	pdf	fuel oil and kerosene sales 2007	
08-22-5	**Oil WKBK**	xls	2008 Oil Use Residential	08-222, 05-027
08-22-6	**Natural Gas**	pdf	NG seattle 2008	David Namura, PSE
08-30-0	**Commercial Buildings**			
08-30-0	**Natural Gas**	pdf	NG seattle 2008	David Namura, PSE
08-30-1	**Point Source WKBK**	xls	WKBK Point Source Emissions	08-421, 08-420
08-30-2	**Point Source**	xls	Seattle_2008_sources_Process_quantities	Kathy Himes, PSCAA
08-30-3	**Point Source**	xls	5 year Degree Days 2009.xls	David Easton, Seattle Steam
08-40-0	**Industrial**			
08-40-0	**Natural Gas**	pdf	NG seattle 2008	David Namura, PSE
08-40-1	**Steel**	pdf	Jorgensen Forge - Emission Rpt Data	Steve Van Slyke, PSCAA
08-41-0	**Cement**	.xls	Ash Grove Emissions	Jerry Brown, Ash Grove
08-41-2	**Cement**	xls	Lafarge emissions	Margaret deGravelle, Lafarge
08-41-3	**Cement**	pdf	Lafarge - Emission Rpt Data.	Steve Van Slyke, PSCAA
08-42-0	**Point Source**	.xls	2008_Fuel_Summary_Seattle_Point_Sources	Kathy Himes, PSCAA
08-42-1	**Point Source**	xls	Seattle_2008_sources_Process_quantities	Kathy Himes, PSCAA
08-42-2	**Point Source**	.xls	CO2 AOP Sources	Kathy Himes, PSCAA
08-42-3	**Point Source WKBK**	xls	WKBK Point Source Emissions	08-42-3
08-50-0	**Waste**			
08-50-0	**Waste**	xls	Seattle Waste	Jenny Bagby, SPU
08-51-0	**Closed Landfill**	.xls	Interbay up to 2008-1.xls	Min-Soon Yim, SPU, Solid Waste Field Operations
08-51-1	**Terminal 5**	pdf	T5 Methane 2ndQtr 2008 Report	Hillary Ritenburg, Port of Seattle
08-51-2	**Terminal 5**	pdf	T5 Methane_4Q-2008 Report	Hillary Ritenburg, Port of Seattle
08-51-3	**Terminal 5**	pdf	T5_Methane_1stQTR_2008	Hillary Ritenburg, Port of Seattle
08-51-4	**Terminal 5**	pdf	T5_Methane_3rdQTR_2008	Hillary Ritenburg, Port of Seattle
08-60-0	**Electricity/Energy Imports**			
08-60-1	**Electricity/Energy Imports**	xls	SCL GHG Inventory 2008 - emailed to OSE - Aug 24, 2009	Corinne Grande, SCL
08-60-2	**Electricity/Energy Imports**	xls	08-60-2 City Light Inventory as of 10.29.09	Corinne Grande, SCL
08-60-3	**Electricity Consumption**	xls	2000-2008 totals and Seattle only	Mary Winslow
08-60-4	**Electricity/Energy Imports**	xls	08-60-4 City Light 2008 annualreport	http://www.seattle.gov/light/aboutus/AnnualReport/
08-60-5	**Electricity/Energy Imports**	xls	08-60-5 Copy of geodata history 95-08	Corinne Grande, SCL
08-60-6	**Electricity/Energy Imports**	doc	08-60-6 system for tracking consumption Corinne Grande.docx	Corinne Grande, SCL
08-60-7	**Electricity/Energy Imports**	doc	08-60-7 Rates Ordinance 121098	City of Seattle website
08-70-0	**Population**			
08-70-0	**Population**	xls	Population Estimates Counties	Census Website
08-70-1	**Population**	xls	Population Estimates States	Census Website
08-73-1	**Employment**	xls	2008 Washington Covered Employment	WA Employee Security Department, http://www.workforceexplorer.com/cgi/dataan
08-73-2	**Employment**	pdf	City- Change in Covered Employment	Jenny Pettyjohn, DPD
08-74-0	**WKBK**	xls	Seattle and WA Populationand Employment Data	08-733, 08-732, 08-700, 08-702,
08-80-0	**Urban Forest Sequestration**			
08-80-1	**Urban Forest Sequestration**	pdf	SOURCE Western_WA_OR_Tree_Benefits_Guide.pdf	E. Gregory McPherson, US Forest Service
08-80-2	**Urban Forest Sequestration**	xls	used in ghg inventory	Tracy Morgenstern

Appendix B

Fossil Fuel Emissions Factors

Emission factors associated with fossil fuel consumption are used throughout the inventory. The 2008 inventory uses the same emissions factors used in 2005, which are summarized here:

Table 20- Fossil Fuel Emissions Factors

Fuel	Emission Factor
Gasoline	
1990	2,326 gCO_2/L
2005 & 2008	2,317 gCO_2/L
Diesel	2,615 gCO_2/L
Natural gas	50 gCO_2/MJ
LPG	1,508 gCO_2/L
Jet Fuel	2,501 gCO_2/L

Only CO_2 emissions directly due to combustion of the fuels are included; higher-order emissions from fuel extraction, processing, and transportation are excluded, as are CH_4 and N_2O emissions at combustion (which are at least an order of magnitude smaller and much less precisely known than CO_2 emissions). The emission factors in the table above are derived from the U.S. Inventory **05-802** and are documented in the master spreadsheet **08-90-0 'ef' tab**. Emission factors required for sources other than fossil fuel combustion are documented in the respective inventory chapters and sections.

Appendix C

Population Information

In several cases it was necessary to estimate 2008 emissions by scaling 2005 emissions by population; or to estimate Seattle emissions by scaling a larger region's emissions by population. The population figures used in these estimates are listed below.

Table 21- Population Information by Area and Employment Type

	1990	2005	2008
Seattle			
Residents	516,259	573,911	598,541
Commercial Employees	-	381,237	405,943
Industrial Employees	-	28,129	31,146
King County			
Residents	1,507,305	1,793,583	1,875,519
Commercial Employees	-	918,224	996,628
Industrial Employees	-	101,354	259,149
Washington State			
Commercial Employees	-	2,119,139	2,368,251
Industrial Employees	-	254,437	288,910
U.S. Residents	**248,709,873**	**296,410,404**	**304,059,724**

Source Notes

Population: Resident populations were all acquired from the U.S Bureau of the Census Population Estimates Program (www.census.gov/popest/). Source files for 1990, 2005, and 2008 are **05-011**, **05-051**, and **08-70-0**, respectively.

Seattle commercial and industrial employee totals are from Jennifer Pettyjohn, City of Seattle Department of Planning and Development **(05-907, 08-73-2)**. The City data is first sorted and geocoded by the Puget Sound Regional Council.

King County and Washington State commercial and employee totals are from the Washington State Employment Security department (**05-907, 08-73-1)**. Population totals were compiled in **08-74-0**.