

City of Seattle Municipal Greenhouse Gas Emissions Inventory

2010

CITY OF SEATTLE

OFFICE OF SUSTAINABILITY & ENVIRONMENT

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Municipal Operations Inventory Overview

This inventory report provides a summary of greenhouse gas (GHG) emissions produced by City of Seattle municipal operations for the 2010 calendar year. The inventory is the City's primary way of gauging progress toward meeting Seattle's near and long-term goals of reducing climate pollution, and highlights where emissions are increasing and decreasing. To date, OSE has completed inventories for 1990, 2005, 2008, 2009, and 2010.

The municipal operations inventory captures emissions produced by City operations, closed landfills, and employee commutes, an area where the City can exert policy influence. Emissions are divided into the following eight sectors: City Light Electricity Generation, Solid Waste Landfills, Buildings and Facilities, Employee Commutes, City-owned Vehicles, Government Generated Solid Waste, Employee Air Travel, and Street Lights and Traffic Signals.

The results of the inventory (Figure 1, Table 1) show that overall 2010 emissions from City municipal operations reflect a 2% decrease from 2008 but a 4% increase from 2009. The City of Seattle's largest source of emissions is energy purchased through contracts by Seattle City Light (SCL). The second largest source of emissions is fuel used by the City's vehicle fleet, followed by building and facility energy use, and methane emitted by closed landfills. Although emissions from the electric utility are the largest source of emissions for the City of Seattle, SCL has purchased offsets for these emissions by investing in carbon reduction projects since 2005, effectively zeroing out the carbon footprint of electricity in Seattle.

City of Seattle Municipal GHG Emissions, 1990-2010 (Metric tons carbon dioxide equivalent)

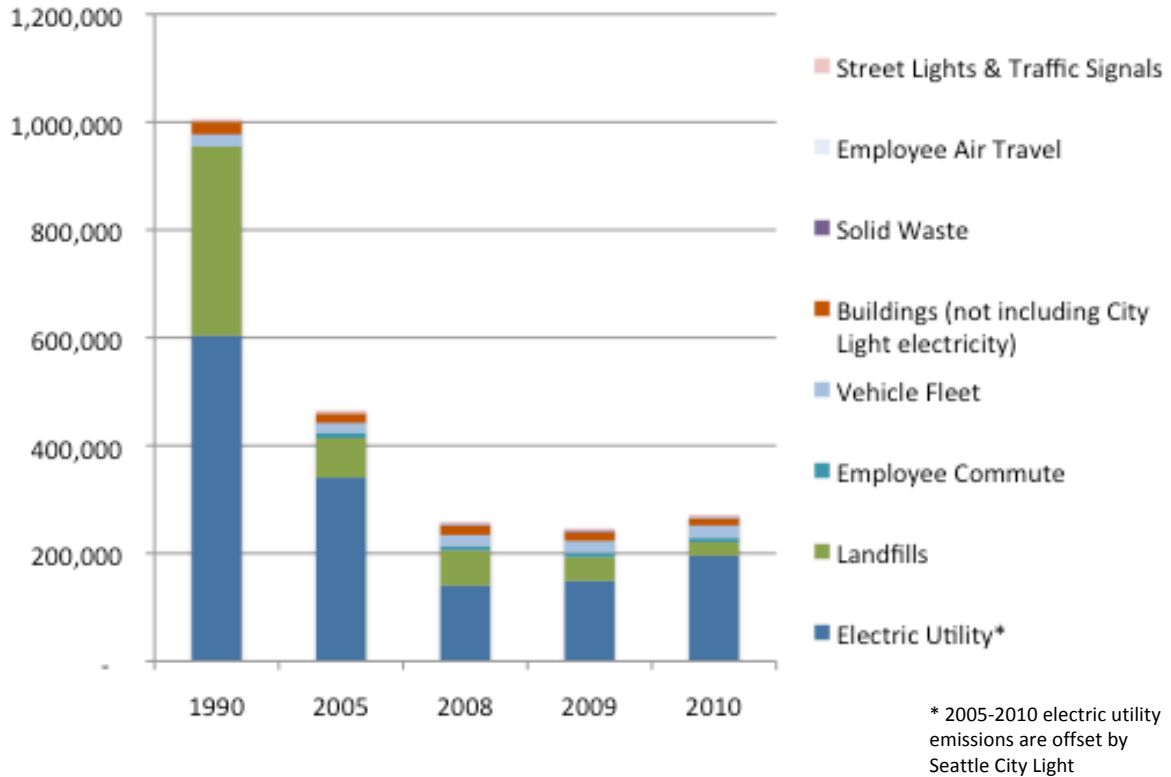


Figure 1 Overview of Municipal GHG Inventory 1990-2010.

Table 1 Emissions from Municipal Operations by Sector, 1990 to 2010¹

¹ The totals and sub-totals listed in the tables and in this report are not to represent all-inclusive, complete totals for Seattle’s operations. These “totals” are only a summation of inventoried emissions using best-available estimation methods. Reporting as a total can be misleading as each inventoried sector may have additional emissions sources associated with them that were unaccounted for, such as Scope 3 sources that could not be estimated. Additionally, reporting a “roll-up” total for multiple sectors can be misleading, as emissions from different scopes can be double-counted when they are reported as one number. For example, if emissions from the Buildings and Municipal Power Generation sectors were reported as a single number, emissions would be double counted, since Seattle City Light provides electricity to most government buildings.

GHG Emissions by Sector	1990	2005	2008	2009	2010	% change 1990-2010	% change 2008-2010	% change 2009-2010
Electric Utility								
Owned generation	594,000	-	-	-	-	-100%	-	-
Switchgear insulation	10,000	5,320	1,810	1,860	418	-96%	-77%	-78%
Transmission and dist. losses	n.d.	n.d.	2,360	2,520	3,380	-	0	34%
Purchased generation**	45,700	335,000	136,000	145,000	192,000	320%	41%	32%
Total	650,000	341,000	140,000	149,000	196,000	-70%	40%	32%
Buildings								
Natural gas heating	20,900	14,900	15,600	14,300	12,500	-40%	-20%	-13%
Refrigerant loss	2,000	13	12	41	17	-99%	42%	-59%
Electricity (Puget Sound Energy)	n.d.	4,230	1,320	1,450	1,460	-	11%	1%
Steam	740	111	157	132	104	-86%	-34%	-21%
Total	23,600	19,200	17,000	15,900	14,100	-40%	-17%	-11%
Electricity (City Light)*	n.d.	3,600	3,320	3,820	4,260	-	28%	12%
Vehicles								
Gasoline	12,400	12,200	12,700	12,100	11,900	-4%	-6%	-2%
Diesel	6,070	3,220	2,050	7,510	11,200	85%	446%	49%
Biodiesel	n.d.	1,210	5,880	2,380	140	-	-98%	-94%
CNG	217	116	54	28	10	-95%	-81%	-64%
Liquid Propane Gas	81	44	-	-	-	-	-	-
Unknown vehicles	3,500	2,280	-	-	-	-	-	-
Refrigerants	n.d.	n.d.	142	142	142	-	-	0%
Total	22,200	19,000	20,800	22,200	23,400	5%	13%	5%
Waste								
Landfills	362,000	78,600	71,200	46,400	12,900	-96%	-82%	-72%
Employee solid waste								
Recycling	n.d.	n.d.	650	541	576	-	-11%	6%
Disposal	n.d.	n.d.	2,890	2,580	2,190	-	-24%	-15%
Total	362,000	78,600	74,700	49,500	15,700	-96%	-79%	-68%
Other Emissions								
Employee commuting	n.d.	9,170	7,590	7,700	7,650	-	1%	-1%
Business air travel	5,060	2,330	2,810	2,160	1,520	-70%	-46%	-30%
Total	5,060	11,500	10,400	9,860	9,160	81%	-12%	-7%
Street Lights*	660	2,300	1,190	1,290	1,610	144%	35%	25%
SubTotal	1,060,000	469,000	263,000	247,000	258,000	-76%	-2%	4%
Optional Information								
Waste-related sequestration	n.d.	n.d.	(3,380)	(3,250)	(2,930)	-	-13%	-10%
Avoided em. from recycling	n.d.	n.d.	(17,700)	(15,200)	(16,000)	-	-10%	5%
Total Emissions	1,060,000	469,000	242,000	228,000	239,000	-77%	-1%	5%

All units are Metric Tons Carbon Dioxide Equivalent, rounded to the nearest hundred.

**These emissions are not included in the inventory total because they are accounted for in the electric utility sector.*

***Emissions from purchased generation are offset by City Light*

Emissions Trends

The following section describes trends in emissions and highlights select Seattle's municipal emission reduction efforts. The arrows indicate whether emissions are increasing, decreasing, or staying the same from 2009 to 2010. A question mark indicates where there is insufficient data to determine emission trends.

- ↑ **Electricity Generation:** From 2009 to 2010, emissions from electricity generation increased by 32% due to an increase in the carbon content of electricity purchased by Seattle City Light to supplement hydropower.

- ↑ **Vehicle Fleet:** Vehicle fleet emissions increased due primarily to the to the City's decision to transition away from biodiesel back to petroleum-based diesel. Emissions increased 5% from 2009 to 2010, and 23% from 2005 to 2010. Both overall gallons of fuel consumed and gallons of gasoline consumed, however, have declined since 2008. Total fuel consumed declined by 2% since 2008 and gasoline consumed decreased by 6% from 2008 to 2010.
- ↓ **Solid Waste Landfills:** Emissions from closed, City-owned landfills decreased by 46%. The closed landfills will continue to emit decreasing amounts of methane until the majority of landfill waste that will decompose does.
- ↓ **Buildings and Facilities:** Emissions from City buildings and facilities have decreased by 12% from 2009 to 2010, and by 27% since 2008. Natural gas consumption decreased by 16% and electricity consumption decreased by 13% from 2008 to 2010. Changes in consumption are most likely explained by fluctuations in the weather and conservation efforts.
- ↓ **Air Travel:** Air travel emissions decreased by 46% from 2008 to 2010 as limited budgets resulted in reduced travel.
- ? **Employee Commute:** Employee commute emissions are estimated based on a biannual survey conducted by King County. The last survey was conducted in 2009 and the next survey will be completed in 2011. The 2010 commute emissions are estimated based on change in number of employees from 2009 to 2010. Since total City employees decreased by 1% from 2009 to 2010, it is likely that total commute emissions followed this trend and decreased slightly as well, but exact commute emissions are not known.
- ? **Government Generated Waste:** Data on the specific amount of waste generated from City of Seattle employees at work is not available. The 2010 government waste data is calculated based on the change in number of City employees from 2009 to 2010, resulting in an estimated 15% decrease in waste emissions.
- ? **Street Lights and Traffic Signals:** The City of Seattle does not have meters on the street lights and traffic signals, so there is no information on changes in electricity usage from year to year. The amount of electricity consumed by street lights and traffic signals in the report is based on estimated monthly electricity usage. Therefore, the report shows the same electricity consumption totals from 2009 to 2010. The electricity emissions from this amount of consumption rose due to the increase in City Light electricity emissions factor.

City Operations Emissions by Sector

The City is interested in the relative magnitude of emissions generated from direct City operations. There are two large sources of emissions included in the inventory that are not directly produced by City operations: emissions from closed landfills and emissions from electricity generation to power buildings not owned by the City of Seattle. To better understand emissions from direct City operations, the following chart excludes these electricity and landfill emissions. When only the electric utility and landfill emissions attributable to direct City operations and services are included in the inventory totals, emissions from vehicle fleets are the largest source of emissions, accounting for 42% of the City's total emissions. Emissions from buildings are second largest source, accounting for about 32% of the City's direct operations emissions.

The "Electricity (SCL)" section of the chart includes only the portion of Seattle City Light emissions associated with electricity consumed by City buildings. The "Electricity (PSE)" section of the chart includes electricity purchased from Puget Sound Energy for City facilities located outside of Seattle City Light's service area. Although Seattle City Light purchases offsets for the electricity emissions shown on the chart, the City chooses to track these emissions because reductions in the amount of electricity the City uses increases the amount of electricity that City Light can sell on the open market. An increase in City Light electricity sold on the market reduces the carbon content of regional electricity use.

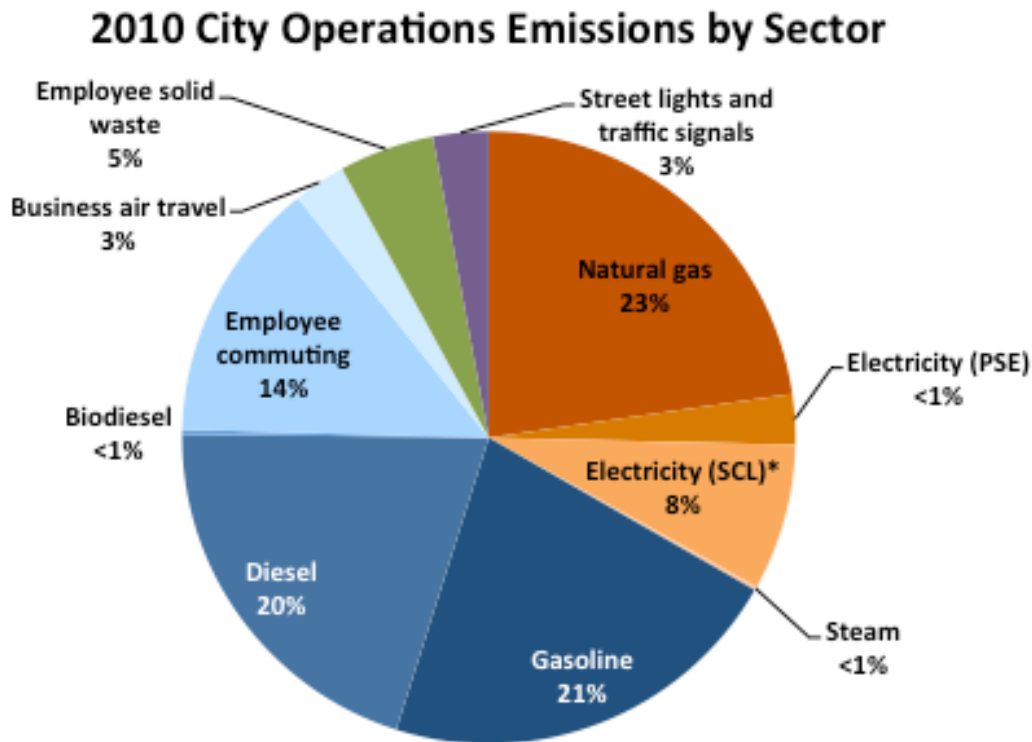


Figure 2 2010 Emissions for Direct Municipal Operations by Sector

Methodology

Local Government Operations Protocol

This inventory was completed using the Local Government Operations Protocol (LGOP), which provides a standardized method for conducting inventories of greenhouse gas emissions produced by local governments. The LGOP was developed by a partnership of organizations in 2008, including the California Air Resources Board, the California Climate Action Registry, The Climate Registry, and ICLEI – Local Governments for Sustainability USA.

This and all emissions inventories represent a best estimate of emissions using available data and calculation methodologies. Emissions estimates are subject to change as better data and calculation methodologies become available in the future.

Greenhouse Gases and Carbon Dioxide Equivalent

In accordance with LGOP recommendations, this inventory calculates and reports all six internationally recognized greenhouse gases regulated under the Kyoto Protocol (Carbon Dioxide, Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons, and Sulfur Hexafluoride).

Greenhouse gas emissions are reported in this inventory as metric tons of carbon dioxide equivalents (MgCO₂e). Since equal quantities of each greenhouse gas influence global warming to a different degree, converting all emissions to CO₂e allows for comparisons between sectors or departments that can assist local policy setting. The global warming potential (GWP) of common greenhouse gases are outlined in the table below. GWP is a measure of the amount of warming a greenhouse gas may cause, measured against the amount of warming caused by carbon dioxide. The higher the GWP, the more potent the greenhouse gas.

Table 2 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 ₂ O	310
Hydroflourocarbons	C _x H _y F _z	Various
Perfluorocarbons	C _y G _y	Various
Sulfur Hexafluoride	SF ₆	23,900

Organizational Boundaries

The inventory uses an operational control framework. The LGOP provides two options for control approaches: operational control or financial control. Operational control includes all emissions from sources for which a government entity has full operational authority, or has the ability introduce and implement policies for operation. Financial control includes operations that are consolidated in a government's financial accounts. The LGOP strongly encourages local governments to utilize operational control for emissions inventories. This method most accurately represents the emissions sources that local governments can most directly influence, and is consistent with other environmental and air quality reporting program requirements.

Inventory Report

The City of Seattle Municipal Inventory is divided into the following sections: Municipal Inventory Overview, Buildings and Facilities, Vehicle Fleet, Street Lights and Traffic Signals, Government Generated Solid Waste, Solid Waste Landfills, Municipal Power Generation, Employee Commute, Employee Air Travel, and Offsets and Other Information. Each section includes emission sources, totals, and a brief analysis of emission trends. A description of the calculation methodologies, an index of source documents, emission factors, and other information, can be found in Appendix B.

1 – Municipal Power Generation

Emissions from the Municipal Power Generation sector result from fuels consumed for the production of electricity. Seattle City Light, a department of the City of Seattle, is one of the nation's largest municipally owned utilities in terms of the number of customers served. The power generation facilities operated by City Light are hydroelectric. In years with normal precipitation, City Light hydroelectric production supplies more than half of Seattle's power needs. The difference is made up by purchasing power from other renewable energy sources, such as hydropower from British Columbia and Bonneville Dam, and from wind farms. When these sources do not meet the City's energy load, City Light also purchases power from other regions on the open market. The overall resource mix of City Light electricity is over 90 percent hydroelectric, resulting in very low emissions.

From 2009 to 2010, municipal generation increased by 19%, and emissions increased by 32%, due to an increase in the amount of energy City Light had to purchase on the open market. Energy sold on the open market has higher emissions factor than City Light's other renewable energy sources. For example, the emissions factor for open market energy in the Pacific Northwest was 1,279 pounds of carbon dioxide per megawatt hour in 2010, compared to 44 pounds of carbon dioxide per megawatt hour for City Light.

The direct emissions from Seattle City Light operations are summarized in Table 3, and include emissions from owned generation, purchased generation, losses in transmission and distribution, and emissions from the leakage of sulfur hexafluoride (SF₆), a gaseous insulator used in electrical switchgear. Each year, a certain quantity of SF₆ must be replaced due to leakage. SF₆ has an extremely high global warming potential of 23,000, so even the small leaked quantity makes a measurable contribution to greenhouse gas emissions. Emissions from Municipal Power Generation are Scope 1 emissions.

In 1990, Seattle had partial ownership in the Centralia coal plant, which generated all of the 594,000 metric tons of carbon dioxide equivalents listed below in Table 4. The City sold its ownership of the plant in mid-2000, so in 2005, all remaining generation facilities owned by SCL were hydroelectric and there are zero emissions from owned generation. The decline in emissions from 2005 to 2008 is due primarily to the ending of the Klamath Falls contract, which provided electricity generated from a natural gas fired plant. SCL replaced the contract with lower-emissions sources of electricity, including wind and hydroelectric sources.

Table 3 Municipal Power Generation by Source

Source	Electricity Generation, MWh					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Owned Generation	8,230,000	5,540,000	4,520,000	4,520,000	5,120,000	-38%	-8%	13%
Purchased Generation	-	6,380,000	5,850,000	5,660,000	6,970,000	-	9%	23%
Totals	8,230,000	11,900,000	10,400,000	10,200,000	12,100,000	47%	2%	19%

Table 4 Municipal Power Emissions by Source

Source	Emissions, MgCO ₂ e					% change		
	1990	2005	2008	2009	2010	1990-2010	2008-2010	2009-2010
Owned Generation	594,000	-	-	-	-	-	-	-
Purchased Generation	45,700	335,000	136,000	145,000	192,000	-	-43%	32%
Transmission & Distribution Losses	n.d.	n.d.	2,360	2,520	3,380	-	-	34%
SF ₆	10,000	5,320	1,810	1,860	418	-96%	-92%	-78%
Totals	650,000	341,000	140,000	149,000	196,000	-70%	-43%	32%

Source Notes

Electricity Generation: All data are from Seattle City Light’s inventory provided in spreadsheet **10-50-03**. **10-50-7** contains information about the emission factor for energy purchased on the open market.

The information needed to quantify direct stationary combustion GHG emissions for Seattle City Light is readily available from the annual inventory produced by Seattle City Light in accordance with their reporting to The Climate Registry. It includes information on generation owned by SCL, energy purchases made by SCL, SF₆ usage, transmission and distribution losses, offsets purchased, and entity-wide greenhouse gas emission factors.

2 – Buildings and Facilities

The operation of buildings contributes to greenhouse gas emissions in two major ways: from consumption of electricity and fuels such as natural gas, and from leakage of materials used for fire suppression, air conditioning, and refrigeration equipment, which emit hydroflourocarbons (HFCs) and other greenhouse gases. The majority of emissions are from electricity and natural gas consumption. Building emissions decreased by 27% from 2008 to 2010, and by 12% from 2009 to 2010. The decrease is most likely primarily due to warmer weather in 2010 than in 2009 and 2008. For instance, there were 7% fewer heating degree days in 2010 than in 2009, and 10% fewer in 2010 than in 2008. A heating degree day is the difference between the average daily temperature and 65 degrees, and is used to measure weather trends from year to year.² Also contributing to the decrease, the City of Seattle has conducted energy efficiency upgrades in many buildings, pools, and other facilities, including installing energy efficient lighting in the Seattle Municipal Tower, new boilers at the Seattle Center, and new pool covers at community centers.

Table 5 1990- 2010 Buildings and Facilities Energy Consumption by Source

Energy Type	Energy Consumption					% change		
	1990	2005	2008	2009	2010	1990-2010	2008-2010	2009-2010
PSE Electricity (MWh)	n.d.	11,000	13,900	13,900	12,600	-	15%	-9%
Natural Gas (Th)	3,420,000	2,770,000	2,920,000	2,680,000	2,350,000	-31%	-15%	-12%
Steam (MLBs)	n.d.	1,890	1,770	1,480	1,240	-	-34%	-16%
SCL Electricity (MWh)	n.d.	128,000	154,000	155,000	143,000	-	12%	-8%

² <http://www.seattle.gov/light/ddays.html>

Table 6 1990- 2010 Buildings and Facilities Emissions by Source

Energy Type	Emissions (MgCo2e)							
	1990	2005	2008	2009	2010	% change 1990-2010	% change 2008-2010	% change 2009-2010
PSE Electricity (MWh)	n.d.	4,230	1,180	1,610	1,460	-	-65%	-9%
Natural Gas (Th)	20,900	14,900	15,600	14,300	12,500	-40%	-16%	-13%
Steam (MLBs)	740	111	157	132	104	-86%	-6%	-21%
SCL Electricity (MWh)	n.d.	3,590	2,020	2,210	2,800	-	-22%	27%
Total	21,600	19,200	16,900	16,000	14,100	-35%	-27%	-12%

The following chart (Figure 3) shows total emissions from City of Seattle building and facilities by energy type. The majority of building emissions are from natural gas use, followed by emissions from electricity use, and only a very small percentage of emissions are from steam consumption. SCL electricity is not included in total emissions because these emissions are accounted for in the electric utility sector. SCL purchases offsets for these emissions, effectively zeroing them out.

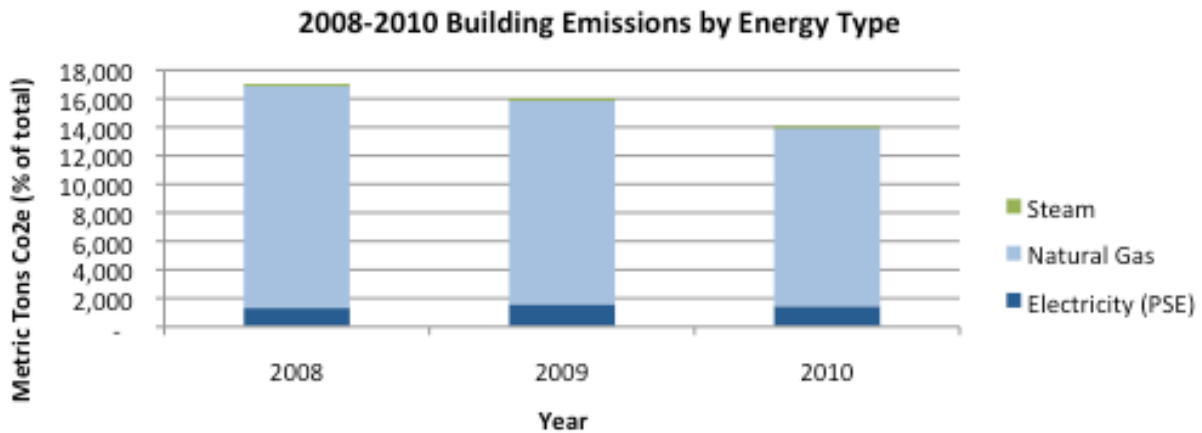


Figure 3 2008-2010 Building Energy Emissions by Energy Type

Building Emissions by Department Ownership

The following tables and charts show 1990 to 2010 energy consumption from steam, natural gas and electricity consumption by City Department. Department electricity consumption decreased from 2009 to 2010 for all departments except the Fire Department, which had a 24% increase in electricity consumption. Natural gas consumption likely decreased due to the warmer winter weather in 2010 than 2009. Electricity consumption for the Fire Department likely increased due to the expansion of several fire stations, which occurred as part of the Fire Levy, and the installation of new, electricity-intensive equipment in the new buildings.

Electricity Consumption and Emissions

The following two tables show electricity consumption and emissions by City department. Since electricity emissions are already accounted for by City Light electricity generation emissions, these emissions are not added to the inventory total and are included here for informational purposes.

Table 7 1990 - 2010 Electricity Consumption

Department	Electricity Consumption, MWH					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Facilities & Admin. Services	n.d.	52,000	53,000	54,800	47,000	-11%	-14%
Fire	n.d.	4,320	6,700	6,180	7,400	10%	20%
Library	n.d.	8,600	10,600	9,460	9,150	-14%	-3%
Parks	n.d.	45,800	15,300	23,900	17,300	13%	-28%
Seattle Center	n.d.	12,300	17,000	15,800	14,900	-12%	-6%
Seattle City Light	n.d.	n.d.	34,500	33,700	30,700	-11%	-9%
Seattle Dept of Trans.	n.d.	3,020	3,140	2,870	2,750	-12%	-4%
Seattle Public Utilities (SCL & PSE)	n.d.	35,300	27,300	28,200	26,100	-4%	-7%
City misc accounts	n.d.	334	-	-	-	-	-
Total	n.d.	161,000	168,000	175,000	155,000	-8%	-11%

Table 8 1990 - 2010 Electricity Emissions

Department	Electricity Emissions, MgCo2e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Facilities & Admin. Services	n.d.	1,460	698	779	921	32%	18%
Fire	n.d.	121	88	88	145	65%	65%
Library	n.d.	242	140	135	179	28%	33%
Parks	n.d.	644	202	340	338	67%	-1%
Neighborhoods	n.d.	4	-	-	-	-	-
Seattle Center	n.d.	344	224	224	292	30%	30%
Seattle City Light	n.d.	n.d.	453	479	602	33%	26%
Seattle Dept of Trans.	n.d.	85	45	47	59	31%	26%
Seattle Public Utilities (SCL & PSE)	n.d.	685	1,360	1,810	1,720	26%	-5%
City misc accounts	n.d.	9	-	-	-	-	-
Total	n.d.	3,600	3,210	3,900	4,260	33%	9%

2008-2010 Electricity Consumption by Department Ownership

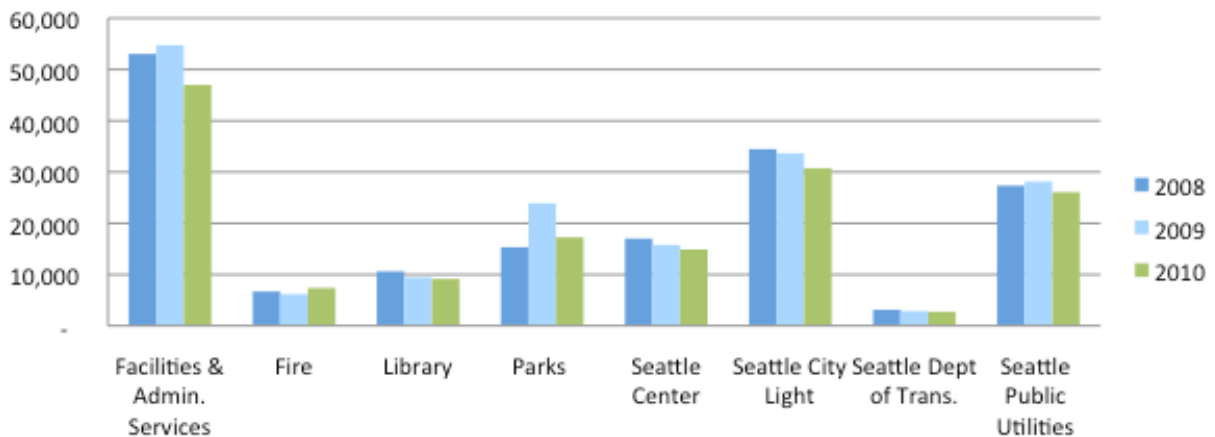


Figure 4 2008-2010 Electricity Consumption by Department Ownership

Natural Gas Consumption

The following tables show total natural gas consumed and emissions produced from natural gas per department. Natural gas consumption and emissions decreased for all departments from 2009 to 2010 except Seattle City Light.

Table 9 1990-2010 Natural Gas Consumption

Department	Natural Gas Consumption, Therms					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Facilities & Admin. Services	582,000	771,000	617,000	586,000	519,000	-11%	-16%	-11%
Fire	133,000	170,000	232,000	201,000	182,000	37%	-22%	-9%
Library	81,300	92,900	99,300	97,500	74,600	-8%	-25%	-23%
Parks	1,560,000	1,120,000	1,290,000	1,220,000	1,070,000	-31%	-17%	-12%
Seattle Center	651,000	490,000	563,000	455,000	390,000	-40%	-31%	-14%
Seattle City Light	n.d.	n.d.	54,400	35,800	37,000	-	-32%	3%
Seattle Dept of Trans.	n.d.	n.d.	8,380	7,490	7,400	-	-12%	-1%
Seattle Public Utilities	415,000	93,400	64,400	76,200	66,620	-84%	3%	-13%
Unkown accts	-	34,200	-	-	-	-	-	-
Total	3,420,000	2,770,000	2,920,000	2,680,000	2,350,000	-31%	-20%	-12%

Table 10 1990-2010 Natural Gas Emissions

Department	Natural Gas Emissions, MgCo2e					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Facilities & Admin. Services	3,560	4,070	3,280	3,120	2,760	-22%	-16%	-12%
Fire	814	896	1,230	1,070	969	19%	-21%	-9%
Library	497	490	528	519	397	-20%	-25%	-24%
Neighborhoods	16	-	-	-	-	-	-	-
Parks	9,500	5,910	6,840	6,510	5,710	-40%	-17%	-12%
Seattle Center	3,980	2,580	3,000	2,420	2,080	-48%	-31%	-14%
Seattle City Light	n.d.	265	289	190	197	-	-32%	4%
Seattle Dept of Trans.	n.d.	n.d.	45	40	39	-	-13%	-3%
Seattle Public Utilities	2,535	492	343	405	354	-86%	3%	-13%
Unkown accts	-	180	-	-	-	-	-	-
Total	20,900	14,900	15,600	14,300	12,500	-40%	-20%	-13%

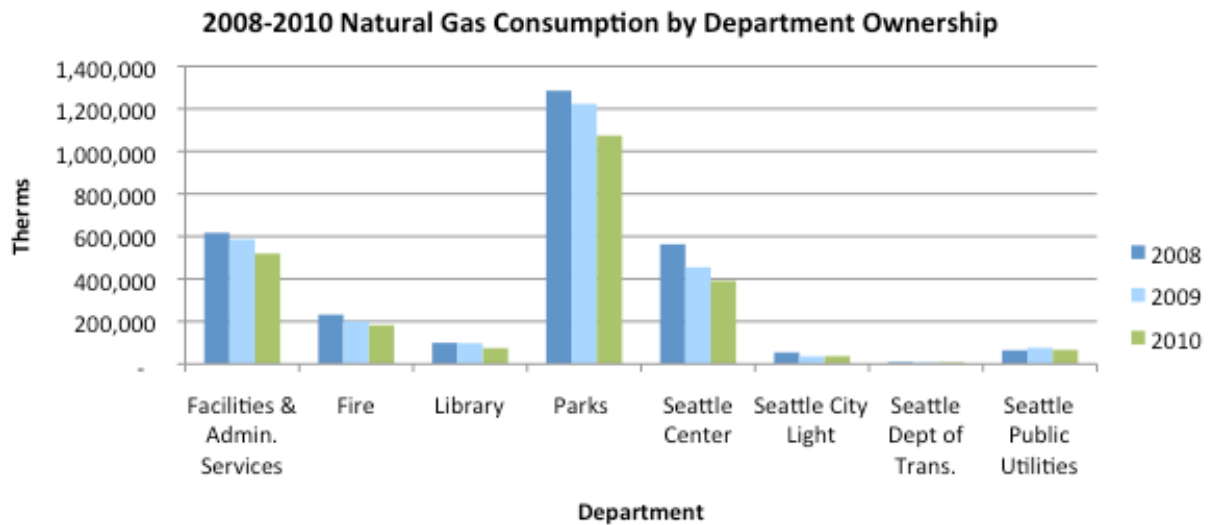


Figure 5 2008-2010 Natural Gas Consumption by Department Ownership

Steam Consumption and Emissions

Pounds of steam consumed by City of Seattle decreased by 16% from 2009 to 2010 and emissions decreased by 21%, demonstrating a decrease in the carbon content of steam produced by Seattle Steam

from 2009 to 2010. Since 1990, the City of Seattle has owned four buildings that receive steam energy: the Arctic Building, the Dexter-Horton Building, Fire Station #10 (Department Headquarters), and the Central Library. In May of 2005, the City sold the Arctic Building so the emissions in Table 11 and 12 represent only those occurring prior to sale. The Dexter-Horton Building was sold in 2000 so only contributed to 1990 steam emissions.

Table 11 1990-2010 Steam Consumption

Department	Steam Consumption, MLBs					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
FAS (Arctic Building)	n.d.	690	-	-	-	-	-
Fire (Headquarters)	n.d.	751	954	854	783	-18%	-8%
Library (Central Library)	n.d.	451	819	629	455	-44%	-28%
Total	n.d.	1,890	1,770	1,480	1,240	-30%	-16%

Table 12 1990-2010 Steam Emissions

Department	Steam Emissions, MgCo2e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
FAS (Arctic Building)	n.d.	64	-	-	-	-	-
FAS (Dexter-Horton Building)	n.d.	-	-	-	-	-	-
Fire (Headquarters)	n.d.	69	85	76	65	-24%	-14%
Library (Central Library)	n.d.	42	73	56	39	-47%	-30%
Total	740	175	157	132	104	-34%	-21%

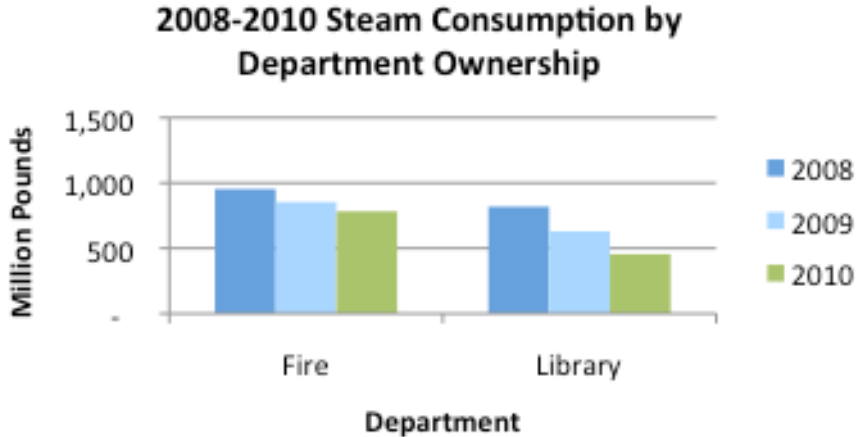


Figure 6 2008-2010 Steam Consumption by Department Ownership

Source Notes

Natural gas and electricity data sources:

- **City Light:** Natural gas and electricity consumption from City Light facilities was provided by City Light in **10-11-18**.
- **Fleets & Administrative Services:** FAS provided natural gas and electricity consumption data for FAS facilities in **10-11-1**.
- **Library:** Library staff provided Library electricity, steam, and natural gas consumption data in **10-11-9**.
- **Parks:** Parks Department provided 2010 electricity consumption in **10-11-3** and natural gas consumption in **10-11-4**.
- **Seattle Center:** Electricity and natural gas consumption data for Seattle Center in **10-11-13**.
- **Seattle Department of Transportation:** Seattle City Light provided SDOT electricity consumption in **10-20-13**. Natural gas records were provided by Valerie Rucker and Kathy Larson of Puget Sound Energy.
- **Seattle Public Utilities:** SPU provided electricity and natural gas consumption data for SPU in **10-11-12**.

Steam consumption: Seattle Steam provided 2010 steam consumption in million pounds and carbon dioxide emissions in file 10-13-1. Seattle Steam calculated emissions based on the carbon content of their fuel mix. There are two City of Seattle facilities that use steam – the Central Library, and the Fire Station Headquarters.

City Light Electricity: The departmental totals were multiplied by the 2008 and 2009 Seattle City Light emission factor (28.99 and 31.35 lbs CO₂e/MWh, respectively) to determine annual emissions in metric tons of carbon dioxide equivalent.

Puget Sound Energy Electricity: PSE electricity consumption totals were multiplied by the 2008 and 2009 PSE emissions factor for electricity (.808 lbs Co₂e/MWh and .978 lbs Co₂e/MWh).

Natural gas: Departmental natural gas totals were multiplied by the pipeline national average natural gas emission factor of 53.02 kg CO₂/MMBtu from table G.1 of LGO Protocol v1.1 to determine annual emissions in metric tons of carbon dioxide equivalent.

3 – Vehicle Fleet

The City of Seattle operates a vehicle fleet with approximately 4,100 vehicles. About half the fleet consists of light duty passenger cars, light trucks and vans, while the other half are heavy-duty vehicles. Close to 600 of the light duty vehicles are gasoline electric hybrids. The operation of vehicles contributes to greenhouse gas emissions in two major ways. Vehicles burn gasoline, diesel, and other fuels, which results in greenhouse gas emissions. In addition, vehicles with air conditioning or refrigeration equipment emit hydrofluorocarbons (HFCs) and other greenhouse gases when these systems leak.

The City of Seattle vehicle fleet is a source of Scope 1 emissions from the combustion of mobile fuels, and to a lesser extent refrigerants that leak from vehicle air conditioning systems. Refrigerant leakage from vehicles is calculated by the amount of refrigerant replaced each year. The following table and figures show amount of fuel consumed and emissions generated from City-owned vehicle fleets.

Emissions from vehicle fuel consumption increased by 12% from 2008 to 2010 and 5% from 2009 to 2010. Gasoline consumption decreased by 2% and diesel consumption increased by 48%, due to a decrease in biodiesel consumption.

Table 13 Vehicle Fleet Fuel Consumption by Source

	Fuel Consumption, Gallons					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Gasoline	1,400,000	1,390,000	1,440,000	1,380,000	1,350,000	-4%	-6%	-2%
Diesel	605,000	321,000	201,000	736,000	1,090,000	80%	442%	48%
Biodiesel (B20)	-	572,000	244,000	22,600	16,200	-	-93%	-28%
Biodiesel (B40)	-	-	635,000	358,000	1,350	-	-100%	-100%
CNG	32,500	16,800	7,840	4,080	1,490	-95%	-81%	-63%
LPG	14,130	7,780	-	-	2,020	-	-	-
Other vehicles	n.d.	n.d.	-	-	-	-	-	-
Totals	2,050,000	2,300,000	2,530,000	2,500,000	2,470,000	20%	-2%	-1%

Table 14 Vehicle Fleet Emissions by Source

	Emissions by Fuel Type, MgCo2e					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Gasoline	12,400	12,200	12,700	12,100	11,900	-4%	-6%	-2%
Diesel	6,070	3,220	2,050	7,510	11,200	85%	446%	49%
Biodiesel (B20)	n.d.	1,210	1,990	185	132	-	-93%	-29%
Biodiesel (B40)	n.d.	-	3,890	2,190	8	-	-100%	-100%
CNG	217	116	54	28	10	-95%	-81%	-64%
LPG	81	44	-	-	-	-100%	-	-
Other vehicles	3,500	2,280	-	-	-	-100%	-	-
Totals	22,200	19,000	20,700	22,100	23,200	5%	12%	5%

Table 15 Vehicle Refrigerant Usage

	Refrigerant Consumed (pounds)					% change 2008-2010
	1990	2005	2008	2009	2010	
Refrigerants	n.d.	n.d.	240	240	240	0%

Table 16 Vehicle Refrigerant Emissions

	Emissions (MgCo2e)					% change 2008-2010
	1990	2005	2008	2009	2010	
Refrigerants	n.d.	n.d.	142	142	142	0%

The following chart shows change in carbon dioxide emissions by fuel source from City-owned vehicles from 1990 to 2009.

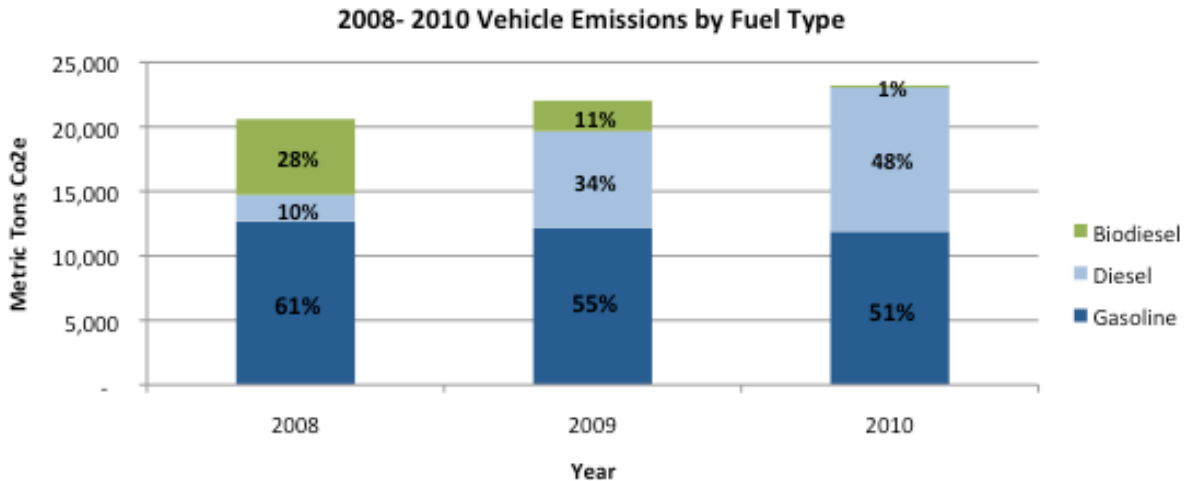


Figure 7 2008-2010 Vehicle Emissions by Fuel Type

Fuel Consumption by Department

The following table shows the total gallons of fuel consumed by each City of Seattle department that uses fleet vehicles. The Police Department consumed the most fuel of any department in 2008 and 2009, followed by SPU. Total fuel consumption decreased by 30,000 gallons from 2009 to 2010, a 1% decrease.

Table 17 Total Fuel Consumption by Department

Dept	Total Fuel Consumption (gal)				
	1990	2005	2008	2009	2010
Arts & Culture	n.d.	253	265	107	361
Dept of Exec Admin.	n.d.	13,800	12,200	12,800	10,700
Dept of Info. Technology	n.d.	4,970	4,810	3,470	3,560
Dept of Planning & Develop.	n.d.	22,000	24,200	20,600	18,500
Facilities & Admin. Services	n.d.	35,700	31,200	36,500	35,000
FAS - Motorpool	n.d.	26,000	20,600	14,700	9,930
Fire	n.d.	194,000	198,000	196,000	198,000
Housing	n.d.	1,630	1,580	1,610	1,480
Human Services	n.d.	5,370	5,180	4,210	3,840
Intergovernmental Relations	n.d.	-	116	396	-
Law	n.d.	126	332	273	122
Library	n.d.	13,800	14,700	14,400	14,000
Mayor's Office	n.d.	1,830	1,330	1,210	581
Municipal Court	n.d.	195	330	249	172
Neighborhoods	n.d.	415	592	773	629
Parks	n.d.	301,000	283,000	273,000	259,000
Police	n.d.	600,000	615,000	641,000	682,000
Seattle Center	n.d.	2,080	2,370	1,440	1,640
Seattle City Light	n.d.	337,000	439,000	443,000	443,000
Seattle Dept of Trans.	n.d.	282,000	309,000	282,000	259,000
Seattle Office of Civil Rights	n.d.	59	-	-	-
Seattle Public Utilities	n.d.	454,000	566,000	555,000	528,000
Total		2,300,000	2,530,000	2,500,000	2,470,000

Vehicle Fleet Emissions by Department

As shown on the chart below, emissions from the City’s vehicle fleet have steadily increased or stayed roughly the same across most departments since 2008. The following departments have vehicle fleet emissions that total less than 100 metric tons carbon dioxide equivalent, or less than 5,000 gallons of fuel consumed, and are not included in Figure 8: Arts & Culture Human Services, Information Technology, Housing, Law, Mayor’s Office, Municipal Court, Neighborhoods, and Seattle City Light.

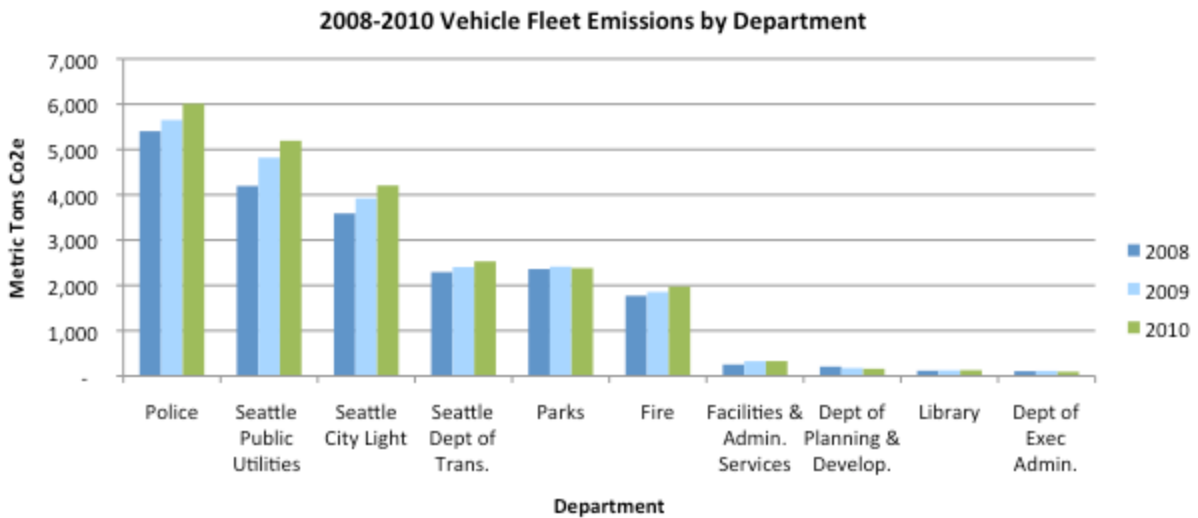


Figure 8 2008-2010 Vehicle Fleet Emissions by Department

Per Employee Vehicle Fleet Emissions

Per employee vehicle fleet emissions were calculated by dividing department fuel emissions by the number of employees per department. As shown on the chart below, Seattle Public Utilities has the highest per employee fuel use, followed by SDOT, Police, and the Parks department (Figure 9). Figure 9 includes only departments with employee emissions greater than .3 metric tons. The chart shows departments in order of highest per employee emissions for 2010.

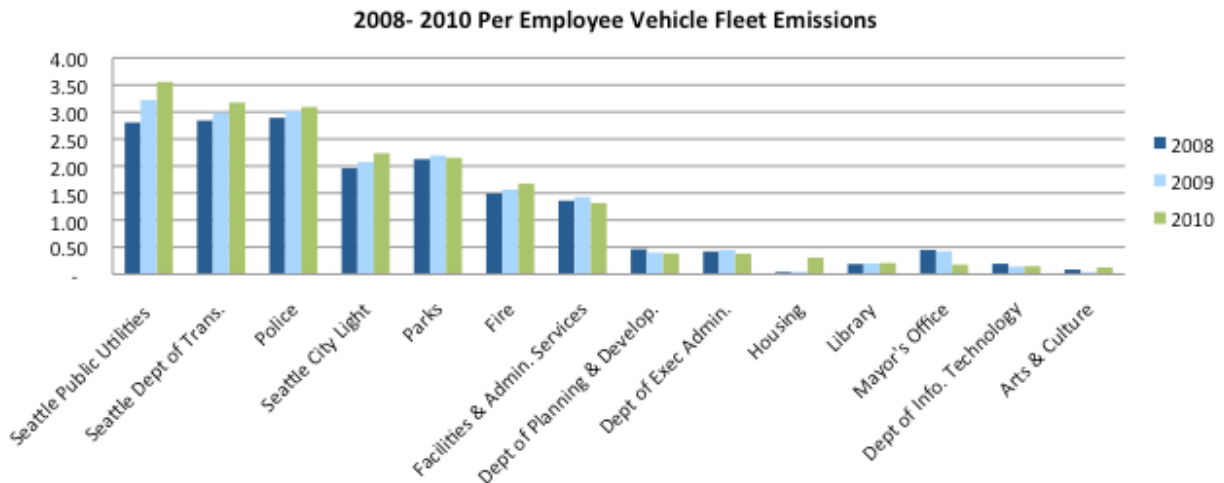


Figure 9 2008-2010 Vehicle Emissions per Employee by Department

Source Notes

Vehicle Fleet: Fleets and Administrative Services provided data on vehicle fleet fuel consumption for all departments in **10-20-3**. Seattle City Light provided fuel use for City Light consumption at the Skagit watershed work site in **10-50-03**.

The City of Seattle uses gasoline, diesel, B20 biodiesel, B40 biodiesel, and compressed natural gas to power its vehicle fleet. The totals for each fuel type category were multiplied by emission factors from Table G.11 of LGO Protocol v1.1 – Default CO₂ Emission Factors for Transport Fuels – to determine annual emissions in metric tons of carbon dioxide. For biofuel blends, the biogenic portion of the fuel was calculated and is reported separately from the fossil fuel component.

2010 Emission Factors		
Fuel type	Value	Units
Gasoline	8.78	kgCO ₂ /gal
Diesel	10.15	kgCO ₂ /gal
B100	9.45	kgCO ₂ /gal
CNG	6.90	kgCO ₂ /gal

Source: Table G.11 of LGO Protocol v1.1

Vehicle Refrigerant Calculations:

The quantification of emissions from **refrigerant leakage** follows the alternate methodology outlined in section **6.6.2.1 of LGO Protocol v1.1** – the Simplified Mass Balance Method. Using data provided by Chris Wiley of FAS in **10-20-03**, factors from table G.1 of LGO Protocol v1.1 were used to determine annual emissions in metric tons of carbon dioxide equivalent. Refrigerant calculations are available in file **10-90-01 tab 'Vehicles- Fuel'**.

4 – Solid Waste

Closed Landfills

Emissions from the Solid Waste Landfills sector are the result of historic waste deposited in closed City of Seattle landfills. There are no active landfills within the City of Seattle limits, but there are six closed landfills that the City operates: Interbay, Genessee, Judkins Park, South Park, Kent Highlands, and Midway. Of these landfills, Kent-Highlands and Midway have systems that fully cap and flare methane, and Interbay has a partial monitoring system. For the unmonitored landfills – Genessee, Judkins Park, and South Park – emissions are estimated based on a per-volume emissions rate assumed to be equal to that of Interbay. The scale of these emissions depends upon the size and type of the landfill and the presence of a landfill gas collection system. Landfill emissions are Scope 1 emissions. See Appendix B for a definition of scopes.

After being placed in a landfill, organic waste (such as paper, food scraps, and yard trimmings) is initially decomposed by aerobic bacteria. After the oxygen has been depleted, the remaining waste is available for consumption by anaerobic bacteria, which break down organic matter into substances such as cellulose, amino acids, and sugars. These substances are further broken down through fermentation into gases and organic compounds that form the substrates for the growth of methanogenic bacteria. These CH₄-producing anaerobic bacteria convert the fermentation products into stabilized organic materials

and biogas consisting of approximately 50% carbon dioxide and 50% methane, by volume. It is important to note that a significant amount of carbon does not decompose and is sequestered in the landfill.

Once a landfill is closed and is no longer accepting material, methane emissions gradually decline over time as the waste decays. This trend can be seen with the decline in emissions from 1990 to 2010. The emissions estimates shown here are based on the latest EPA methods found in the Mandatory Reporting Rule, estimating methane capture for capped landfills at 95%. Table 18 shows the decrease in landfill emissions since 1990. Emissions have decreased by 96% since 1990 and by 72% from 2009 to 2010.

Table 18 Landfill Emissions by Source

Landfill	Emissions, MgCO ₂ e					% change 1990-2010	% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010			
Interbay	68,000	31,600	27,900	18,700	4,600	-93%	-84%	-75%
Genessee	64,600	30,000	26,500	17,700	4,370	-93%	-84%	-75%
Judkins Park	11,600	5,380	4,740	3,170	782	-93%	-84%	-75%
South Park	24,700	11,500	10,100	6,790	1,670	-93%	-83%	-75%
Kent-Highlands	193,000	n.d.	1,300	1,100	987	-99%	-24%	-10%
Midway	n.d.	n.d.	600	500	521	-	-13%	4%
Totals	361,700	78,600	71,200	46,400	12,900	-96%	-82%	-72%

Source Notes

Closed 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). Seattle Public Utilities provided the 2010 Interbay monitoring data (**10-45-1**), which indicates that 639 MgCO₂e 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 (**10-90-0 '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. Seattle Public Utilities provided the landfill volume ratios (**05-066**). Calculations are in **10-90-0 'Waste-Landfills'**.

This inventory uses equation HH-8 from the EPA Mandatory Reporting Rule to calculate emissions from the Midway and Kent-Highlands landfills. The calculations were conducted by SPU, and are available in **10-45-1**.

Government Generated Solid Waste

Emissions reported in the Government Generated Solid Waste section are an estimate of waste produced by City of Seattle employees while at work and are a Scope 3 source. Typical sources of waste include paper and food waste from offices and facilities, construction waste, and plant debris. The sources of waste emissions included in the inventory include:

- Emissions from collection and processing of waste and recycled materials.
- Emissions from transport of waste to the landfill.
- Methane (CH₄) generated from decomposition of organic waste in the landfill.

Table 19 shows the amount of waste emissions produced for each of the above sources, as well as emissions avoided from landfill carbon storage and from recycling. Waste emissions decreased by 12%

from 2009 to 2010, based on the decrease in the number of City employees. Avoided emissions from recycling and carbon storage increased by 5% from 2009 to 2010. The details of avoided emissions sources are described below.

Table 19 Government Generated Solid Waste Emissions Produced and Avoided by Source

Type	Emissions, MgCO ₂ e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Waste Disposal Collection	n.d.	n.d.	169	150	139	-18%	-7%
Waste Transport to Landfill	n.d.	n.d.	455	402	374	-18%	-7%
Landfill CH ₄	n.d.	n.d.	2,260	2,030	1,680	-26%	-17%
Recycling Collection	n.d.	n.d.	126	115	116	-8%	1%
Recycling Processing	n.d.	n.d.	523	426	460	-12%	8%
<i>Total emissions produced</i>			3,540	3,120	2,760	-22%	-12%
Landfill Carbon Stored	n.d.	n.d.	(3,380)	(3,250)	(2,930)	-13%	-10%
recycling	n.d.	n.d.	(3,260)	(2,980)	(3,590)	10%	20%
Avoided emissions from manufacture of new materials and products	n.d.	n.d.	(14,400)	(12,200)	(12,400)	-14%	2%
<i>Total emissions avoided</i>	n.d.	n.d.	(21,100)	(18,500)	(19,000)	-10%	3%
Total	n.d.	n.d.	(16,900)	(14,800)	(15,600)	-8%	5%

Solid waste disposal in the City of Seattle is contracted to a third-party supplier. This contractor services the entire city, including City of Seattle facilities. Since data on waste generated per facility is not available, pounds of waste produced by City employees are estimated based on the City’s share of total citywide employment. While it is likely that City of Seattle emissions did decline consistent with the decline in waste citywide, these figures are most likely driven by citywide economic trends and the aggregate impact of citywide efforts to reduce waste and boost recycling rates more so than operating policies at City of Seattle facilities.

Avoided Emissions from Recycling and Landfill Carbon Stored

Avoided emissions from recycling and carbon stored from landfill waste far exceed the emissions generated from waste collection, transport to the landfill, and the methane released from decaying waste, as shown in Figure 10.

Recycling

By recycling large amounts of material, Seattle Public Utilities' recycling program avoids emissions associated with disposal of municipal solid waste, as well as the manufacture of new materials and products. The benefit of avoided materials manufacture far surpasses emissions from collecting and processing recyclable material. In 2010, the government operations share of avoided emissions from collection and disposal was 3,590 metric tons CO₂e. Avoided manufacturing emissions were 12,400 metric tons CO₂e.

Table 20 Avoided Emissions from Recycling

Type	Emissions, MgCO ₂ e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Avoided landfill emissions from recycling	n.d.	n.d.	(3,260)	(2,980)	(3,590)	10%	20%
Avoided emissions from manufacture of new materials and products	n.d.	n.d.	(14,400)	(12,200)	(12,400)	-14%	2%
Total	n.d.	n.d.	(15,700)	(13,200)	(16,000)	2%	21%

Landfill Carbon Stored

The majority of government generated solid waste 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. The values 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. In 2010, carbon sequestration in landfills from government-generated solid waste was 2,930 metric tons of CO₂e.

Table 21 Landfill Carbon Stored

Type	Emissions, MgCO ₂ e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Landfill Carbon Stored	n.d.	n.d.	(3,380)	(3,250)	(2,930)	-13%	-10%

The following chart graph shows how the emissions avoided through recycling far exceed the emissions produced from waste collection, transport, and landfill decay.

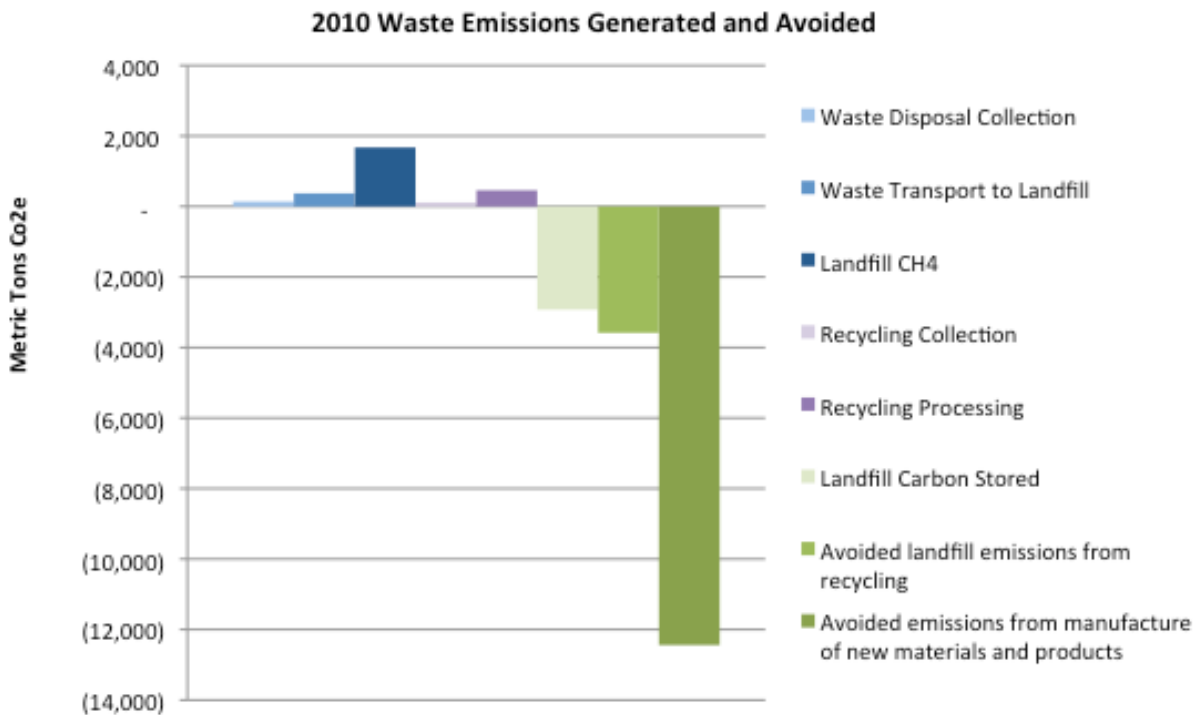


Figure 10 2009 Waste Emissions Generated and Avoided

Source Notes

Employee generated solid waste, recycling, and other avoided emissions: SPU supplied all waste management emissions data in **10-40-1**. SPU maintains a thorough inventory of municipal solid waste generation and disposal, as well as statistics on solid waste generation and disposal amounts for various different occupation categories and facility types. The City of Seattle uses the EPA WARM method to estimate the emissions impact of its waste management practices.

The City’s share of total waste was based on the City’s share of citywide employment. The City has 10,998 employees. Citywide employment is 501,234, making the City’s share of total waste 2.2%. As such, for each category of recycling and waste disposal, government operations were assumed to contribute 2.2% of the citywide total.

5 – Street Lights and Traffic Signals

City of Seattle street lights and traffic signals are a source of Scope 2 emissions from electricity consumption. In addition to the City’s 82,000 street lights, this section also includes electricity consumed by other traffic control signs and pedestrian crossing signals. The City does not have meters that track street lighting and traffic signal usage and electricity usage is estimated based on monthly electricity bills. Therefore, there is no data on changes in electricity usage from 2009 to 2010. Emissions based on the estimated data from street lights and traffic signals increased by 25% from 2009 to 2010 due to a small increase in the emissions factor of Seattle City Light electricity. The City is in the midst of a major lighting replacement initiative in which 40,000 street lights with energy-efficient LED technology will be installed during the next 5 years. This will result in a significant decline in emissions from lighting.

Table 22 Street Light and Traffic Signal Electricity Consumed by Source

	Electricity Consumed, KWh				
	1990	2005	2008	2009	2010
Street Lighting	n.d.	79,300	79,100	79,100	79,100
Pedestrian Lighting	n.d.	-	197	197	197
Traffic Control	n.d.	3,560	2,950	2,950	2,950
Totals	n.d.	82,900	82,200	82,200	82,200

Table 23 Street Light and Traffic Signal Emissions by Source

	Emissions, MgCO ₂ e					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Street Lighting	n.d.	2,200	1,150	1,240	1,550	35%	25%
Pedestrian Lighting	n.d.	n.d.	3	3	4	33%	33%
Traffic Control	n.d.	100	43	46	58	35%	26%
Totals	n.d.	2,300	1,190	1,290	1,610	35%	25%

Source Notes

Street Lights: City Light provided data on street light and traffic signals in **09-30-02**. 2010 totals are assumed to be the same as 2009 totals, and are estimated based on electricity bills, since no meters are available.

Monthly energy use totals in kilowatt hours were provided by Seattle City Light for street lighting, traffic signals, and pedestrian lighting. Monthly usage was multiplied by 12 to achieve annual totals. The totals for each category were multiplied by the 2010 Seattle City Light emission factor (.0196 MgCo2e/ MWh) to determine annual emissions in metric tons of carbon dioxide equivalent.

6 – Employee Commute

Emissions from the Employee Commute sector result from the combustion of mobile fuels in personal vehicles and carpools from travel to and from work. These are Scope 3 emissions. Commute emissions are based on results of a biannual survey conducted by King County as part of the Washington’s Commute Trip Reduction Program, which requires reporting of commute trips for all facilities with over 100 employees. The last survey was conducted in 2009, with the next survey to be completed in 2011. Since there is no data on commute trips for 2010, commute trip mileage and emissions were estimated based on change in number of total City employees. Tables 24 and 25 show a decrease in commute mileage and emissions due to the decrease in the number of total City employees. As per the Local Government Operations Protocol, emissions from public transportation are not included.

Table 24 Employee Commute Fuel Consumed by Commute Mode

Commute Mode	Fuel Consumed, gallons					% change 2008-2010	% change 2009-2010
	1990	2005	2008*	2009	2010**		
Drive Alone	n.d.	813,000	781,000	734,000	729,000	-7%	-1%
Carpool	n.d.	227,000	81,900	139,000	138,000	68%	-1%
Total	n.d.	1,040,000	863,000	873,000	867,000	0%	-1%
* Based on 2007 Commute Trip Reduction (CTR) Survey results							
** Estimated from 2009 CTR Survey results based on change in # of City employees from 2009 - 2010							

Table 25 Employee Commute Emissions by Commute Mode

Commute Mode	Emissions, MgCO ₂ e					% change 2008-2010	% change 2009-2010
	1990	2005	2008*	2009	2010**		
Drive Alone	n.d.	7,140	6,860	6,440	6,400	-7%	-1%
Carpool	n.d.	1,990	719	1,220	1,220	70%	0%
Total	n.d.	9,130	7,580	7,670	7,610	0%	-1%
* Based on 2007 Commute Trip Reduction (CTR) Survey results							
** Estimated from 2009 CTR Survey results based on change in # of City employees from 2009 - 2010							

Source Notes

Employee Commuting: Seattle Department of Transportation provided data on employee commuting for the eight business sites listed below from 2010 (**10-60-1, 09-60-1**):

CTR code	Site Name	Emp.
E83949	CBD Site	5500
E83956	Charles Street Complex	260
E83964	Haller Lake	122
E83972	Seattle Center	246
E83980	Utilities Field Operation	190
E83998	City Light/N Service Ctr	357
E85100	City Light/S Service Ctr	490
E89284	Parks and Recreation	185

Employee commute data is from a biannual survey of City of Seattle employees conducted as part of the King County Commute Trip Reduction Program. Since the next survey will be conducted in 2011, 2010 totals are calculated based on 2009 commuting, and adjusted for changes in employment. In workbook **10-90-0 tab 'Employee Commute'** the survey mode shares, site populations, and average trip lengths are converted to passenger miles traveled in each mode, and also into vehicle-miles traveled for automobiles, carpools, and vanpools. The miles are then converted into fuel consumption using fuel intensity data provided in the **LGO Protocol v1.1**. Bus passenger miles are not included in the commute miles traveled, as per the **LGO Protocol v1.1**.

For both surveyed and non-surveyed work locations, annual vehicle miles traveled were calculated as follows:

- Annual VMT = (Total Employees * Mode Share Percentage) * (One Way Distance * 2) * (Days Per Year – Holidays – Sick Days – Vacation Days)
- For the carpool and vanpool modes, the number of occupants in each carpool or vanpool divided the above equation.
- VMT was converted into fuel consumption using a fuel efficiency of 20 miles per gallon and assuming all fuel consumed was gasoline. The emission factor for gasoline is from **LGO Protocol v1.1**.

7 – Employee Air Travel

Emissions from employee air travel result from the combustion of mobile fuels in commercial aircraft from employee air trips to attend meetings, conferences, and trainings, and are a Scope 3 source. Air travel emissions decreased by 30% from 2009 to 2010, most likely due budget constraints and a decrease in City funds available for employee travel. Miles traveled and emissions are shown in Tables 26 and 27.

The passenger miles traveled includes all flights purchased by the City and by outside agencies or organizations, to the extent that data is available. Most of the air travel data is based on trips recorded by City employees through the travel authorization form. Since the travel authorization form is only required for air travel purchased by the City, and employees frequently take trips paid for by outside organizations and agencies, the air travel data likely under represents total air miles traveled at the City.

Table 26 Employee Air Travel Miles Traveled

Flight Distance	Distance Traveled (Passenger Miles)					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Short	n.d.	n.d.	21,300	13,800	15,300	-28%	11%
Medium	n.d.	n.d.	156,000	184,000	197,000	26%	7%
Long	n.d.	n.d.	5,260,000	3,960,000	2,690,000	-49%	-32%
Total	n.d.	4,540,000	5,440,000	4,160,000	2,910,000	-47%	-30%

Table 27 Employee Air Travel Emissions by Flight Distance

Flight Distance	Emissions (Metric Tons Co2e)					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Short	n.d.	n.d.	16	10	12	-25%	20%
Medium	n.d.	n.d.	97	114	122	26%	7%
Long	n.d.	n.d.	2,700	2,030	1,380	-49%	-32%
Total	5,060	2,330	2,810	2,160	1,520	-46%	-30%

Air Travel by Department

The table and figure below show total emissions by department for 2008 to 2010 (Figure 11). There is no data on department-specific travel for 1990 or 2005. Staff from the Police Department flew the greatest number of miles in 2010, followed by the Fire Department and Seattle City Light. The Police department has high passenger miles traveled due to required trainings.

Table 28 Employee Air Travel Emissions by Department

	Emissions (Metric Tons Co2e)					% change 2008-2010	% change 2009-2010
	1990	2005	2008	2009	2010		
Arts & Cultural Affairs	n.d.	n.d.	-	2	9	-	350%
Seattle Office for Civil Rights	n.d.	n.d.	57	18	35	-39%	94%
Dept of Executive Admin	n.d.	n.d.	67	11	-	-100%	-100%
Dept of Information Technology	n.d.	n.d.	-	89	92	-	3%
Neighborhoods Dept	n.d.	n.d.	38	31	30	-21%	-3%
Dept of Planning & Development	n.d.	n.d.	122	75	69	-43%	-8%
Facilities and Admin Services	n.d.	n.d.	-	92	29	-	-68%
Fire Department	n.d.	n.d.	84	217	282	236%	30%
Housing	n.d.	n.d.	23	32	12	-48%	-63%
Human Services	n.d.	n.d.	79	76	37	-53%	-51%
Law Department	n.d.	n.d.	26	16	-	-100%	-100%
Legis	n.d.	n.d.	125	85	24	-81%	-72%
Library	n.d.	n.d.	123	106	49	-60%	-54%
Mayor's Office	n.d.	n.d.	25	36	7	-72%	-81%
Office of Econ Develop	n.d.	n.d.	-	22	28	-	27%
Intergovernmental Relations	n.d.	n.d.	29	19	15	-48%	-21%
Office of Policy & Management	n.d.	n.d.	16	2	-	-100%	-100%
Office of Sust & Env	n.d.	n.d.	20	26	20	0%	-23%
Parks	n.d.	n.d.	115	43	67	-42%	56%
Personnel	n.d.	n.d.	28	8	7	-75%	-13%
Police	n.d.	n.d.	641	516	296	-54%	-43%
Seattle Center	n.d.	n.d.	6	4	9	50%	125%
Seattle City Light	n.d.	n.d.	754	364	248	-67%	-32%
Seattle Dept of Trans	n.d.	n.d.	91	132	59	-35%	-55%
Seattle Public Utilities	n.d.	n.d.	346	94	90	-74%	-4%
Total	5,060	2,330	2,810	2,120	1,520	-46%	-28%

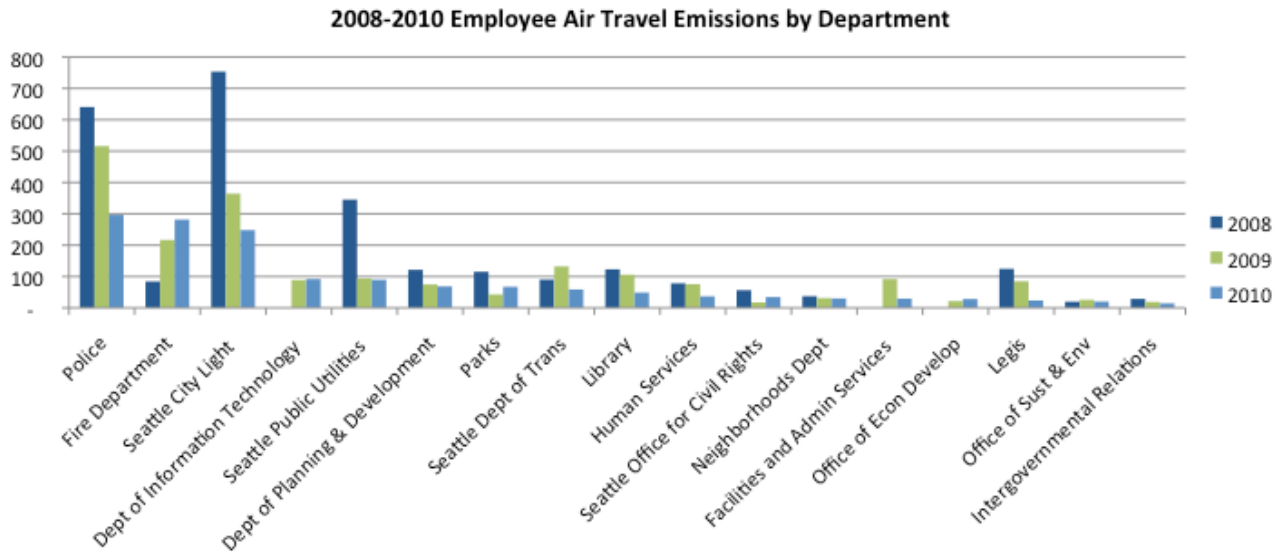


Figure 11 2008-2010 Air Travel Emissions by Department

Per Employee Air Travel by Department

In 2010, the Office of Sustainability & Environment had the highest per employee air travel, followed by the Seattle Office for Civil Rights and the Office of Economic Development. For the number of employees per department, see Appendix A.

Table 29 Per Employee Air Travel by Department 1990- 2010 (listed in order of 2010 values)

	Emissions (Metric Tons Co2e)				
	1990	2005	2008	2009	2010
Office of Sust & Env	n.d.	n.d.	2.8	3.7	2.6
Seattle Office for Civil Rights	n.d.	n.d.	2.4	0.7	1.4
Office of Econ Develop	n.d.	n.d.	n.d.	0.8	1.4
Intergovernmental Relations	n.d.	n.d.	2.6	1.6	1.2
Dept of Information Technology Dept	n.d.	n.d.	n.d.	0.4	0.4
Arts & Cultural Affairs	n.d.	n.d.	n.d.	0.1	0.4
Neighborhoods Dept	n.d.	n.d.	0.4	0.3	0.3
Housing	n.d.	n.d.	0.5	0.8	0.3
Legis	n.d.	n.d.	1.4	1.0	0.3
Fire Department	n.d.	n.d.	0.1	0.2	0.2
Law Department	n.d.	n.d.	0.5	0.5	0.2
Mayor's Office	n.d.	n.d.	0.9	1.5	0.2
Dept of Planning & Development	n.d.	n.d.	0.3	0.2	0.2
Police	n.d.	n.d.	0.3	0.3	0.2
Human Services	n.d.	n.d.	0.2	0.2	0.1
Facilities and Admin Services	n.d.	n.d.	n.d.	0.3	0.1
Personnel	n.d.	n.d.	0.2	0.1	0.1
Parks	n.d.	n.d.	0.1	0.0	0.1
Library	n.d.	n.d.	0.1	0.1	0.0
Seattle Center	n.d.	n.d.	0.1	0.0	0.0
Seattle City Light	n.d.	n.d.	0.0	0.0	0.0
Seattle Dept of Trans	n.d.	n.d.	0.0	0.0	0.0
Dept of Executive Admin	n.d.	n.d.	0.3	0.0	-
Office of Policy & Management	n.d.	n.d.	0.8	0.1	-

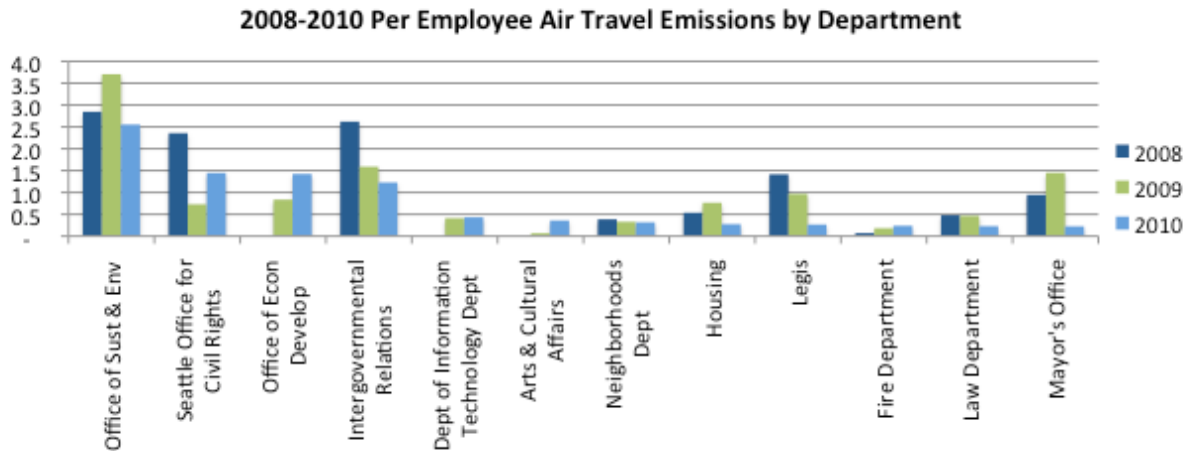


Figure 12 2008-2009 per Employee Air Travel Emissions by Department

Departments are listed in order of 2010 values and only departments with per employee emissions greater than 1 metric ton in 2008, 2009, or 2010 are included in the figure.

Source Notes

Employee Air Travel: Employee air travel per department was provided staff listed in **10-90-0 tab 'Data Source Index.'** Air miles were calculated using the Terra Pass air mileage calculator (<http://www.terrapass.com/carbon-footprint-calculator/#air>). Emissions were calculated in workbook **10-90-0 tab 'Air Travel.'** Miles were separated into short (0-300 miles), medium (300-700 miles), and long (greater than 700 miles), and multiplied by a radiative forcing index of 2.70 and the following emissions factors from the EPA Climate Leaders Greenhouse Gas Inventory Protocol Module Guidance, May 2008:

Flight Distance	Emissions Factor	Units
Short (less than 300 mi)	0.28	kg CO2/mi/ person
Medium (300- 700 mi)	0.23	kg CO2/mi/ person
Long (> 700 mi)	0.19	kg CO2/mi/ person

8 – Electric Utility Offsets

Over 90% of Seattle City Light's owned or purchased electricity generation is from hydro and wind power, but there are some emissions associated with market purchases. Since 2005, City Light has invested in carbon reduction projects to offset the emissions associated with its electricity purchases. City Light purchases offsets that meet the standards of the Climate Action Reserve or the Voluntary Carbon Standard. Most offsets come from agricultural and landfill methane capture projects. City Light seeks projects that are local, verifiable, reasonably priced, 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.

Source Notes

Electricity offsets: Corinne Grade of Seattle City Light provided a description of Seattle City Light's offset program.

Appendix A Employee Count by Department

Table 30 Employee Totals per Department

Department	2008	2009	2010
Arts & Cultural Affairs	27	27	25
City Finance Office	40	37	37
City Light	1,831	1,891	1881
Dept of Planning & Development	448	441	417
Dept of Executive Admin	254	253	251
Fire Department	1,189	1,185	1178
Fleets & Facilities	319	319	317
Housing	43	42	42
Human Services	336	349	339
Information Technology Dept	217	216	213
Intergovernmental Relations	11	12	12
Law Department	164	162	161
Legislative-City Council	88	88	89
Library	626	626	626
Mayor's Office	26	25	29
Municipal Court	246	247	238
Neighborhoods Dept	97	95	95
Office for Civil Rights	24	24	24
Office of Economic Development	26	26	20
Office of Policy & Management	19	18	
Office of Sustainability & Env	7	7	8
Parks Dept	1,109	1,100	1106
Personnel Dept	124	125	119
Police Dept	1,868	1,875	1943
Seattle Center	296	289	280
SDOT	807	807	797
Seattle Public Utilities	1,495	1,495	1460
Total employees	11,737	11,781	11,707

Appendix B Methodology

Introduction

This document specifies the emissions sources, methodologies and data sources used to calculate the emissions for each of the sectors included in the City of Seattle's 2008 and 2009 Corporate Greenhouse Gas Emissions Inventories. These sectors are: buildings and facilities, vehicle fleets, street lights and traffic signals, government generated solid waste, municipal power generation, employee commute, and employee air travel.

Methodology organization:

For each sector, the report includes information about the emission source and scope, calculation steps, protocol used, emissions factors, and data sources, including references to source files and relevant Master Data Workbook (MDW) tabs. This document will make frequent reference to the Local Government Operations, as well as to worksheets contained in the City of Seattle's 2008 and 2009 Master Data Workbooks (MDW).³ The reader should have available and be familiar with both of these resources to fully take advantage of the information provided below.

Data files:

Data sources are listed according to their reference number. Each file used in the inventory is numbered and listed in the 'data log' tab of the Master Data Workbook (MDW). All files used in the inventory are numbered according to a six-digit numbering system: xx (year)- xx (category)- xx (file number + name of file). Unless otherwise noted, the emissions sources and methodologies for each year are the same.

Inventory Organization:

The City of Seattle inventory divides emissions into categories based on level of control, as specified by the LGO Protocol. The categories, or scopes, allow the inventory to separately account for direct and indirect emissions and improve transparency. The scope definitions in the LGO Protocol follow the WRI/WBCSD GHG Protocol Corporate Standard, and include the following.

Scope 1: All direct GHG emissions (with the exception of direct CO₂ emissions from biogenic sources). For Seattle's inventory, this includes equipment and materials owned by the City government, such as on-site natural gas heating and vehicle fleets.

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. Scope 2 emissions include wholesale energy imports into the city-owned electric system, as well as retail energy purchased by other city-owned facilities.

Scope 3: All other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting and business travel), outsourced activities, waste disposal, etc.

³ The Local Government Operations Protocol can be downloaded from the following web site:
<http://www.theclimateregistry.org/resources/protocols/local-government-operations-protocol/>

Together the three scopes provide a comprehensive accounting framework for managing and reducing direct and indirect emissions. The LGO Protocol provides standard methodologies for calculating emissions from the sources shown in the table below.

Table 31 Inventoried Emissions Sources by Scope

Scope 1	Scope 2	Scope 3
Fuel consumed to heat/cool facilities	Purchased electricity consumed by facilities	Solid waste generated by government operations
Fuel consumed by vehicle fleet and mobile equipment	Purchased steam for heating or cooling facilities. Purchased electricity consumed by electric vehicles	Fuel consumed for employee vehicles used for commuting
Fuel consumed to generate electricity	Purchased steam for heating or cooling facilities	Fuel consumed for airplanes used for employee business travel
Electricity, steam, and cooling purchased from an outside utility		
Leaked refrigerants from facilities and vehicles		
Solid waste in government landfills		

While LGO Protocol standardizes inventories from government operations, it does not seek to be a wholly accurate inventory of all emissions sources, as certain sources are currently excluded or otherwise impossible to accurately estimate. This and all emissions inventories represent a best estimate of emissions using best available data and calculation methodologies; it does not provide a complete picture of all emissions resulting from the City’s operations, and emissions estimates are subject to change as better data and calculation methodologies become available in the future.

Types of Emissions:

As described in the LGO Protocol, emissions from each of the greenhouse gases can come in a number of forms:

- **Stationary or mobile combustion:** These are emissions resulting from on-site combustion of fuels (natural gas, diesel, gasoline, etc.) to generate heat, electricity, or to power vehicles and mobile equipment.
- **Purchased electricity:** These are emissions produced by the generation of power from utilities outside of the jurisdiction.
- **Fugitive emissions:** Emissions that result from the unintentional release of greenhouse gases into the atmosphere (e.g., leaked refrigerants, methane from waste decomposition, etc.).
- **Process emissions:** Emissions from physical or chemical processing of a material (e.g., wastewater treatment).

Appendix C Data Source Index

File #	Type	ext	File name	Source	Received
10-10-0 Buildings & Facilities					
10-11-1	Electricity & Natural Gas	.xls	FD_EnergyUseViewer_2008-2010_Annual	Sarah Calvillo-Hoffman, FAS	06/10/11
10-11-1b	Electricity & Natural Gas	.xls	FFD_EnergyUseViewer_Q3_2008-2011_Annual (1-26-12)	Sarah Calvillo-Hoffman, FAS	01/19/12
10-11-2	Electricity & Natural Gas	.xls	Natural Gas Parks 2010 xls	David Broustis, Parks	06/22/11
10-11-3	Electricity & Natural Gas	.pdf	Parks Electricity 2010	David Broustis, Parks	06/22/11
10-11-4	Electricity & Natural Gas	.pdf	Parks gas 2010	David Broustis, Parks	06/22/11
10-11-5	Electricity & Natural Gas	.xls	Parks electricity 2010 xls	David Broustis, Parks	06/22/11
10-11-6	Electricity & Natural Gas	.txt	RE 2010 energy consumption data	David Broustis, Parks	06/22/11
10-11-7	Electricity & Natural Gas	.txt	RE Library energy consumption and air travel information	Dean Nishimura, Library	06/22/11
10-11-8	Electricity & Natural Gas	.txt	RE Library energy consumption and air travel information	Dean Nishimura, Library	06/22/11
10-11-9	Electricity & Natural Gas	.xls	2008-2010 Library Energy Consumption	Dean Nishimura, Library	06/22/11
10-11-10	Electricity & Natural Gas	.xls	Parks electricity 2010 xls	David Broustis, Parks	06/22/11
10-11-11	Electricity & Natural Gas	.xls	SPU Electricity SCL 2007-2010 data from Leighton Stewart	Leighton Stewart, SCL	04/01/11
10-11-12	Electricity & Natural Gas	xls	2010 SPU Electricity and Nat Gas - PSE	Sandy Cheng, SPU	07/06/11
10-11-12b	Electricity & Natural Gas	xls	10-11-12b SPU Elec and Nat Gas-PSE.xlsx	Sandy Cheng, SPU	07/06/11
10-11-13	Electricity & Natural Gas	.pdf	SC 2010 Energy Use Report	Ned Dunn, SC	07/18/11
10-11-14	Electricity & Natural Gas	.xls	SDOT Nat Gas Accts PSE City of Seattle 2010 Usage	Valerie Rucker, Kathy Larson, Puget Sound Energy	06/24/11
10-11-15	Electricity & Natural Gas	.xls	SDOT Eelectric Account Q1 2011	Leighton Stewart, SCL	08/05/11
10-11-16	Electricity & Natural Gas	.pdf	PSE 2010 Inventory	http://pse-pilot.com/aboutpse/Environment/Documents/GHG_Inventory2010.pdf	08/09/11
10-11-17	Electricity & Natural Gas	.xls	City Light ENOP1210	Corinne Grande, via Leighton Stewart, SCL	08/16/11
10-11-18	Electricity & Natural Gas	.txt	City Light Natural Gas Consumption	Corinne Grande, SCL	08/10/11
10-11-19	Electricity & Natural Gas	.txt	2010 SCL emissions factor	Corinne Grande, SCL	08/10/11
10-12-1	Refrigerants	.xls	Smt refrig 2010	Sarah Calvillo-Hoffman, FAS	06/21/11
10-12-2	Refrigerants	.txt	Library refrigerant	Dean Nishimura, Library	06/22/11
10-12-3	Refrigerants	.pdf	2010 Parks refrigerant usage	David Broustis, Parks	06/22/11
10-12-4	Refrigerants	.pdf	2010 shops refrigerant	Sarah Calvillo-Hoffman, FAS	07/05/11
10-13-1	Steam	xls	City of Seattle customer load history	David Easton, Seattle Steam	06/03/11
10-13-2	Steam	txt	FW City of Seattle steam consumption	David Easton, Seattle Steam	06/03/11
10-13-3	Steam	.txt	Re 2010 Acquarium steam usage	David Broustis, Parks	06/22/11
10-14-1	HDD	.pdf	HDD 2007-2010 fm citylight website	http://www.seattle.gov/light/days.html	11/27/11
10-20-0 Vehicle Fleet					
10-20-1	Vehicle Fleet	.xls	Big Six monthly YTD 2010	Chris Wiley, FFD	05/12/11
10-20-2	Vehicle Fleet	.xls	2010 Fuel Data (12-10 report)	Chris Wiley, FFD	02/01/11
10-20-3	Vehicle Fleet	.txt	RE Vehicle fleet fuel usage questions	Chris Wiley, FFD	05/12/11
10-20-4	Vehicle Fleet	.xls	City Light Fuel Consumption	Corinne Grande, SCL	08/17/11
10-20-5	Vehicle Fleet	.txt	RE VMT for SDOT vehicles, Jemae Hoffman	Jemae Hoffman, SDOT	05/11/11
10-30-0 Street Lights & Traffic Signals					
10-30-1	Street Lights & Traffic Signals	.doc	Lighting Types.doc	Leighton Stewart, SCL	2009
10-30-2	Street Lights & Traffic Signals	.xls	Monthly street light & signal consumption	Leighton Stewart, SCL	2009
10-30-3	Street Lights & Traffic Signals	.jpg	street light kwh	Leighton Stewart, SCL	2009

10-40-0 Municipal Solid Waste					
10-40-1	Municipal Solid Waste	.xls	2010 SPU MSW GHG Inventory	Jenny Bagby, SPU	07/08/11
10-45-0 Solid Waste Landfills					
10-45-1	Solid Waste Landfills	.xls	Seattle GHG Interbay MDW 2010	Min-Soon Yim, SPU	06/20/11
10-50-1 Municipal Power Generation					
10-50-1	Municipal Power Generation	.xls	TD losses- email communication with Corinne Grande, 8.16.11	Corinne Grande, SCL	08/17/11
10-50-2	Municipal Power Generation	.xls	City Light Emissions from Corinne 8.16.11	Corinne Grande, SCL	08/17/11
10-50-3	Municipal Power Generation	.xls	City Light Purchased Generation	Corinne Grande, SCL	08/17/11
10-50-4	Municipal Power Generation	.pdf	tcr 2010	Corinne Grande, SCL	08/17/11
10-50-5	Municipal Power Generation	.html	crisreport_org - Emissions Inventory - 2010	Corinne Grande, SCL	08/17/11
10-50-6	Electricity & Natural Gas	.txt	2010 Egrid emissions factor	Corinne Grande, SCL	01/16/12
10-50-7	Electricity & Natural Gas	.txt	2009 Egrid emissions factor	Corinne Grande, SCL	01/20/12
10-60-0 Employee Commute					
10-60-1	Employee Commute	.txt	RE Commute survey data	Eric Mamroth, SDOT	06/22/11
10-70-0 Employee Air Travel					
10-70-1	Employee Air Travel	.xls	DoIT Travel	Emelita Barber (Mitz)	06/21/11
10-70-2	Employee Air Travel	.xls	OH Air Travel	Denise Laird	06/21/11
10-70-3	Employee Air Travel	.xls	MO Travel	Julie Tobin	06/21/11
10-70-4	Employee Air Travel	.xls	SOCR Air Travel	Latrice Ybarra	06/21/11
10-70-5	Employee Air Travel	.xls	DON Air Travel	Elenor Hense	06/21/11
10-70-6	Employee Air Travel	.xls	Air travel Arts 2010	Steven Eng	06/21/11
10-70-7	Employee Air Travel	.xls	2010 Library Air travel	Dean Nishimura	06/22/11
10-70-8	Employee Air Travel	.xls	SDOT 2010 Air travel	Kathy Song, Gail Srithongsuk*, Donal Padgett	06/24/11
10-70-9	Employee Air Travel	.xls	Personnel air travel	Barbara Gangwer, Jackie Yang	06/27/11
10-70-10	Employee Air Travel	.xls	Fire Air Travel 2010	Carolyn Barton, Debbie Brooks	06/30/11
10-70-11	Employee Air Travel	.xls	DPD air travel 2010	Denise Cambell, Zeny Manalato	06/27/11
10-70-12	Employee Air Travel	.xls	OIR 2010 Air travel	Jasmine Weaver, Tony Vo	07/05/11
10-70-13	Employee Air Travel	.txt	OSE 2010 air travel	Jeanie Boawn	06/23/11
10-70-14	Employee Air Travel	.xls	Parks 2010 air travel	Connie McClure	07/07/11
10-70-15	Employee Air Travel	.xls	Human Services Air Travel 2010 - Final	Sharon Gill, Sara Levin	07/07/11
10-70-16	Employee Air Travel	.xls	Law 2010 Air Travel	Anne Molina-Sarinas, Rithy Lim, Dana Anderson	07/08/11
10-70-17	Employee Air Travel	.xls	Fire Air Travel 2010- Complete travel report	Debbie Brooks	07/08/11
10-17-18	Employee Air Travel	.xls	LEG 2010 Air Travel Summary	Eric Ishino	07/13/11
10-70-19	Employee Air Travel	.xls	FAS 2010 Air travel	Debbie Nagasawa, David Behrndt	07/05/11
10-70-20	Employee Air Travel	.xls	OED-2010 Air travel	Tim Rash, OED	07/15/11
10-70-21	Employee Air Travel	.pdf	2010 Police air travel	Donna DiMola, Colette Alberts	07/20/11
10-70-22	Employee Air Travel	.xls	2010 Air Travel Police	Donna DiMola, Colette Alberts	07/20/11
10-17-23	Employee Air Travel	.xls	OSE 2010 air travel	Jeanie Boawn	07/26/11
10-17-24	Employee Air Travel	.xls	Seattle Center Air travel 2010 to HP 8 9 11	Ned Dunn	08/09/11