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GHG Emissions Baseline Inventory, 2008

for Metro internal and business operations

August 2010

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About Metro

Clean air and clean water do not stop at city limits or county lines. Neither does the need for jobs, a thriving economy and good transportation choices for people and businesses in our region. Voters have asked Metro to help with the challenges that cross those lines and affect the 25 cities and three counties in the Portland metropolitan area.

A regional approach simply makes sense when it comes to protecting open space, caring for parks, planning for the best use of land, managing garbage disposal and increasing recycling. Metro oversees world-class facilities such as the Oregon Zoo, which contributes to conservation and education, and the Oregon Convention Center, which benefits the region's economy

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Acknowledgements

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GLOSSARY

Anthropogenic: Emissions made or generated by a human or caused by human activity. The term is used in the context of global climate change to refer to gaseous emissions that are the result of human activities, as well as other potentially climate-altering activities, such as deforestation.

Biogenic: Greenhouse Gas emissions generated during combustion or decomposition of biologically-based material, such as forest or agricultural products.

Climate Change (United Nations Framework Convention on Climate Change – UNFCCC): A change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Emissions Factor: A representative value that relates the quantity of a pollutant released into the atmosphere with an activity associated with the release of that pollutant. Emission factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e. g., pounds CO_2 emitted per gallon of fuel burned).

Greenhouse Gas (GHG): A gas that absorbs radiation at specific wavelengths within the spectrum of radiation (infrared radiation) emitted by the Earth's surface and by clouds. The gas in turn emits infrared radiation from a level where the temperature is colder than the surface. The net effect is a local trapping of part of the absorbed energy and a tendency to warm the planetary surface. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are the six Kyoto gases covered by the United Nations Framework Convention on Climate Change (UNFCCC).

Global Warming Potential (GWP): Global Warming Potential factors represent the heat-trapping ability of each greenhouse gas relative to that of carbon dioxide.

Intergovernmental panel on climate change (IPCC): The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP). The IPCC is open to all member countries of WMO and UNEP and was established to provide decision-makers and others interested in climate change with an objective source of information about climate change.

EXECUTIVE SUMMARY

In 2008 Metro council made a commitment to systematically address the sustainability of all Metro internal government operations and practices and identified climate change as a critical component of this effort. Metro Council committed to supporting the State of Oregon's greenhouse gas (GHG) reduction targets and made a public proclamation in support of the Global Day of Climate Action and the efforts to reduce atmospheric carbon levels.[1] Metro has since developed a strategic plan which guides Metro's operations to achieve internal sustainability goals.[2]

The Sustainability Plan identifies environmental impacts of Metro's operations, sets a baseline from which progress can be measured over time, and creates a framework of the specific strategies and actions that need to be completed to meet these goals. The Metro Agency GHG Inventory report sets the GHG baseline for the Sustainability Plan using calendar year 2008 data for all Metro facilities including the Metropolitan Exposition Recreation Commission (MERC). For consistency with Metro's Regional Climate Initiative and the efforts of various regional partners, Metro staff completed an internal GHG inventory, which includes all direct and indirect emission sources within Metro's operational boundary.

Analysis Results: Overview

Metro's GHG emissions for calendar year 2008 (CY08) equaled roughly 58,000 MT CO_2e (metric tons carbon-dioxide equivalent). The various emission sources for this baseline total are organized as follows (see Figure 1):

Scope 1: Vehicle and non-mobile fuel combustion; refrigerants and St. Johns landfill gas (LFG)
Scope 2: Building energy consumption from purchased electricity
Scope 3: Business travel; embodied emission in material goods purchased, and services contracted; landfilled solid waste; and employee commute
The inventory does not capture the transportation related impacts of visitors to Metro owned facilities and venues.

The largest emissions sources in 2008 for each scope category include:

Scope 1 emissions totaled 20,009 MT CO_2e (35%)

- Solid Waste operations including direct **St. Johns landfill gas** and fuel burned for **long-haul waste transport** (contract).
- Natural gas use at visitor venues (**MERC** and the **Oregon Zoo**)

Scope 2 emissions totaled 13,352 MT CO_2e (23%)

- Electricity use at **MERC** facilities
- Electricity use at the **Oregon Zoo**

Scope 3 emissions totaled roughly 24,215 MT CO_2e (42%)

- Supply Chain emissions at the **Oregon Zoo**
- Employee commute at the **Oregon Zoo** and **MERC** facilities

[1] Metro Council resolution No. 09-4080, "For the Purpose of Proclaiming October 24, 2009 as a Global Day of Climate Action and recognizing the number 350 as a message to the Copenhagen Conference on climate change," 2009.
[2] Metro's sustainability plan addresses five environmental sustainability goals that were adopted by Metro Council in 2003. These goals address the following areas: climate change (GHG reductions); toxins; waste; water; and habitat. For information on Metro's Sustainability Plan contact Molly Chidsey (Molly.Chidsey@oregonmetro.gov).

Figure 1: Metro agency-wide emissions from regional government operations (2008), by emissions source

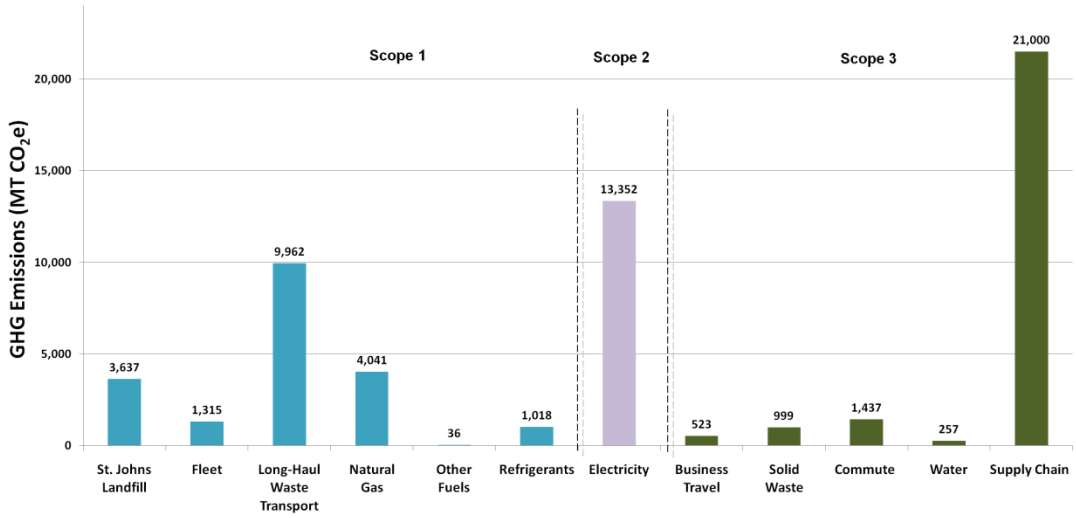


Table 1 provides an overview of the largest emission sources, both at the agency-wide level and within each of the emissions categories (scopes). Emissions values for high and medium emissions sources are provided for a sense of scale for the greatest emissions reductions opportunities in the short to mid-term.

Table 1: Metro agency-wide emissions from regional government operations (2008), by largest emissions source

Scope	Emissions Source	MRC	Solid Waste	MERC	Parks	Zoo	*% emissions source total*
Scope 1	Landfill gas		**3,637** (M)				*100%*
	Waste Transport		**9,962** (M)				*100%*
	Natural Gas			**2,190** (M)		**1,763** (M)	*97%*
	Fleet		**305** (M)			**231** (M)	*41%*
Scope 2	Electricity		**1,703** (M+U)	**7,499** (56%) (M +U)		**3,119** (M+U)	*92%*
Scope 3	Supply Chain	**3,103** (M +V)		**3,351** (M +V)		**11,442** (54%) (M +V)	*85%*
	Commute			**431** (M + C)		**428** (M + C)	*59%*
	Solid Waste					**506** (M +C)	*50%*
	% functional area total	*67%*	*88%*	*91%*		*96%*	

Figure key

Emissions Scale
- high =
- medium =
- low =

Responsible party
- (M) = Metro
- (M + C) = Metro and community-wide
- (M + U) = Metro and utility
- (M + V) = Metro and vendors

INTRODUCTION

Mitigating the impacts of climate change is a priority for Metro, both in the context of long-range regional planning and other community services the agency provides, as well as in the day-to-day internal operations of facilities. Metro has adopted aggressive goals for reducing greenhouse gas (GHG) emissions from internal operations as a way to demonstrate this commitment and bring about real reductions in the emissions over which Metro has direct and indirect control. Metro Council adopted five environmental sustainability goals in 2003, one of which was to achieve "Zero net increase in carbon emissions" by 2025.[3]

Since then, climate science has advanced and Metro has stepped up its commitment to support the State of Oregon's targets to reduce greenhouse gas emissions to at least 10 percent below 1990 levels by 2020, and reduce emissions to at least 75 percent below 1990 levels by 2050.[4] Metro has also has made a public proclamation in support of the Global Day of Climate Action and the efforts to stabilize atmospheric carbon levels at 350 ppm.[5]

Greenhouse Gas Emission Reduction Goal

For Internal Metro Operations

Reduce direct and indirect greenhouse gas emissions (CO_2e) 80 percent below 2008 levels by 2050.

In response to this Council direction, Metro developed a strategic Sustainability Plan which guides Metro's operations to achieve these internal sustainability goals. The adopted climate goal was also refined to reflect current climate science and Metro's commitment to the State of Oregon's GHG goal (see inset box this page). The Sustainability Plan identifies environmental impacts of Metro's operations, sets a baseline from which progress can be measured over time, and creates a framework of the specific strategies and actions that need to be completed to meet these goals.

In order to effectively select strategies for reducing greenhouse gas emissions from operations, a current baseline was needed. And while the Metro Auditor included a GHG inventory in a 2009 report of recommendations on internal sustainability management, the methodology used didn't reflect the consumption-based model that Metro used to create the regional GHG inventory a year later.[6]

For consistency and accuracy, Metro staff completed an internal GHG inventory based on best practices in reporting. This report is the result of that analysis.

[3] Metro Council resolution 03-3338, "Establish a Sustainable Business Model for Metro Departments and Facilities and to Undertake Related Duties," 2003.

[4] Metro Council resolution No. 08-3931, "For the Purpose of Adopting a Definition of Sustainability to Direct Metro's Internal Operations, Planning Efforts, and Role as Regional Convener," 2008.

[5] Metro Council resolution No. 09-4080, "For the Purpose of Proclaiming October 24, 2009 as a Global Day of Climate Action and recognizing the number 350 as a message to the Copenhagen Conference on climate change," 2009.

[6] Metro Auditor Suzanne Flynn (2009) "Sustainability Management: Focus Efforts and Evaluate Progress" http://www.oregonmetro.gov/index.cfm/go/by.web/id=32285/level=4; Metro Regional GHG inventory Available at: http://www.oregonmetro.gov/index.cfm/go/by.web/id=32823

Policy Context

The Intergovernmental Panel on Climate Change, the United Nations body that regularly convenes climate scientists, has identified human activity as the primary cause of the climate change that has occurred over the past few decades and quickened in recent years. Consensus statements from the IPCC suggest that human-caused emissions must be reduced significantly – perhaps more than 50% globally, and by 80% in wealthier nations that are the largest emitters – by mid-century in order to avoid the worst potential climate impacts on human economies.

Many individual corporations, government agencies, universities, non-profits and even individuals have proactively sought to take on this challenge. Emissions from government operations can be significant, which means public agencies have a direct impact through emissions reductions. Public agencies also have a role in educating policy makers and citizens. By measuring emissions from Metro's operations, this inventory is a step toward taking action, managing risk and leading the way forward.

There has recently been much regulatory action regarding Greenhouse Gas (GHG) emissions, as well as energy- and transportation-related legislation and policy related to climate action. Action is taking place at the international, national, regional, state and local levels as shown in the table below.

Table 2: Overview of policy activity related to greenhouse gas emissions management

SCALE	RECENT ACTIVITY
International	The world's leaders met in Copenhagen in December 2009 to negotiate the next international climate agreement to follow the Kyoto Protocol, which is set to expire in 2012. While the Copenhagen Summit did not result in any legally-binding emissions reductions targets, the Copenhagen Accord, which was drafted by the United States, China, Brazil, India and South Africa, calls for nations to take actions to keep increases in global temperatures below 2 degrees Celsius.
Federal	The US Congress is considering sweeping energy and climate legislation. In parallel, the US EPA has issued mandatory reporting guidelines for large emitters. Other energy and economic stimulus legislation recently passed by the federal government supports renewable energy development and other climate-related initiatives.
Regional	The Western Climate Initiative (WCI) Regional Program includes seven U.S. states (including Oregon) and four Canadian provinces. The objective of the WCI Partner jurisdictions' plan is to reduce regional GHG emissions to 15 percent below 2005 levels by 2020. The central component of the WCI Partner jurisdictions' comprehensive strategy (July 2010) is a flexible, market-based, regional cap-and-trade program. The WCI regional cap-and-trade program will be composed of the individual jurisdictions' cap-and-trade programs implemented through state and provincial regulations.
State	In Oregon, recent legislation includes climate and energy bills targeting fuels, solar power opportunities, and GHG emissions from land use and transportation. A number of statewide efforts are facilitating the widespread deployment of electric vehicles. Dozens of states are taking these and similar actions.
Local	At the local level, over 1,000 cities from all 50 states have signed the US Mayors Climate Protection Agreement, including 13 in Oregon. A comprehensive GHG inventory is the first step toward fulfilling a signatory's commitments. While most communities are still at an early stage we hope Metro's work here will provide a good example to other communities in Oregon.

Mandatory Reporting in Oregon

Oregon Department of Environmental Quality will require GHG reporting for a wide range of entities, beginning in 2011 for the 2010 calendar year. The threshold for reporting is currently set at 2,500 MT CO_2e annually. In general, the sources and entities required to report are holders of Title V air pollution permits or Air Contaminant Discharge Permits (ACDP), with at least one discrete permitted source emitting above the threshold.[7]

As currently articulated, these requirements will not require reporting from many organizations that have aggregate emissions from multiple sources (building energy, fleet fuel, etc.) that together exceed the reporting threshold. Municipal governments likely fall into this category of non-reporters. As a result, only a few Oregon municipalities will have regulatory reporting burdens, but many are likely to have total emissions from local government operations that well exceed 2,500 MT CO_2e annually. However, Metro holds a Title V air pollution permit for St. Johns Landfill and is subject to DEQ mandatory reporting. Therefore, the emissions associated with the methane management practices at St John's Landfill, and included in this inventory, follow state DEQ reporting requirements.

Mandatory Reporting at the Federal Level

US EPA has also issued mandatory reporting guidelines, finalized in September 2009, with a reporting threshold of 25,000 MT CO_2e per year.[8] It is possible that future federal climate legislation will require participation by some large entities in carbon trading and auctions for emissions allowances. Given the current structure of proposed legislation, very few Oregon entities – and probably no government agencies – will have such responsibilities.

[7] For more information on Oregon's rules, visit DEQ's GHG reporting page www.deq.state.or.us/aq/climate/reporting.htm.

[8] For more information on Federal rules, visit EPA's GHG rulemaking page http://www.epa.gov/climatechange/emissions/ghgrulemaking.html

BOUNDARIES

Metro owns and operates a diverse portfolio of facilities, which presented challenges when determining the organizational boundaries for the GHG inventory. However, Metro used standard GHG inventory protocols to define the organizational boundaries for this inventory. In many GHG inventory protocols, emissions sources and activities are defined as either producing direct or indirect GHG emissions. Direct emissions are those that stem from sources owned or controlled by a particular organization. Indirect emissions occur because of the organization's actions, but the direct source of emissions is controlled by a separate entity. The following inventory captures all direct and indirect emissions associated with Metro's operations (excluding those sources identified in the following Inventory Exclusions section on p. 10).

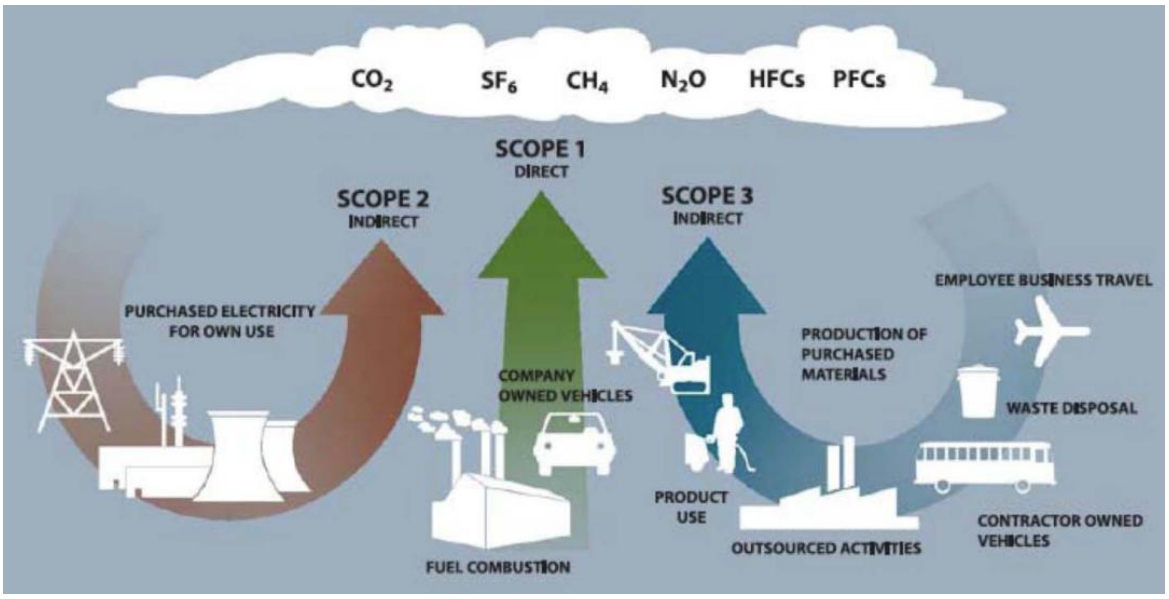
To distinguish direct from indirect emissions sources, three "scopes" are defined for traditional GHG accounting and reporting.[9] Figure 2 illustrates the three emission scopes.

Scope 1: All direct GHG emissions occur from equipment and facilities owned and/or operated by Metro (excluding direct CO_2 emissions from biogenic sources, which are reported separately – See St. Johns Landfill section).

Scope 2: Indirect GHG emissions from purchased electricity, heat or steam.

Scope 3: All other indirect emission sources that result from Metro activities but occur from sources owned or controlled by another company or entity, including: business travel; embodied emission in material goods purchased, and services contracted by Metro; emissions from landfilled solid waste; and emissions associated with Metro employee commute patterns.

Figure 2: Greenhouse gases and accounting and reporting scopes



[9] Source: WRI/WBSCD Greenhouse Gas Protocol, Corporate Accounting and Reporting Standard (Revised Edition), Chapter 4.

In an effort to organize Metro's diverse operations portfolio all facilities are grouped by type and hereafter referred to as functional areas. Table 3 is a summary of the facilities included in the analysis, grouped by functional area.

Table 3: GHG baseline Inventory boundaries

METRO FUNCTIONAL AREA	FACILITIES INCLUDED IN THE INVENTORY	FACILITIES EXCLUDED FROM INVENTORY
Metro Regional Center	Office Building	
Regional Parks	Blue Lake Boreland Field Station Oxbow Smith and Bybee Lakes Cooper Mountain Nature Park Rental Homes	Beggars Tick Wildlife Refuge Cemeteries Glendoveer Golf Course Mt Talbert Nature Park Chinook Landing
MERC Facilities	Oregon Convention Center Expo PCPA Keller Auditorium PCPA Arlene Schnitzer Hall PCPA Antoinette Hatfield Hall/Admin	
Solid Waste	Metro South Transfer Station Metro South Hazardous Waste Facility Metro Central Transfer Station Metro Central Hazardous Waste Facility Metro Paint St Johns Landfill Long Haul Waste Hauling (fleet)	
Oregon Zoo	64 acre zoo Off-site condor facility	

Inventory Exclusions

This inventory attempts to estimate emissions from all of Metro's facilities for calendar year 2008 (CY2008), however due to data limitations a number of Metro's facilities are not included in the inventory and complete data sets were not available for each facility included in the inventory. In addition to the handful of individual facilities not included in the inventory, this analysis does not capture the transportation related impacts of visitors to Metro owned facilities and venues due to data and resource limitations. Also Metro does not have direct control over how visitors choose to travel to Metro owned properties. That said, Metro plays a significant role in regional transportation planning and has the capacity to promote alternative transportation modes at the majority of Metro's facilities, especially the visitor venues. It is recommended that future GHG analyses include these "visitor" impacts.

AGENCY-WIDE INVENTORY RESULTS

Agency-wide summary

Metro's emissions from vehicle fuel and building energy consumption account for 33,361 metric tons carbon dioxide equivalent (MT CO_2e), shown in Figure 3 and described in Table 4 as Scope 1 and Scope 2 emissions. Estimated Scope 3 emissions total 24,215 MT CO_2e, which accounts for the emissions from mission-critical operations and activities related to Metro operation, but outside of its direct control.[10]

Metro's total emissions equal 58,062 MT CO_2e.

Unique to Metro's regional government services are the emissions associated with the St. Johns Landfill and long-haul waste transport (Scope 1 emissions) and the regional waste disposal contracts (Scope 3 emissions). These emissions result from operating a closed landfill (St. Johns Landfill located in N. Portland) and Metro's responsibility to manage the processing and transfer of the region's waste. These emissions sources are discussed in detail in the Solid Waste Functional Area Analysis section (p. 34)

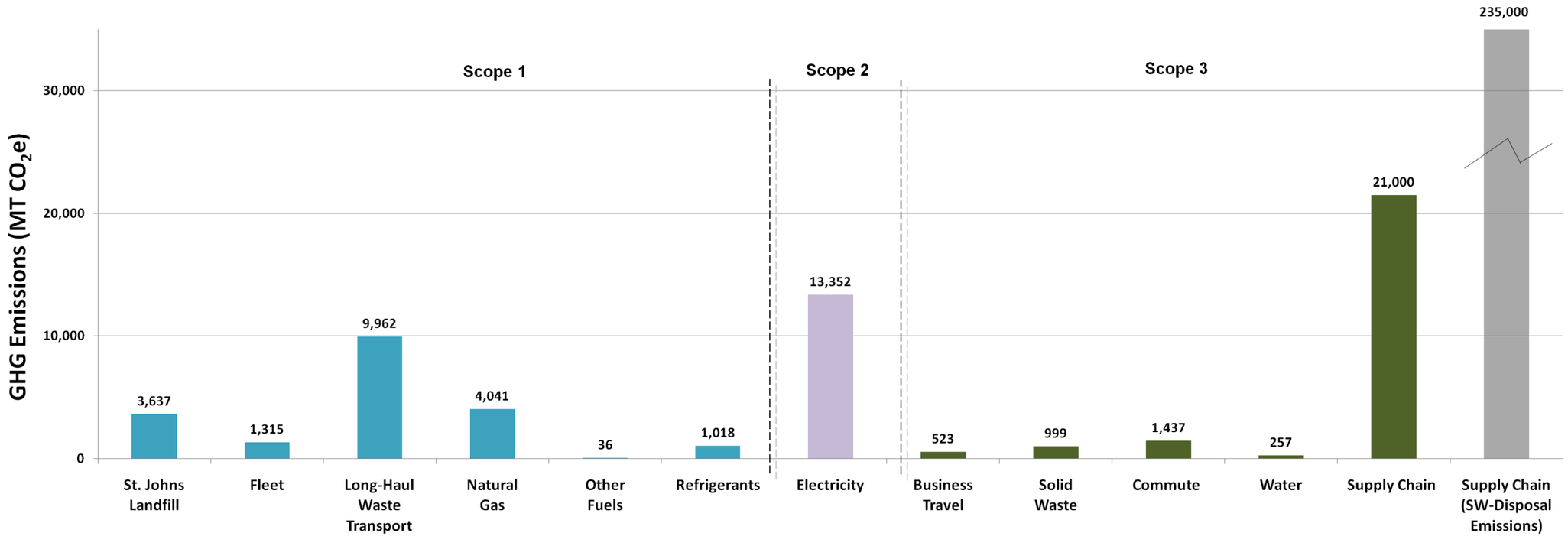
Scopes 1 and 2 yield 33,361 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 6,379 passenger vehicles
- Annual emissions from the energy consumed by 2,839 homes (US average)

Scope 3 yields 24,701 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 4,723 passenger vehicles
- Annual emissions from the energy consumed by 2,102 homes (US average)

Figure 3: Metro agency-wide emissions from regional government operations (2008)[1]



[10] Supply Chain emissions are rounded to demonstrate the level of uncertainty for this emission source.

Figure 4 provides a breakdown of the total GHG emissions for calendar year 2008 by functional area. MERC, the Oregon Zoo and Solid Waste functional areas each account for roughly one-third of Metro's total 2008 emissions; and the Metro Regional Center (MRC) and Parks account for eight and four percent, respectively.

Figure 4: Metro agency wide greenhouse gas emissions (2008), by functional area

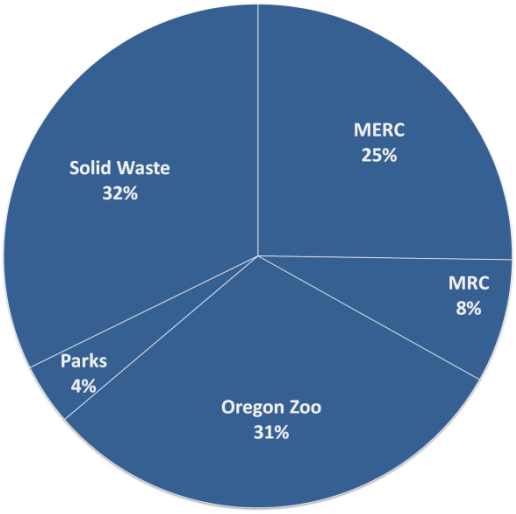


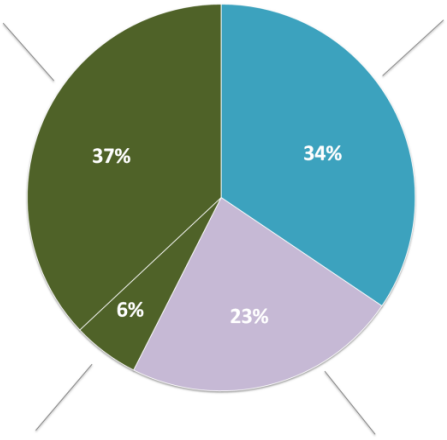
Figure 5 includes a breakdown of GHG emissions for calendar year 2008 by emissions scope and distinguishes supply chain emissions within the total share of Scope 3 emissions. Roughly 73% of the total Scope 1 emissions (owned vehicle fuel use, natural gas consumption for building heat, and refrigerants) come from Solid Waste operations, with MERC accounting for the next largest source at 15%. Scope 2 emissions (electricity) account for the second largest emissions source at 23% of Metro's total GHG emissions; 57% of all Scope 2 emissions result from MERC operations.

Scope 3 emissions, Metro's largest emissions source, are separated into two general categories; the purchase of potable water, solid waste disposal, employee commute, and business travel and supply chain emissions from purchased materials and services. Supply chain emissions make up the largest portion of Scope 3 emissions, the majority of which come from Zoo operations. The remaining Scope 3 emissions comprise six percent of Metro's total emissions, and similar to the supply chain emissions, the two largest sources result from operations at the Zoo and MERC functional areas.

Figure 5: Metro agency-wide greenhouse gas emissions (2008), by emissions scope

Scope 3: Supply Chain (Metro Operations)
- 53% of this scope results from Zoo operations
- 16% of this scope results from MERC operations
- 14% of this scope results from MRC operations

Scope 1: Fleet, Stationary Fuels, Refrigerants, Long-Haul Waste Transport, St Johns Landfill
- 73% of this scope results from Solid Waste operations
- 15% of this scope results from MERC operations



Scope 3: Travel, Commute, Water and Waste
- 37% of this scope results from Zoo operations
- 28% of this scope results from MERC operations

Scope 2: Electricity
- 56% of this scope results from MERC operations
- 23% of this scope results from Zoo operations

Table 4 includes a detailed overview of all emission sources for all Metro functional areas.

Table 4: Description of Metro's operational greenhouse gas emissions categories

EMISSIONS SCOPE	EMISSIONS CATEGORY	MT CO_2e	INPUT DATA (DESCRIPTION)
Scope 1 (Direct Emissions)	**Natural gas**	4,041	Metro uses natural gas for space heating at a 13 of the facilities included in the GHG inventory.
	Fleet	1,315	This emission category includes emissions from the following sources: On-road fleet vehicles (owned and leased through Multnomah County and DAS); Off-road vehicles – Parks, Solid Waste, Oregon Zoo and MERC; Fuel types used by these vehicles include diesel, diesel blend, gasoline, and propane.
	Other fuels	36	Metro has diesel generators at all facilities excluding MRC. However, a minimal amount of fuel is consumed by these generators and data for this emissions source is often not separated from diesel used in mobile vehicles.
	Refrigerants	1,018	Refrigerants are used in HVAC and commercial food refrigeration systems at all of Metro facilities. However, refrigerant use data at Metro Parks was not available for inclusion in this inventory; therefore this total may represent an emissions undercount. Refrigerant systems at Metro facilities use: HCFC-22 (R-22): Though preferable to prior refrigerants including CFCs, the manufacture of R-22 contributes significant greenhouse gasses to the atmosphere and contains chlorine, which contributes to atmospheric ozone depletion. CFC-11: This refrigerant in on the Class 1 Ozone Depleting Substance list and is on the phase-out list through Clean Air Act Regulations. The other refrigerants used at Metro include: R-404 (and -404A); R-410; R-414 (A and B); and R-134
	Regional waste hauling	9,962	This emissions category includes the fuel used to transport waste loads from Metro South and Metro Central Transfer Stations to the Columbia Ridge Landfill (under contract with Walsh Trucking Co.) By following standard GHG inventory protocols used to define the organizational boundaries of baseline inventories, Metro is responsible for these source emissions for the following reasons: Metro purchases the fuel used by Walsh Trucking Co from Devin Oil; the long haul waste fleet was designed to Metro specifications; and Metro holds the contract for regional waste hauling services as part of the agency's mission-critical responsibilities
	St. Johns Landfill	4,188	The emissions reported here are based on a preliminary GHG inventory of emissions from various aspects of operating the St. Johns Landfill. Under new Title V air pollution permit reporting requirements, Metro must meet DEQ reporting requirements related to the methane management practices at the landfill. The preliminary estimate reported in this St. Johns landfill source only includes the landfill gas emissions. The emissions associated with operating the St. Johns landfill are included in the other emission scopes outlined in this table.
Scope 2 (Indirect Emissions)	**Electricity**	13,352	Metro calculated the electricity consumption from all facilities included in the inventory boundary. The electricity consumption totaled 32,639,109 kWh for 2008.
Scope 3 (Indirect Emissions)	**Business travel**	523	Business travel includes employees' use of airlines, rental cars and personal vehicles for travel associated with training, conferences, and meetings.
	Solid waste	999	The emissions associated with solid waste generation are calculated based on the methane management practices at the landfills where Metro generated solid waste is disposed.
	Commute	1,437	In 2008 Metro employed 508 people at MERC facilities and 1150 employees at Metro facilities, totaling 1658 employees (including benefits eligible, part-time, seasonal and non-benefits eligible employees). Mode split information was available for 1000 of the total 1658 employees; the average distance of travel was 10 miles one way.
	Water	257	Metro purchases water and sewer services from multiple providers and utilizes non-potable sources such as wells at a number of park facilities. The emissions reported here result from the electricity associated with the treatment and distribution of potable water to Metro facilities. The emissions associated with the distribution or collection of well and river water as included in the Scope 2 emissions estimate since these emissions are captured by the direct energy (electricity) used at the facility site and included in METRO's utility bills.
	Supply chain	21,000	Embodied emissions in purchased goods and services accounts for emissions that result from all of the products and services Metro purchases.

The emissions results above are normalized for each functional area using the following where applicable.

FUNCTIONAL AREA	SCOPE 1 AND 2 EMISSIONS (MT CO_2e) BY:					
	Employee	Building Square Foot (1000 sq ft)	$1 Million of Revenue	Visitors (1000 visitors)	Show Days	Shows
MERC	30	7	347	5	4	7
MRC	3	9	N/A	Unknown	N/A	N/A
Oregon Zoo	15	30	342	3	N/A	N/A
Parks	6	1	N/A	Unknown	N/A	N/A
Solid Waste	83	6	N/A	Unknown	N/A	N/A

Methods: Data, Protocols and Sensitivity Analysis

This inventory follows the Local Government Operations Protocol, which provides the highest-consensus guidelines for minimum reporting and was developed jointly by The Climate Registry and other organizations.[11] However, the protocol only requires emissions in Scopes 1 and 2. Scope 3 is usually considered an optional emissions reporting category and has typically been ignored by conventional inventories. However, including Scope 3 emissions analysis in a GHG baseline presents a more accurate picture of an organization's carbon footprint and better illustrates the potential regulatory and financial risks associated with carbon emissions. While Metro may not have complete or direct control over all Scope 3 emissions, it can influence all emissions sources to varying degrees.

All emissions are reported in metric tons of carbon-dioxide equivalent (MT CO_2e).

The analysis attempts to cover all six "Kyoto gases" including: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6) and the groups of high Global Warming Potential (GWP) gases, perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs).

Overwhelmingly, the direct and indirect CO_2e emissions are CO_2 from combustion of fossil fuels.

The analysis drew on high-consensus public-domain tools for emissions factors and methods. Some sources (such as embodied emissions in purchases) were estimated by combining available budget data with careful assumptions, while others had more direct data, such as electricity use (from billing information), and solid waste from hauler account data and waste sort studies. The following is a description of the completeness of data for the major categories, as well as assumptions made to calculate estimated emissions. Following this methodology section is a detailed analysis of each

[11] The Local Government Operations (LGO) Protocol was developed as a collaboration of The Climate Registry (TCR), the California Air Resources Board (CARB), the California Climate Action Registry (CCAR, now the Climate Action Reserve), and ICLEI Local Governments for Sustainability. The LGO Protocol follows the same format as The Climate Registry's General Reporting Protocol (GRP).

of the inventory reports by functional area, including MERC, Metro Regional Center, Parks, the Oregon Zoo and Solid Waste. All assumptions detailed in the following methodology section apply to the analysis completed for each functional area inventory, unless otherwise noted.

Fleet

Data related to vehicle fuel consumption is most likely incomplete and results for this emissions category should be considered estimates since they potentially represent an undercount of the total emissions associated with Metro's fleet. Fuel or mile use information was accessible for roughly 68% of the total vehicles included in the inventory; it was not possible to collect or estimate total fleet use information for the remaining 32% of the fleet The accuracy limitations associated with this emissions category result from a number of data collection limitations in Metro's business operations. Metro and MERC's fleet and fleet fuel use is not tracked and reports are difficult to obtain for a number of reasons.

First, there is no single inventory of all Metro vehicles, off-road or on-road. Second, Metro uses multiple fuel vendors and no single department tracks all fuel use. In addition to having multiple fuel contracts with private vendors, in 2008 Metro leased about half of the on-road fleet vehicles from Multnomah County and the State of Oregon. All efforts were made to assemble a complete fleet inventory and complete fuel use reports, however it is assumed that these reports are incomplete. In addition to these data limitations, assumptions about vehicle fuel use were made for the following functional areas:

MRC

- All vehicles housed at MRC were assigned to the MRC fleet, even though these vehicles are used by Parks and Solid Waste staff.

Oregon Zoo

- Diesel fuel purchases are tracked by month at an on-site fuel tank. However, building generators, fleet vehicles, the four train engines and miscellaneous equipment (e.g. leaf blowers) all draw from the same fuel tank however only the Zoo train engine fuel use is tracked.
- Gasoline is primarily used by vehicles, but equipment such as leaf blowers and lawnmowers are also powered by gasoline. However, fuel use is not tracked by end use, therefore all gasoline use was assigned to the vehicle fleet.

Parks

- Data for fuel use at Blue Lake Park was not available so fuel consumption data from Oxbow Park was used as a proxy.
- The total vehicle fuel emissions are most likely an undercount because of the difficulties of tracking vehicle use for the vehicles stationed at MRC (conversely, MRC vehicle fuel emissions are most likely an over count.) Vehicle reservation records for CY 2008 (maintained by Office Services) did not track total miles traveled by department. However, Office Services is now tracking this information and submitting monthly use reports to the new fleet operations manager. This tracking improvement is part of the Metro fleet centralization project.

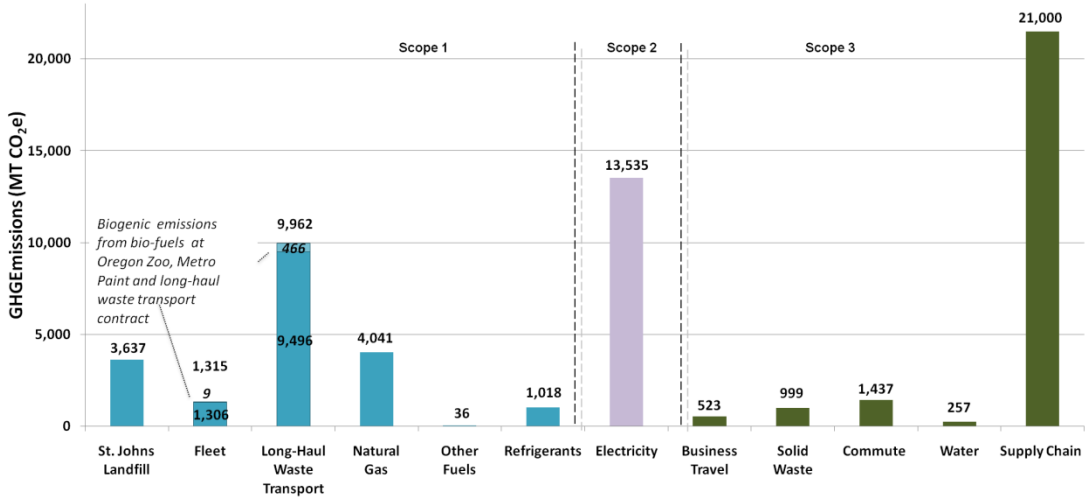
Solid Waste

- Because Solid Waste Enforcement vehicles are tracked separately from the Metro fleet, emissions from the five SW Enforcement vehicles are included in the Solid Waste fleet emissions despite being stationed at MRC.
- The total miles driven by the Metro Paint box truck (delivery truck) are used as a proxy for the box truck at Metro Central since vehicle use data are not tracked at Metro Central.
- Fuel use or mileage records are not available for solid waste education or toxics reduction vehicles.

The fleet inventory includes all available heavy or off-road equipment fuel use. Metro is currently in the process of improving all fleet use tracking systems as part of the fleet centralization project, which includes the implementation of a centralized fleet tracking software system that will monitor fleet mileage and fuel use by department.

After assembling a master fleet list (including total gallons used by vehicle and average fuel efficiency, based on US fleet averages), diesel and gasoline emission factors were used to calculate total emissions.[12] Alternative fuels (ethanol and biodiesel) are used at the Oregon Zoo (10% ethanol mix in gasoline), Metro Paint (15% bio-diesel) and for the long-haul waste transport fuel as part of the Walsh Trucking hauling contract (5% bio-diesel). Figure 6 below identifies the biogenic emissions (associated with the biological carbon cycle of burning plant materials) from these bio-fuels from the anthropogenic emissions (human-caused from the mining of fuels out of the Earth's crust) from the burning fossil fuels. The benefit of using bio-fuels is captured by conducting a life-cycle analysis comparing the carbon intensity of different fuel feed stocks.[13]

Figure 6: Agency-wide biogenic fuel emissions from bio-fuel (2008) (used at Oregon Zoo, Metro Paint, and Long-haul waste transfer contract)



[12] Environmental Protection Agency (2007): Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2007. Available at: www.fueleconomy.gov The Climate Registry, Version 1.1 (May 2008). Available at: http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol.php

[13] For more information on the GHG benefits of using bio-fuels see Oregon DEQ's low carbon fuels standards, available at: http://www.deq.state.or.us/aq/committees/lowcarbon.htm or California Air Resources Board Low Carbon Fuel Standard Program, available at: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

Various biofuels can have very different life-cycle carbon-intensities based on raw materials used for production and energy intensity of the production processes. When selecting biofuels for use in Metro's fleets it is important to select fuels based on life-cycle carbon intensity to insure the greatest carbon reduction benefit. There are current limitations to this however, given that life-cycle emissions of biofuels are still being studied, and new biofuels are constantly under development. Despite this fast-changing landscape and the limited life-cycle assessments of biofuels there are recent analyses of fossil fuel and biofuel pathways by the California Air Resources Board (CARB) and the Oregon Department of Environmental Quality that apply to the fuels available in Oregon.[14]

Natural Gas

Billing records from Northwest Natural (NW Natural), Metro's natural gas utility, were used to determine the total volume of natural gas burned at all facilities that use natural gas. Because Metro does not track utility data (except at the MERC facilities) it was necessary to contact NW Natural directly to request billing and fuel use data.

Emissions factors based on an average U.S. heat content (provided by the Local Government Operations Protocol) were used to calculate emissions from burning natural gas.

In 2008 Metro owned and maintained 37 rental properties at a number of regional park facility locations. While Metro is not directly accountable for all operational GHG emissions associated with these rental properties, Metro does pay for utility bills when the houses are vacant. Metro also has direct control over all energy efficiency upgrades and building maintenance at each facility. Scope 1 and 2 GHG emissions estimates are calculated for each rental property and presented in Figure 7. These emissions estimates are calculated using the U.S. Energy Information Administration's 2005 Residential Energy Consumption Survey (RECS).[15] The Survey provides energy-related consumption and expenditure data for the average US household. After identifying the energy fuel sources at each rental location national average energy consumption data for Climate Zone 3 was used to estimate average annual energy use for each of the residential rental properties. These emissions results should be viewed as estimates and are provided for sense of scale purposes only. To improve the accuracy of the results for this emissions source, all relevant emission source data for Metro rental properties should be collected for future GHG emissions tracking and monitoring purposes.

[14] For more information on the GHG benefits of using bio-fuels see California Air Resources Board Low Carbon Fuel Standard Program, available at: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm. CARB's Low Carbon Fuel Standard, available at: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm or Oregon DEQ's low carbon fuels standards, available at: http://www.deq.state.or.us/aq/committees/lowcarbon.htm

[15] U.S. Energy Information Administration (2005), Residential Energy Consumption Survey (RECS), available at: http://www.eia.doe.gov/emeu/recs/recs2005/c&e/detailed_tables2005c&e.html

Figure 7: Metro parks rental properties, building energy estimates (2008)

Other Stationary Fuels

The total number of stationary backup generators at Metro facilities is unknown. All functional areas have diesel generators, excluding MRC. However, fuel use for the generators is not tracked at any facilities and at a number of facilities (where fuel is delivered and stored onsite) the fuel used to run these generators is typically not differentiated from other fuel sources. Therefore, it is possible that a portion of the generator emissions are accounted for in fleet emissions. This may be a larger issue for the Parks and the Oregon Zoo than for other functional areas (MERC and Solid Waste). In addition, no stationary fuel use data was available for any of the solid waste facilities, which results in an undercount for Scope 1 emissions for all Solid Waste facilities however, it is anticipated that this is not a large undercount given the small number of generators used at these facilities.

Refrigerants

Metro uses refrigerants at all functional area facilities however, refrigerant use data at Metro Parks was not available for inclusion in this inventory. The majority of refrigerants are used for rooftop HVAC systems and commercial food refrigeration units. The emissions associated with this source result from the fugitive refrigerant emissions from seals and gaskets on aging HVAC or refrigerant units. The types of refrigerants used in these systems vary by facility and are presented in Table 4. No Metro facilities maintain refrigerant purchasing or replacement records, therefore estimation methods outlined in The Climate Registry's General Reporting Protocol were used to calculate average annual refrigerant loss at each facility (excluding one known refrigerant leak at the Oregon Zoo). [16] In addition, no refrigerant information was available from any of the Parks facilities. The confidence level for this emissions category is moderate given the data limitations. Comprehensive data collection systems should be established at all Metro facilities in preparation for future inventories and to improve the accuracy of the results for this emission source. While refrigerants may not represent a large share of Metro's total GHG emissions, refrigerants have high global warming potentials relative to other GHGs – small leaks in HVAC or refrigerant units can have a large effect relative to the size of loss.

[16] The Climate Registry, General Reporting Protocol, Version 1.0 (March 2008). Chapter 16, Page 126.

Landfill Gas from St. Johns Landfill

The emissions reported for St. Johns Landfill are exclusively attributable to landfill gas (LFG) flow (2008), not St. Johns landfill facility operation emissions. In other words, all of the emissions for St. Johns Landfill from owned vehicle fuel use (gasoline and diesel), natural gas consumption for building and refrigerants (Scope 1); electricity consumption (Scope 2); and the Scope 3 supply chain, water, solid waste disposal, employee commute, and business travel emissions are included in the respective emission source totals with all other Metro operational emissions.

Metro determines the amount of landfill gas (LFG) that is both released and collected from the landfill using data collected from onsite flow and composition monitoring devices. Flow data is collected by continuous monitoring devices that record data to a central St. Johns computer. Methane concentration is also measured with a portable instrument each work day and recorded. It is assumed that approximately 30% of the direct St Johns Landfill gas is CO_2 and that 95% of LFG is collected and processed.

Metro used data provide by Ash Grove Cement to determine the amount of landfill gas that was sent off site for consumption by Ash Grove in their kilns (based on a contractual agreement that allows Ash Grove Cement exclusive rights to use landfill gasses from St. Johns Landfill as needed, based on their production energy needs). Ash Grove sends Metro monthly statements of gas flow and methane consumption as recorded daily at their site. In 2008, Metro sent 75% of the total collected landfill gas to Ash Grove Cement. Therefore, the following analysis includes only the collected LFG minus the 75% sent to Ash Grove Cement (not total landfill gas flow).

The Local Government Operations Protocol (LGO) does not consider all landfill gas as anthropogenic (human caused). The majority of landfill gases are considered biogenic, or naturally occurring and not contributing to human caused climate impacts.

The total Scope 1 emissions from St. Johns Landfill (3,637 MT CO_2e) are comprised of the following emission sources:

- Direct Landfill Gas (LFG) fugitive emissions from CH_4 emitted from landfill (3,228 MT CO_2e)
- LFG to Flare: CO_2e from CH_4 due to incomplete combustion in landfill flares (169 MT CO_2e)
- LFG to Flare: CO_2e from NO_x emitted due to combustion in landfill flares (240.4 MT CO_2e)
- LFG to Evaporator: CH_4 due to incomplete combustion in evaporator (4.72E-04 MT CO_2e)
- LFG to Evaporator: CO_2e from NO_x emitted due to combustion in evaporator (4.72E-04 MT CO_2e)

Electricity

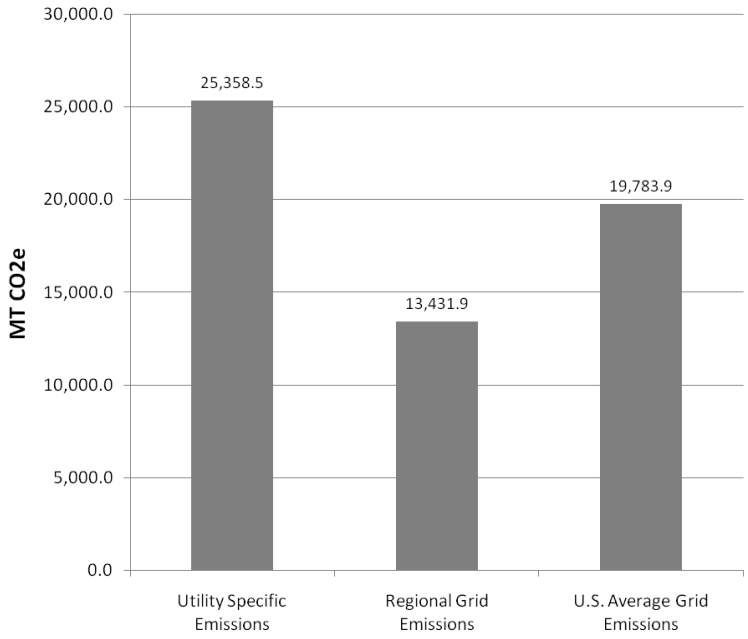
PacificPower and PGE are the electricity utility providers for Metro facilities. Billing data from both utility companies were used to determine the total amount of electricity used at all Metro facilities (by meter). This data was cross referenced with electricity inventories provided by facility managers at a number of facilities. The data related to electricity consumption is complete and results for this emissions category should be considered highly accurate. It should be noted however, that there is a sub-meter at the Metro Central Hazardous Waste Facility that is not

tracked. This meter should be read monthly to get accurate facility readout for ongoing energy related inventories.

The calculations reported in Figure 3 (p.11) are the sum of the electricity emissions calculated for each functional area. These results were calculated using the CO_2 emissions factor for the Northwest Power Pool (NWPP)—907.3 lbs CO_2e/kWh. Using the utility specific emissions factors and not the regional or national electricity-production emissions factors does not consider the emissions associated with purchased electricity. Therefore, the regional grid emissions factor provides a more meaningful number. However, purchased electricity emissions using utility specific emissions factors are included in figure 8 for reference and sense of scale. PacificPower and PGE, Metro's electricity providers, directly reported 1,776 lbs CO_2/kWh, and 1,625 lbs CO_2/kWh respectively. PacificPower did not provide emissions factors for CH_4 or N_2O, so regional electricity-production emissions factors were used to calculate total CO_2 equivalents. (The average emissions factor for these two utility providers is used to calculate the utility specific emissions results.) It is important to note that this is the "owner-based" emissions factor and does not consider the emission factors from the electricity that they purchase from other producers. Because no utility sells only its "owner-based" produced electricity to its clients, but rather an ever-changing mix of utility produced and purchased power sources (other electricity providers around the country), it is impossible to know the exact energy source mix for an individual facility at any given moment.

The carbon intensity of PacificPower and PGE's generation are distinctly different—considerably higher— than the emissions of the regional and national grids. However, when such large emissions factor differences exist, it is important to acknowledge these differences in order to more accurately compare emissions to other organizations that may use one or more emissions factors. Figure 8 demonstrates how the emissions totals for MRC's Scope 2 emissions would differ when using the local utility emissions factors for PacificPower and PGE (demonstration purposes only), the regional grid mix for the Northwest Power Pool (NWPP) and the national grid mix.

Figure 8 Electricity emissions scenarios for Metro agency-wide emissions using local, regional and national emissions factors (2008)



Electricity Emissions Factors

Utility Specific = 1,700.5 MT CO_2e/kWh

NWPP = 907.3 MT CO_2e/kWh

National Average = 1329.4 MTCO_2e/kWh

Business Travel

Business travel data (total miles traveled by transportation mode; air, train, and vehicle) was challenging and time consuming to collect. Metro does not track miles traveled by mode split in the electronic business travel reports; there is no accounting code to distinguish the dollars spent on travel from other travel expenditures (such as hotel or food). In addition, Metro does not track the total miles traveled for each trip. Data for business travel at Metro facilities was gained by pulling all individual travel reimbursement forms submitted to the accounting department from onsite storage. The travel reimbursement forms require employees to include copies of airline or rail tickets, or mileage traveled by vehicle. The process of pulling individual travel reimbursement forms was time consuming for accounting staff, in part because all accounting documents are filed by check number. However, the data for Metro business travel is complete and should be considered accurate.

MERC's accounting department stores total miles traveled in their accounting system, however a series of time consuming queries were required to compile MERC business travel. While the data compiled for MERC is highly accurate it only includes trips taken for conferences or trainings and does not include local in-city business travel and is therefore an undercount of all MERC business travel related emissions.

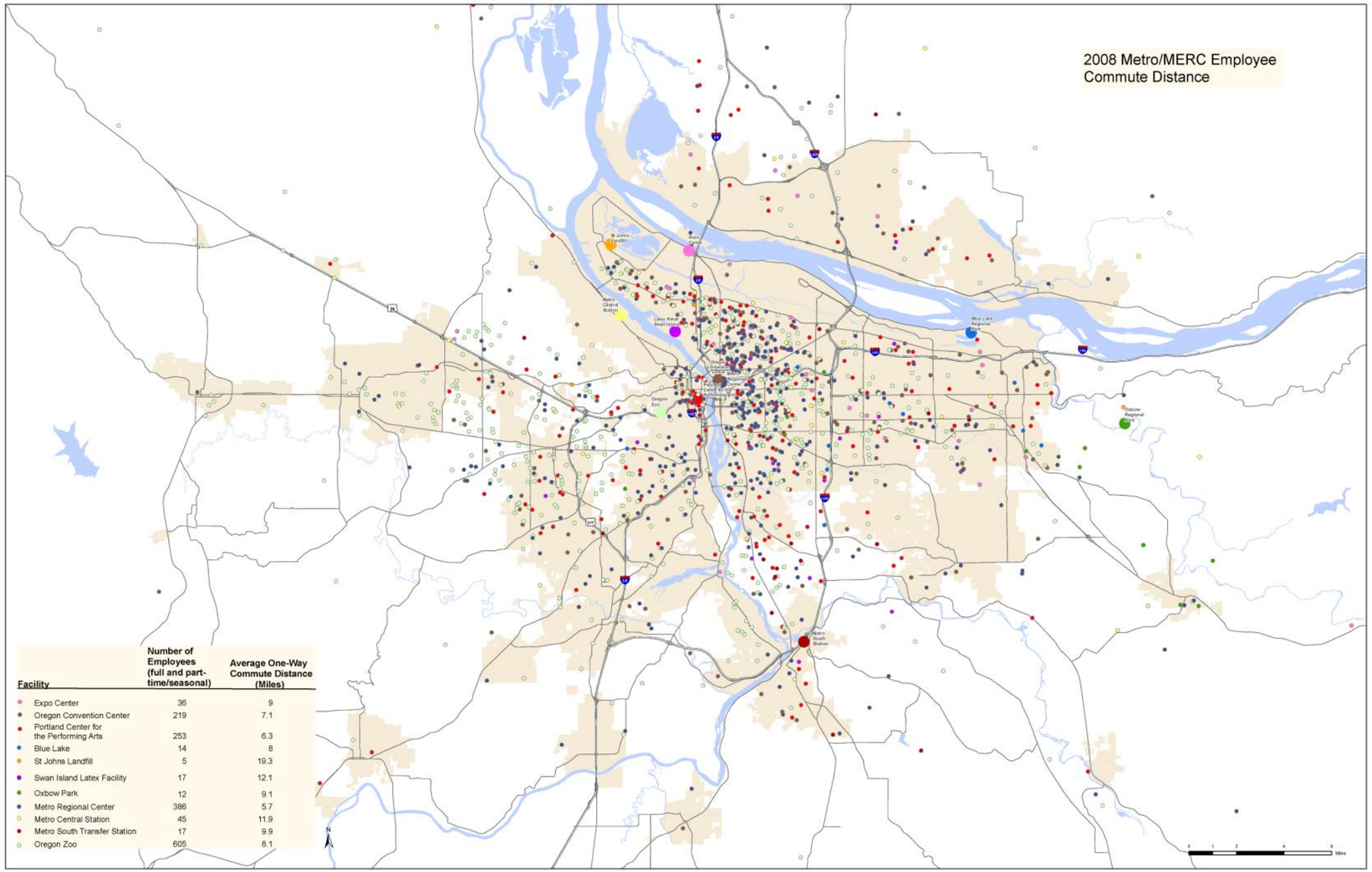
The data for business travel does not include travel by light rail or bus. Metro does not track the total miles traveled by employees by in-city public transit. Metro does provide transit passes to benefits eligible employees at a number of facilities; however it is not possible to determine how many business travel miles are traveled by public transit in 2008.

Commute

The emissions associated with employee commute are calculated using three data sets and with the assistance of Metro's Data Resource Center (DRC). Metro does not track data to estimate the emissions generated by employee commuting, however a series of data sets were compiled to estimate annual employee commute distances and mode split.

Human resources generated the data set used in this inventory to estimate Metro's commute emissions. The data set included Metro employees' home addresses and their work location (no employee identification information was included in the data set to ensure employee privacy). These trip start and end locations were then geo-coded in GIS to generate total miles traveled by employee (as the crow flies). Some employee addresses did not geocode because they were either PO Boxes, missing, or unrecognizable by the locator (the percentage that did not geocode was between 3-5%). The average one-way commute distance (miles) was calculated using the total miles traveled by facility.

Figure 9 2008 Metro/MERC employee commute distance



Facility	Number of Employees (full and part-time/seasonal)	Average One-Way Commute Distance (Miles)
Expo Center	36	9
Oregon Convention Center	219	7.1
Portland Center for the Performing Arts	253	6.3
Blue Lake	14	8
St Johns Landfill	5	19.3
Swan Island Latex Facility	17	12.1
Oxbow Park	12	9.1
Metro Regional Center	386	5.7
Metro Central Station	45	11.9
Metro South Transfer Station	17	9.9
Oregon Zoo	605	8.1

Figure 9 is a map of all employee commute start locations, color coded by the final work destination (facility). The following is the resulting mode split for this sample: Drove alone – 73%; Carpool – 11%; Bus/Rail – 11%; Bike – 3%; Walk – 1%; Telecommute or compressed work week – 1%. The average on-way commute distance for all Metro functional areas is 10 miles.

After generating the average one-way commute distance by facility (work location) average mode split percentages were applied to generate the commute mode split for each location. These mode split data were generated by the Lloyd District Transportation Management Association's (Lloyd TMA) annual survey. The Lloyd TMA survey is distributed only to benefits eligible employees on an annual or biennial basis (depending on facility location) – at some facilities upwards of 50% of the staff may be excluded from the survey. These mode split rates were assigned to the total employee address list in an effort to estimate the emissions associated with all employee commute travel. Because the Lloyd TMA survey is conducted in the summer and asks recipients to report on their commute patterns for one week only, the mode split data may not represent typical annual commuting patterns and possibly over count bus, walk and bike commute modes. Given these limitations, the results of this emissions category should be seen as estimates.

Metro staff is working to develop an annual employee commute survey for all Metro employees (including non-benefits eligible employee) that records travel modes and miles traveled supplemental to the Lloyd TMA survey. Implementing an employee commute survey would provide more accurate data for ongoing tracking and monitoring of employee commute emission sources.

Solid Waste

Data on the solid waste generated at MRC were taken from the waste generation and recycling baseline conducted for Metro's Sustainability Plan. Facility managers requested waste generation reports from the franchised hauler for each facility. These reports include waste estimate calculations based on the number and size (volume) of containers and frequency of collection from all facilities, as well as historical container weight studies conducted by the hauler. However, there are a number of limitations with this dataset; first, no waste data was available for any of the park facilities except for Oxbow Regional Park. Second, this methodology assumes all waste containers are full and does not represent actual waste collection (in tons). Due to these data limitations the results of this emissions category should be considered estimates.

Emission factors associated with landfill methane management techniques at the waste disposal facilities were applied to the estimated waste generation totals discussed above.[17] Because it is not possible to identify the exact landfill destination for each ton of waste generated at Metro facilities, the solid waste emissions estimates are based on the following waste allocation assumptions: regional waste allocation rates by landfill (percent of total tons disposed) were applied to the total tonnage estimates from each facility in an effort to determine the percentage allocation of Metro generated waste throughout the regional waste disposal system. [18]

Metro staff are working with waste haulers to devise more accurate methods to capture volume or weight of solid waste generated at Metro facilities.

Water

Potable water treatment and distribution to regional facilities, residents and businesses is a source of GHG emissions because it takes electricity (and other inputs) to treat water and pump it throughout a community. Metro purchases water from seven different water utilities (Portland Water Bureau, City of Fairview, Sunrise Water Authority, Rockwood Water Public Utility District, Tualatin Valley Water, City of Gresham Stormwater, and Clackamas County Water and Environmental Services). Due to limitations in time and availability associated with collecting utility specific emissions factors for each water provider an emissions factor calculated by Good Company for the Joint Water Commission was used to provide an estimate of Scope 3 GHG emissions associated with Metro's consumption of water. [19] The GHG estimate only applies to water supply, not waste water treatment.

It should be noted that a number of facilities use well water, which was excluded from this analysis. It is assumed that the emissions associated with pumping well water are captured in the electricity emissions for each facility (Scope 2).

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[17] Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, 3rd EDITION, September 2006, Exhibit 6-8. Available at: http://www.epa.gov/climatechange/wycd/waste/SWMGHGreport.html

[18] Regional waste allocation data came from Metro's Solid Waste Information System, which is used to track tonnage information that incurs through Metro's regional system fee and excise tax.

[19] Five agencies share ownership in the Joint Water Commission including: Cities of Hillsboro, Forest Grove, Beaverton and the Tualatin Valley Water District (TVWD). All of the agencies serve areas in Washington County and have varying water source supplies and levels of ownership in the Joint Water Commission.

Supply Chain

A life-cycle greenhouse gas (GHG) analysis using Carnegie Mellon's Economic Input-Output Life-Cycle Assessment (EIO-LCA) model was conducted for all supply chain purchases (including goods, food and services) for all functional area (including Metro and MERC) for calendar year 2008 (CY 2008).[20]

The analysis of all four Metro functional areas (MRC, Zoo, Parks and Solid Waste) was completed by Good Company, while the analysis of the three MERC functional areas was completed in-house by Metro staff. However, the same methodology was used for both data sets and a methodology check was completed to ensure that meaningful comparison could be made between the results of these analyses. (For more information on the EIO-LCA analysis, see Appendix A.)

A detailed account of the supply chain analysis is included in the *Embodied Emissions in Purchased Goods and Services* starting on page 40.

[20] Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available at: http://www.eiolca.net.

FUNCTIONAL AREA INVENTORY ANALYSIS

The following section provides a detailed analysis of emissions from Metro regional government operations by functional area. For consistency with the Metro Sustainability Plan the functional areas are defined as follows: MERC, Metro Regional Center (MRC), the Oregon Zoo, Regional Parks and Solid Waste. (For information on the facilities included in each functional area see Table 3, p.10)

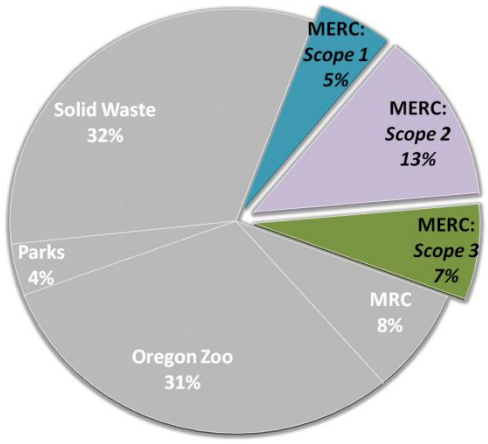
Following the five functional area analysis sections is a detailed summary of the life-cycle supply chain analysis. This inventory includes two separate supply chain analyses sections as a result of the decentralized accounting systems between MERC and Metro. There is one centralized accounting department for all Metro functional areas, including MRC, the Oregon Zoo, Parks and Solid Waste operations. MERC, which includes the Oregon Convention Center, Portland Center for the Performing Arts, and the Portland Expo Center has a separate accounting department. These two accounting departments use different accounting software and do not coordinate consolidated quarterly or annual reports. In addition, MERC and Metro have different procurement codes and procedures. Because of these decentralized and varied accounting structures the EIOLCA (or supply chain) analyses for calendar year 2008 expenditure reports was conducted separately for MERC and Metro. However, the same methodology was used for both data sets. The analyses results were combined to provide an overall snapshot of supply chain emissions for calendar year 2008 for all Metro functional areas.

MERC

In 2008, the emissions from operating MERC facilities accounted for 14,445 metric tons of carbon equivalent (MT CO_2e) or **roughly 25% of Metro's total operational emissions**.

Scope 1 and 2 emissions:
- 7 MT CO_2e per building sq. ft.
- 30 MT CO_2e per employee
- 347 MT CO_2e per $1 million of revenue
- 5 MT CO_2e per thousand visitors
- 4 MT CO_2e per show day
- 7 MT CO_2e per show

Figure 10: MERC greenhouse gas emissions as a share of total regional government operation emissions (2008)



MERC's emissions from owned vehicle fuel use (gasoline and diesel), natural gas consumption for building heat, and refrigerants for air conditioning accounted for **3,046** MT CO_2e, defined as Scope 1 emissions. Electricity consumption accounted for **7,499** MT CO_2e, defined as Scope 2 emissions. This electricity was used to light and power performing arts, conference and convention centers. The total Scope 1 and 2 emissions for 2008 was approximately **10,545** MT CO_2e. These are the emissions that Metro has the most control over.

In addition, this inventory identified approximately **3,900** MT CO_2e of other emissions from mission-critical activities that are outside of MERC's direct control (Scope 3). Scope 3 emissions are primarily composed of embodied emissions from the supply chain of purchased materials and services at MRC, but also include the purchase of potable water from the Portland Water Bureau, solid waste disposal, employee commute, and business travel (see Figure 11 below). While Metro may not have direct control over these additional emissions sources, it can influence them by reducing purchases or consumption of waste generating materials and business related travel, and by providing additional employee commute options. By calculating these Scope 3 emissions, Metro is able to explore these areas for emissions reduction opportunities.

Scope 2 emissions from electricity consumption are the largest emissions source for MERC (7,499 MT CO_2e) and is over twice the next largest emissions source – supply chain (3,351 MT CO_2e). **The emissions from MERC's electricity consumption make up roughly 56% of Metro's entire agency wide scope 2 emissions**.

Table 5: MERC supply chain emissions

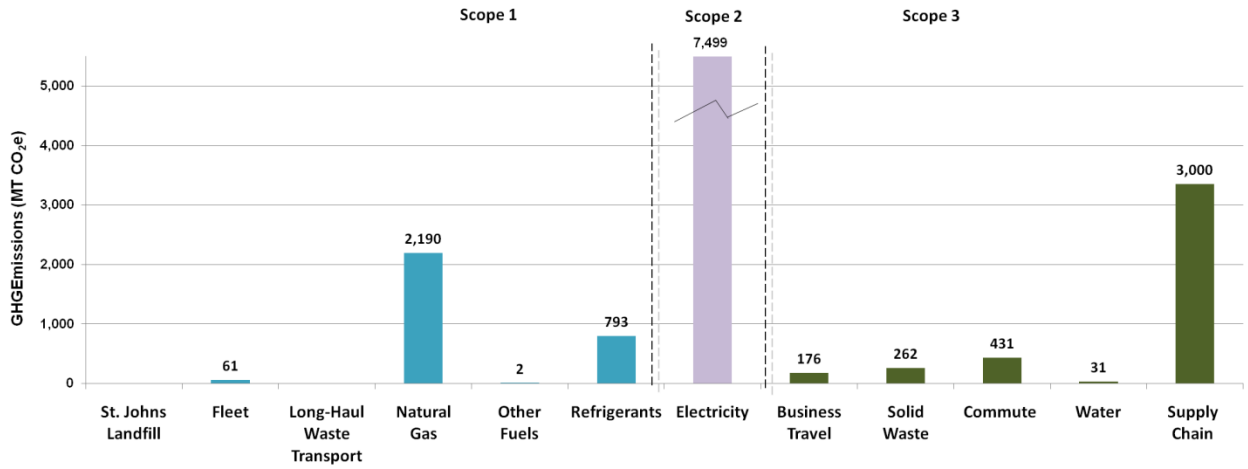
MERC Supply Chain Emissions by Category (CY 2008)	MTCO_2e
Food	1,270
Professional Services	1,023
Buildings (Construction and Maintenance)	571
Other	215
Operating Supplies	107
Office Supplies	96
Vehicles/Equipment (Buy, rent, maintain)	68
Total	**3,350**

Supply chain emissions are the second largest source for the MERC functional area (roughly

3,000 MT CO_2e). Similar to the Zoo, food comprises the largest emissions category within MERC's supply chain. The second largest emissions source includes professional services, which is not surprising given the large number of professional services contracted out by MERC. Table 5 provides details on MRC's largest supply chain emissions categories.

The third largest emissions source for MERC is natural gas, which is used to heat all of the MERC facilities. **Natural gas use at MERC facilities accounts for roughly 54% of Metro's entire agency wide natural gas use.**

Figure 11: MERC greenhouse gas emissions from regional government operations (2008)



Scopes 1 and 2 yield 10,545 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 2,016 passenger vehicles
- Annual emissions from the energy consumed by 897 homes (US average)

Scope 3 emissions yield 3,900 MT CO_2e. For sense of scale, this is equivalent to:

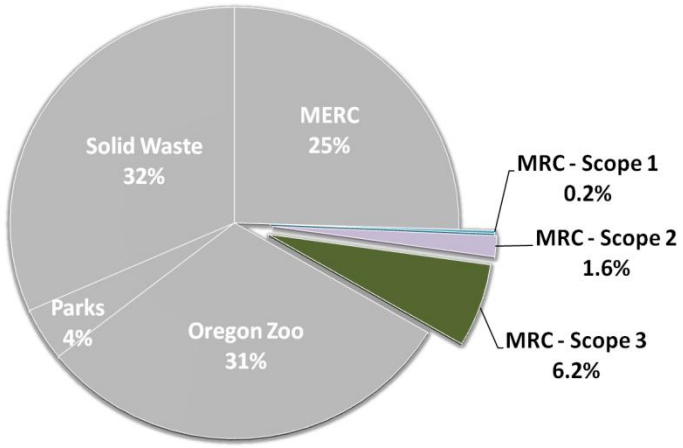
- Annual emissions from 746 passenger vehicles
- Annual emissions from the energy consumed by 332 homes (US average)

Metro Regional Center

In 2008, the emissions from operating the Metro Regional Center accounted for 4,540 metric tons of carbon equivalent (MT CO_2e) or roughly **8% of Metro's total operational emissions**.

Scope 1 and 2 emissions:
- 9 $MTCO_2e$ per building sq ft
- 3 $MTCO_2e$ per employee

Figure 12: Metro Regional Center greenhouse gas emissions as a share of regional government operation emissions



Metro's emissions from owned vehicle fuel use (gasoline and diesel), natural gas consumption for building heat, and refrigerants for air conditioning accounted for **120** MT CO_2e, defined as Scope 1 emissions. Electricity consumption accounted for **913** MT CO_2e, defined as Scope 2 emissions. This electricity was used to light and power Metro's only solely dedicated office building. The total Scope 1 and 2 emissions for 2008 was approximately **1,033** MT CO_2e. These are the emissions that Metro has the most control over.

In addition, this inventory identified approximately **3,507** MT CO_2e of other emissions from mission-critical activities that are outside of Metro's direct control (Scope 3). Scope 3 emissions are primarily composed of embodied emissions from the supply chain of purchased materials and services at MRC, but also include the purchase of potable water from the Portland Water Bureau, solid waste disposal, employee commute, and business travel (see Figure 13 below). While Metro may not have direct control over these additional emissions sources, it can influence them by reducing purchases or consumption of waste generating materials and business related travel, and by providing additional employee commute options. By calculating these Scope 3 emissions, Metro is able to explore these areas for emissions reduction opportunities.

Table 6: MRC supply chain emissions

Metro Regional Center Supply Chain Emissions by Category (CY 2008)	$MTCO_2e$
Professional Services	1,648
Office Supplies	670
Other	273
Buildings (Construction and Maintenance)	247
Vehicles/Equipment (Buy, rent, maintain)	201
Operating Supplies	65
Food[21]	—
Total	**3,163**

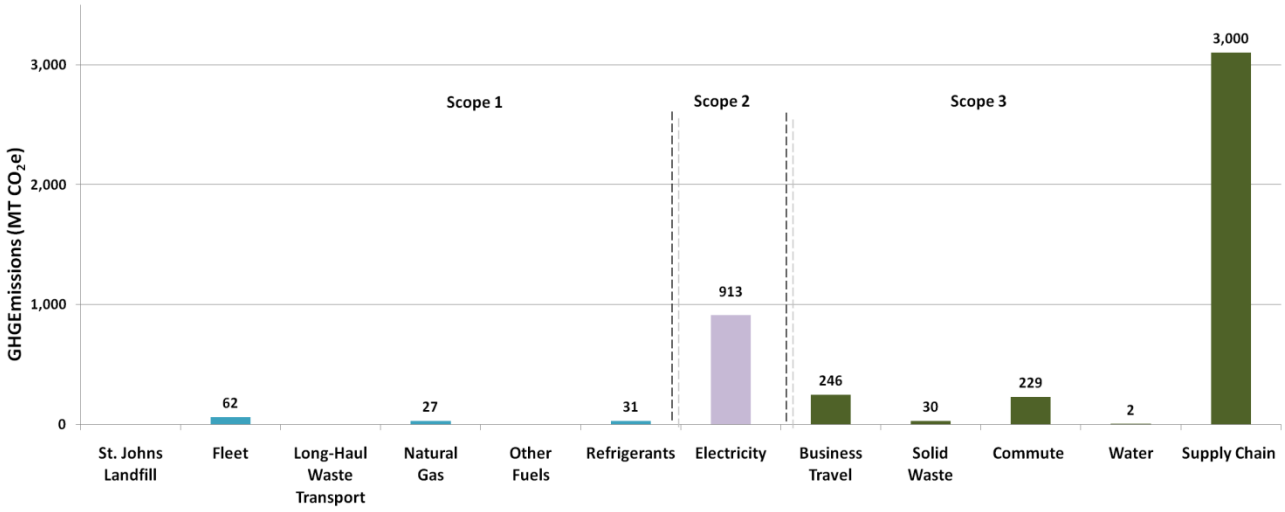
Supply chain emissions are the largest emissions source for MRC (roughly 3,000 MT CO_2e) and is nearly twice the next largest emissions source – building electricity use (913 MT CO_2e). Table 6 provides details on MRC's largest supply chain emissions categories.

The third largest emissions source for MRC is business travel. This results from the number and frequency of international and transcontinental

[21] Meeting expenses for MRC are grouped in the Other Goods and Services category. These expenses likely include food, but the data did not provide clear differentiation between food and other meeting related expenses.

flights taken by Metro staff. While business travel is the third largest emission source for government operations at MRC, it only accounts for 5% of the total emissions attributable to MRC and roughly .4% of Metro's total government operation emissions. Building electricity however, accounts for 20% of MRC's total emissions and roughly 2% of Metro's total emissions.

Figure 13: Metro Regional Center greenhouse gas emissions from regional government operations (2008)



Scopes 1 and 2 yield 1,033 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 198 passenger vehicles
- Annual emissions from the energy consumed by 88 homes (US average)

Scope 3 emissions yield 3,507 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 671 passenger vehicles
- Annual emissions from the energy consumed by 298 homes (US average)

Oregon Zoo

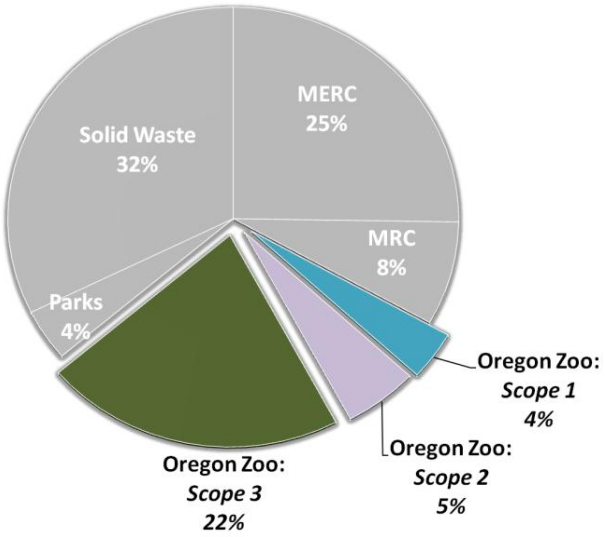
In 2008, the emissions from operating the Oregon Zoo accounted for **17,489 metric tons of carbon equivalent (MT CO_2e) or roughly 31% of Metro's total operational emissions.**

Scope 1 and 2 emissions:

- 30 $MTCO_2e$ per building sq ft
- 15 $MTCO_2e$ per employee
- 342 $MTCO_2e$ per $1 million of revenue
- 3 $MTCO_2e$ per thousand visitors

The Oregon Zoo's emissions from owned vehicle fuel use (gasoline and diesel), natural gas consumption for building heat, and refrigerants for air conditioning accounted for **2,183** MT CO_2e, defined as Scope 1 emissions. Electricity consumption accounted for **3,119** MT CO_2e, defined as Scope 2 emissions. This electricity was used to light and power buildings and animal exhibits, including heating for some of the large exhibit areas. The total Scope 1 and 2 emissions for 2008 was approximately **5,302** MT CO_2e. These are the emissions that the Oregon Zoo (Metro) has the most control over.

Figure 14: Oregon Zoo greenhouse gas emissions as a share of regional government operation emissions (2008)



In addition, this inventory identified approximately **12,187** MT CO_2e of other emissions from mission-critical activities that are outside of the Oregon Zoo's direct control (Scope 3). Scope 3 emissions are primarily composed of embodied emissions from the supply chain of purchased materials and services at the zoo, but also include the purchase of potable water from the Portland Water Bureau, solid waste disposal, employee commute, and business travel (see Figure 15 below). While the Oregon Zoo may not have direct control over these additional emissions sources, it can influence them by reducing purchases or consumption of waste generating materials and business related travel, and by providing additional employee commute options. By calculating these Scope 3 emissions, the Oregon Zoo is able to explore these areas for emissions reduction opportunities.

Supply chain emissions are the largest emissions source for the Oregon Zoo (roughly 11,000 MT CO_2e) and is nearly three times the next largest emissions source – building electricity use (3,119 MT CO_2e). The Oregon Zoo's supply chain emissions account for roughly

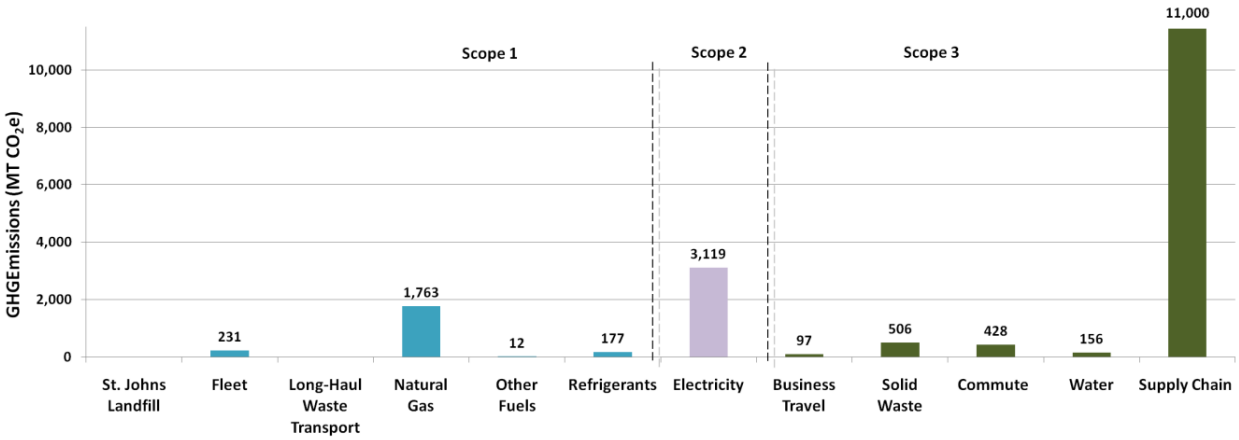
Table 7: Oregon Zoo supply chain emissions

Oregon Zoo Supply Chain Emissions by Category (CY 2008)	$MTCO_2e$
Food	8,055
Buildings (Construction and Maintenance)	1,307
Operating Supplies	692
Professional Services	537
Office Supplies	301
Other	280
Vehicles/Equipment (Buy, rent, maintain)	269
Total	**11,442**

20% of Metro's total GHG emissions from all government operations. Table 7 provides details on the Oregon Zoo's largest supply chain emissions categories. It is important to reference the scale of emissions that food purchases at the Oregon Zoo have relative to Metro's total government operations emissions. The food-related embodied emissions at the Oregon Zoo are the largest aggregated supply chain category, contributing 44% of Metro's (excluding MERC and the previously discussed "community-owned" solid waste emissions) total supply chain emissions and 14% of Metro's total emissions.

The third largest emissions source for Oregon Zoo is natural gas, which results from heating large areas, especially the visitor venue areas and the commercial kitchens.

Figure 15: Oregon Zoo greenhouse gas emissions from regional government operations (2008)



Scopes 1 and 2 yield 5,302 MT CO_2e. For sense of scale, this is equivalent to:[22]

- Annual emissions from 1,014 passenger vehicles
- Annual emissions from the energy consumed by 451 homes (US average)

Scope 3 emissions yield 12,187 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 2,330 passenger vehicles
- Annual emissions from the energy consumed by 1,037 homes (US average)

[22] Source: http://www.epa.gov/RDEE/energy-resources/calculator.html

Parks

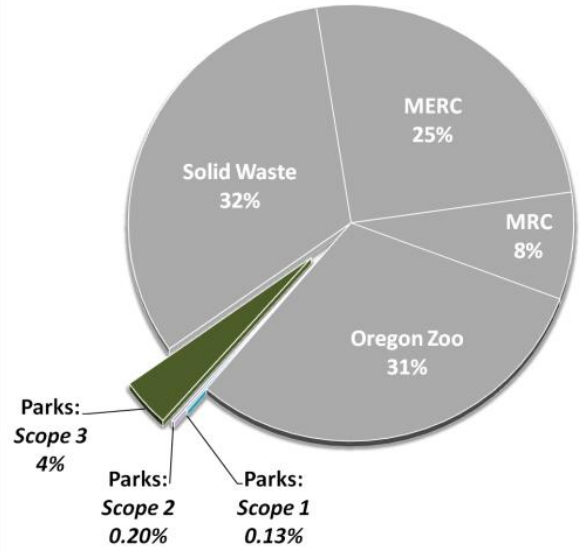
In 2008, the emissions from operating the regional parks system (referred to as Metro Parks) accounted for 2,307 metric tons of carbon equivalent (MT CO_2e) or roughly 4% of Metro's total operational emissions.

Scope 1 and 2 emissions:

- 1.7 $MTCO_2e$ per building sq ft
- 8.3 $MTCO_2e$ per employee

Metro Parks' emissions from owned vehicle fuel use (gasoline and diesel), and natural gas consumption for building heat accounted for **78** MT CO_2e, defined as Scope 1 emissions. Electricity consumption accounted for **118** MT CO_2e, defined as Scope 2 emissions. This electricity was used to light and power buildings including rental properties owned and managed by Metro. The total Scope 1 and 2 emissions for 2008 was approximately **196** MT CO_2e. These are the emissions that the Metro Parks have the most control over.

Figure 16: Metro Parks greenhouse gas emissions as a share of regional government operation emissions (2008)



In addition, this inventory identified approximately **2,111** MT CO_2e of other emissions from mission-critical activities that are outside of Metro Parks' direct control (Scope 3). Scope 3 emissions are primarily composed of embodied emissions from the supply chain of purchased materials and services at the parks, but also include the purchase of potable water from a number of water providers, solid waste disposal, employee commute, and business travel (see Figure 17 below). While Metro Parks may not have direct control over these additional emissions sources, it can influence them by reducing purchases or consumption of waste generating materials and business related travel, and by providing additional employee commute options. By calculating these Scope 3 emissions, Metro Parks is able to explore these areas for emissions reduction opportunities. It is important to note that Glendoveer Golf Course, and other smaller facilities, are not included in the scope of this analysis due to data collection limitations. In addition, a number of emission categories for Metro Parks are based on limited data (e.g. fleet fuel at Oxbow park is used as a proxy for fleet fuel use at Blue Lake).

Table 8: Parks supply chain emissions

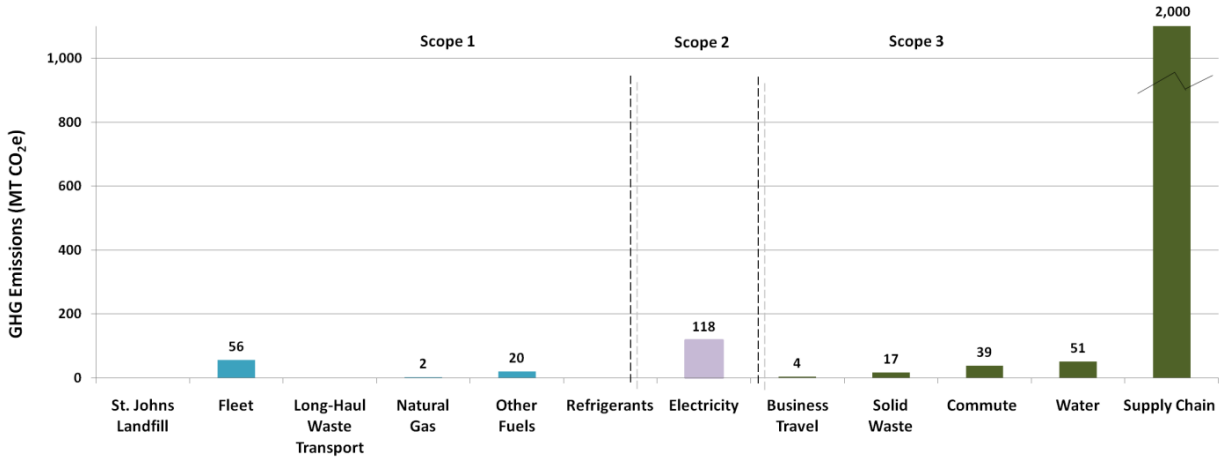
Metro Parks Supply Chain Emissions by Category (CY 2008)	$MTCO_2e$
Buildings (Construction and Maintenance)	1,400
Professional Services	275
Office Supplies	123
Vehicles/Equipment (Buy, rent, maintain)	93
Operating Supplies	74
Other	40
Food	—
Total	**2,005**

Supply chain emissions are the largest emissions source for Metro Parks (roughly 2,000 MT CO_2e) and is nearly sixteen times larger than the next largest emissions source – building electricity use (118 MT CO_2e). Metro Parks' supply chain emissions account for just under 3%

of Metro's total GHG emissions from all government operations. Table 8 provides details on Metro Parks' largest supply chain emissions categories.

The third largest emissions source for Metro Parks' is fleet fuel, which results from both the type of operations tasks associated with Parks maintenance as well as the location of the majority of Metro Parks. Most of the regional parks are located far from the urban core and require long distance vehicle trips (most regional parks are not served by public transit).

Figure 17: Metro Parks greenhouse gas emissions from regional government operations (2008)



Scopes 1 and 2 yield 196 MT CO_2e. For sense of scale, this is equivalent to:[23]

- Annual emissions from 37.5 passenger vehicles
- Annual emissions from the energy consumed by 17 homes (US average)

Scope 3 emissions yield 2,111 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 404 passenger vehicles
- Annual emissions from the energy consumed by 180 homes (US average)

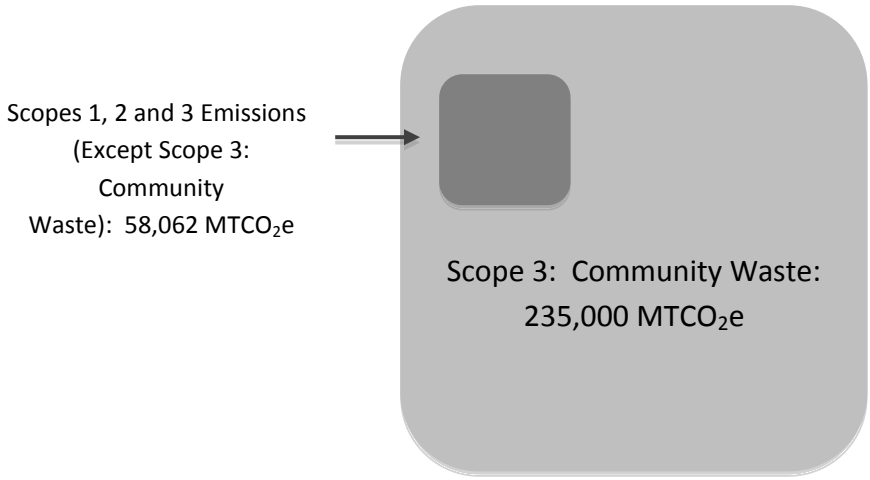
[23] Source: http://www.epa.gov/RDEE/energy-resources/calculator.html

Solid Waste

There are five separate areas of Metro's operations, or in some cases legislative responsibilities, covered in the solid waste inventory report. Those include the operation related emissions of both regional transfer stations and hazardous waste facilities; Metro Paint; St. Johns Landfill operations and methane management practices; and the direct purchase of the fuel used by the long-haul waste hauling fleet. It also includes the regional waste disposal contracts managed by Metro. Not all of the emissions from these sources fit neatly into the standard reporting protocol scopes. However, all of which fall along a spectrum of control along which Metro controls or influences an aspect of each of these emission sources. Therefore, Metro is responsible for taking ownership over a portion of the GHG emissions from each of the following sources, whether shared or fully owned.

The GHG emissions from Metro's solid waste operations include the operational activities at Metro's transfer stations (equipment, electricity use, etc.) as well as the emissions associated with final disposal of the waste, be it landfilled or incinerated. These solid waste emissions associated with final waste disposal are included in this inventory, and discussed in the Solid Waste supply chain analysis, because Metro pays for the operation of the transfer stations as well as for the disposal of the solid waste brought to those stations. With that said, these solid waste handling activities are conducted on behalf of Metro residents who generate the waste and as such the associated emissions are considered (for the purpose of this analysis) "community-owned". Figure 18 compares the scale of these "community-owned" solid waste emissions (community waste) to all other sources of emissions included in Metro's GHG inventory. The size of the two boxes is meant to visually show that emissions associated with the community waste are over 4 times that of *all* other emissions sources included in Metro's GHG inventory.

Figure 18: Comparison of "community-owned" solid waste emissions versus all other Metro emissions sources.



Like Figure 18, Figure 19 also compares the scale of various emissions sources included in Metro's GHG inventory, but in greater detail by breaking the emissions into scope categories. It compares the community waste emissions (Scope 3 – Community Waste) to the embodied emissions in Metro's purchased goods, food and services (Scope 3 – Metro Operations) to all other Metro 2008 emissions sources (Scopes 1, 2 and all other Scope 3 sources), aggregated by Scope category. As can be seen in Figure 19, the embodied emissions at 21,486 metric tons of carbon dioxide equivalent (MT CO_2e) are almost equal to all Scope 1 emissions (directly controlled emissions).

Figure 19: Metro agency-wide emissions from regional government operations (2008) by scope category including supply chain

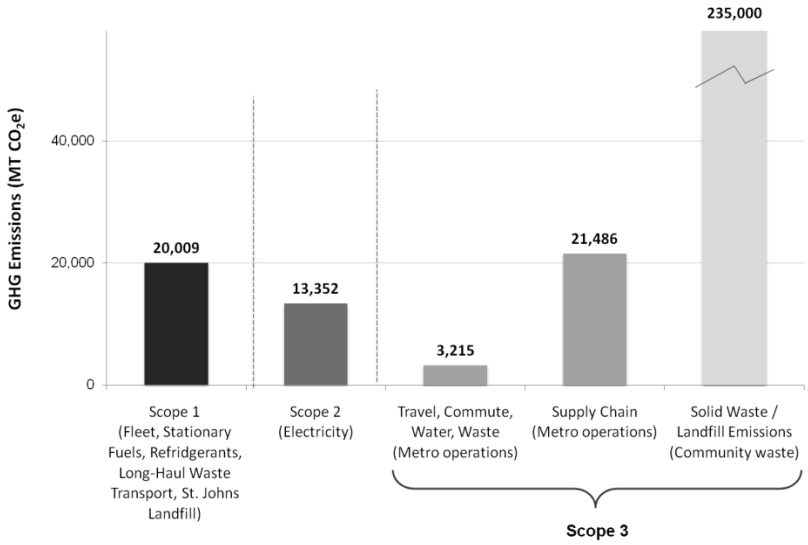
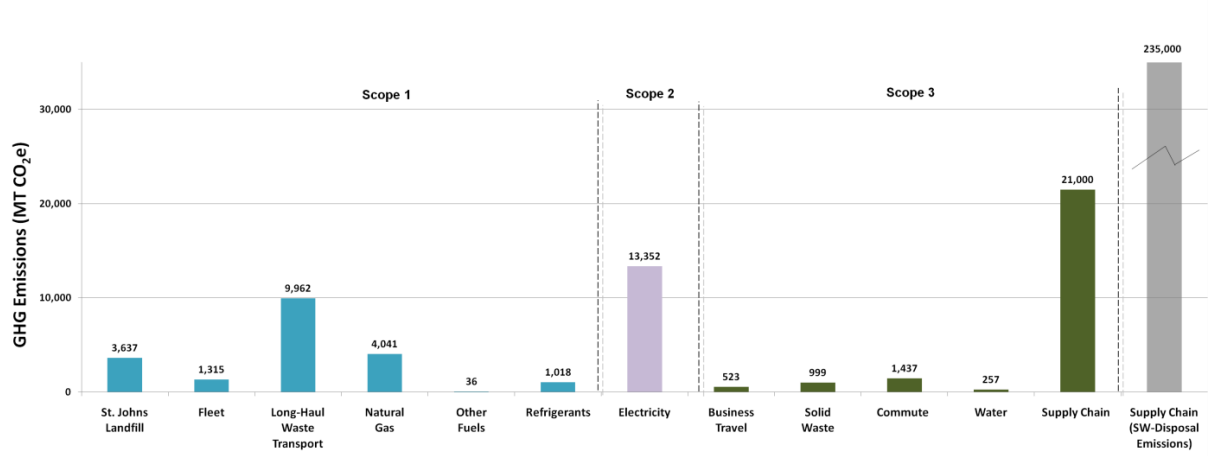


Figure 20 provides a comparison of all Metro Solid Waste Operations' emissions to the "community-owned" supply chain emissions that are held in contract by Metro.

Figure 20: Metro Solid Waste greenhouse gas emissions from regional government operations (2008) and community-owned solid waste emissions



These figures are included to provide the scale of emissions from the disposal of solid waste from Metro transfer stations, but are excluded from the general supply chain results analysis because these emissions are outside of the direct control of Metro and its vendors. Additional information on the "community-owned" solid waste GHG emissions may be found in Metro's Community GHG Inventory.[24] From this point forward these "community-owned" emissions are excluded from the general solid waste inventory results.

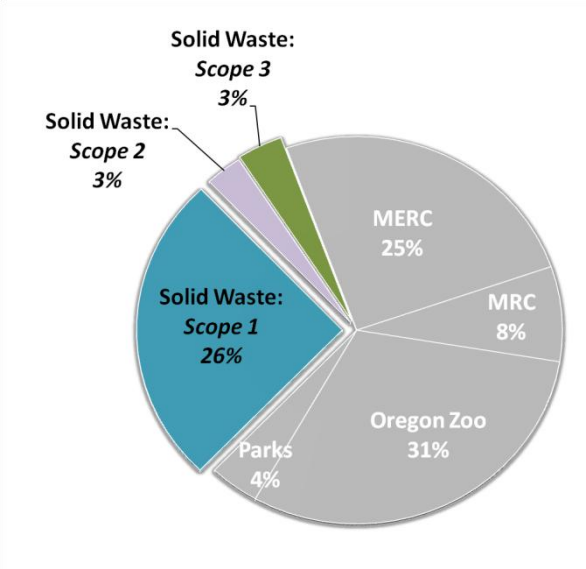
In 2008, the emissions from Metro's Solid Waste operations accounted for **18,380**metric tons of carbon equivalent (MT CO_2e) or **roughly 32% of Metro's total operational emissions**.

Scope 1 and 2 emissions:

6 MTCO_2e per building sq ft

83 MTCO_2e per employee

Figure 21: Solid waste operations greenhouse gas emissions as a share of regional government operation emissions (2008)



Metro Solid Waste emissions from owned vehicle fuel use (gasoline and diesel), the emissions from the regional long-haul fuel use (purchased directly by Metro), St. Johns Landfill emissions, natural gas consumption for building heat, and refrigerants for air conditioning accounted for **14,582** MT CO_2e, defined as Scope 1 emissions. Electricity consumption accounted for **1,703** MT CO_2e, defined as Scope 2 emissions. This electricity was used to light and power buildings owned by Metro. The total Scope 1 and 2 emissions for 2008 was approximately **16,285** MT CO_2e. These are the emissions that Metro Solid Waste operations have the most control over.

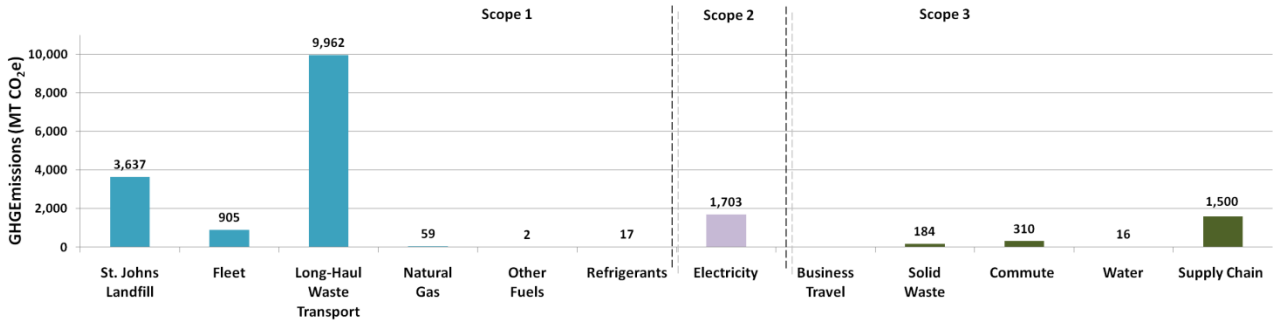
In addition, this inventory identified approximately **2,010** MT CO_2e of other emissions from mission-critical activities that are outside of Solid Waste Operation's direct control (Scope 3). Scope 3 emissions are primarily composed of embodied emissions from the supply chain of purchased materials and services at the various Solid Waste facilities, but also include the purchase of potable water from a number of water providers, solid waste disposal of waste generated by Metro employees, employee commute, and business travel (see Figure 22 below). While Metro Solid Waste Operations may not have direct control over these additional emissions sources, it can influence them by reducing purchases or consumption of waste generating materials and business related travel, and by providing additional employee commute options. By calculating these Scope 3 emissions, Metro is able to explore these areas for emissions reduction opportunities.

Long haul fleet fuel is the largest emissions source for Solid Waste Operations (9,962 MT CO_2e) and is nearly two times greater than the next largest emissions source – St. Johns

[24] Metro's Community GHG Inventory may be found online at http://www.oregonmetro.gov/index.cfm/go/by.web/id/32823.

Landfill Emissions (3,637 MT CO_2e). The long-haul waste transport emissions only capture the fuel used by Walsh Trucking for the transport of the region's solid waste to the Columbia Ridge Landfill. The emissions associated with hauling the numerous recycling and hazardous waste streams that result from operating Metro Central and South are accounted for in the supply chain emissions source. This distinction is the result of organizing GHG emissions into direct and indirect emission categories; Metro directly purchases the fuel used by Walsh Trucking and is therefore directly responsible for reporting the emissions that result from burning this fuel; Metro contracts out all aspects of the recycling and hazardous waste hauling services and is therefore only indirectly responsible for these emissions.

Figure 22: Metro solid waste greenhouse gas emissions from regional government operations (2008)



Scopes 1 and 2 yield 16,285 MT CO_2e. For sense of scale, this is equivalent to:[25]

- Annual emissions from 3,114 passenger vehicles
- Annual emissions from the energy consumed by 1,386 homes (US average)

Scope 3 emissions yield 2,010 MT CO_2e. For sense of scale, this is equivalent to:

- Annual emissions from 384 passenger vehicles
- Annual emissions from the energy consumed by 171 homes (US average)

The St. Johns landfill emissions (2008) *only* represent landfill gas (LFG) emissions, not operational emissions from the St. Johns landfill. (For more information see the St. Johns Landfill Methods section.) The emissions reported for St. Johns Landfill (3,637 MT CO2e) are exclusively attributable to landfill gas (LFG) flow.[26] **Only 49% of the landfill gas managed on-site is reported as Scope 1 and considered anthropogenic.** The other 51% is considered biogenic CO_2 and comes from two landfill sources. The first is generated by converting methane to CO_2 by combusting the landfill gas and the second is "pass-through" CO_2. "Pass-through" CO_2 is the portion of the landfill gas that is directly emitted from the landfill as CO_2. St. Johns landfill gas is approximately 30% CO_2 and 50%

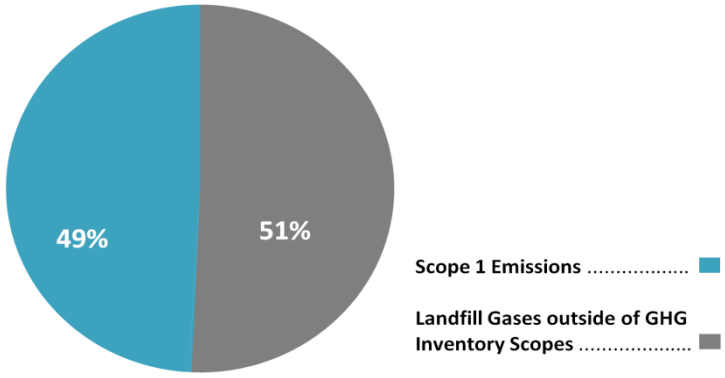
[25] Source: http://www.epa.gov/RDEE/energy-resources/calculator.html

[26] The CO_2 emission factor in table G-2 of the LGO was used to determine the amount of biogenic CO_2e emitted from onsite consumption of landfill gas. Equation 9.1 of the Local Government Operations Protocol (LGO) was used to determine the amount of CO_2 equivalence emitted from the landfill. Available at: http://www.theclimateregistry.org/resources/protocols/local-government-operations-protocol/

methane (CH_4). It is important to note that 75% of landfill gas collected in 2008 from St. Johns was sent off site to Ash Grove Cement and therefore not included in emissions calculations for St. Johns.

Figure 23 demonstrates the relative scale of these anthropogenic Scope 1 emissions compared to the biogenic emissions, which are excluded from the LGO Protocol reporting requirements. The LGO states that these "pass through" CO_2 emissions, along with other biogenic CO_2 emissions from combustion, should not be reported.[27] While Metro would not be required to report these biogenic emissions from on-site methane management as part of a voluntary reporting program, they are presented here to more accurately demonstrate the climate impacts of operating a landfill and of materials management in general.

Figure 23: Comparison of St Johns Landfill Scope 1 emissions to all St. Johns landfill gas processed on-site (2008)



If Metro did not manage the direct release of landfill gasses from St. Johns Landfill, either through flaring or through the contract with Ash Grove Cement, the total Scope 1 emissions for the St. Johns Landfill would increase significantly. Using 2008 emissions values it is possible to calculate two alternative Scope 1 emissions scenarios without these management practices (for demonstration purposes only). First, if no landfill gas had been sent to Ash Grove Cement in 2008 but was processed on-site using the flare, the St. Johns Landfill emissions would have totaled 19,315 MT CO_2e; this would have almost equaled Metro's largest emissions source for 2008 (Supply Chain: 21,000 MT CO_2e). Similarly, if none of the LFG had been sent to Ash Grove Cement or flared on-site the emissions would have increased to 76,823 MTCO_2e; this would have more than doubled the agency-wide 2008 emissions total.

It is important to recognize that while methane management practices are critical to mitigating the large climate impact of landfills, the current accounting protocols do not capture the entirety of these impacts. This accounting methodology continues to underestimate the beneficial impact that materials consumption and waste reduction programs can have in addressing climate change.

[27] Box 8.1 of the LGO

The third largest emissions source for the Solid Waste functional area is from building electricity (approximately 15% of the total Solid Waste emissions). Supply chain emissions are the fourth largest emissions source for Solid Waste functional area (roughly 1,500 MT CO_2e) – this is the only functional area within Metro where operational supply chain emissions are not the largest emissions source; Table 9 provides details on Metro Solid Waste Operation's largest supply chain emissions categories.

Table 9: Solid waste supply chain emissions

Solid Waste Supply Chain Emissions by Category (CY 2008)	$MTCO_2e$
Operating Supplies	590
Professional Services	346
Vehicles/Equipment (Buy, rent, maintain)	337
Buildings (Construction and Maintenance)	247
Office Supplies	53
Other	12
Food	-
Total	**1,585**

Embodied Emissions in Purchased Goods and Services

The following section provides an analysis of the embodied emission in the purchased goods and services for all Metro functional areas and two additional summaries for both Metro and MERC facilities.

The Economic Input Output Life –Cycle Assessment (EIO-LCA) analysis estimates the upstream GHG emissions generated by raw material extraction, production and transportation of goods and services, and associated waste disposal, up to the point of retail. The responsibility for embodied emissions in purchases is not equal to the responsibility for emissions produced directly by Metro operations and owned equipment (such as the combustion of fossil fuels). The embodied emissions are clearly shared, as the responsibility for the activities is in the hands of both vendors (who control the production processes directly) and Metro (who purchases and relies on these goods and services).

Agency Wide Embodied Emissions in Purchased Goods and Services

Figure 24 presents the total embodied emissions from seven aggregated purchasing categories for all Metro functional areas. The first six categories listed below are large discrete categories (food, buildings construction, professional services, office supplies, vehicles / equipment and operating supplies) of individual expense accounts grouped by like items, while the last is a catchall category for items that do not fit into any of the first six categories.

Food: Includes food purchased for resale as well as animal feed (Oregon Zoo).

Buildings Construction: Includes the labor and materials in building construction, renovation and maintenance services.

Professional Services: Includes various professional services such as accounting, advertising, legal, management consulting, employment, educational, architecture and engineering, real estate, insurance, etc.

Office Supplies: Includes paper and printing, all other supplies commonly found in office settings as well as information technology hardware, software and services.

Vehicles / Equipment: This category includes the purchase, rental and maintenance of vehicles and equipment.

Operating Supplies: This category includes general operating supplies as well as postage and delivery.

Other Goods and Services: Includes "all other" goods and services that were not included in the first six categories and were not large enough to be grouped into a separate category. This category includes widely disparate economic sectors that include: art, exhibits, permitting services, meetings, animal care, parking operations, grants, staff development and education as well as other things.

Figure 24: Metro agency wide supply chain emissions (21,000 MT CO_2e), by purchasing category (2008)

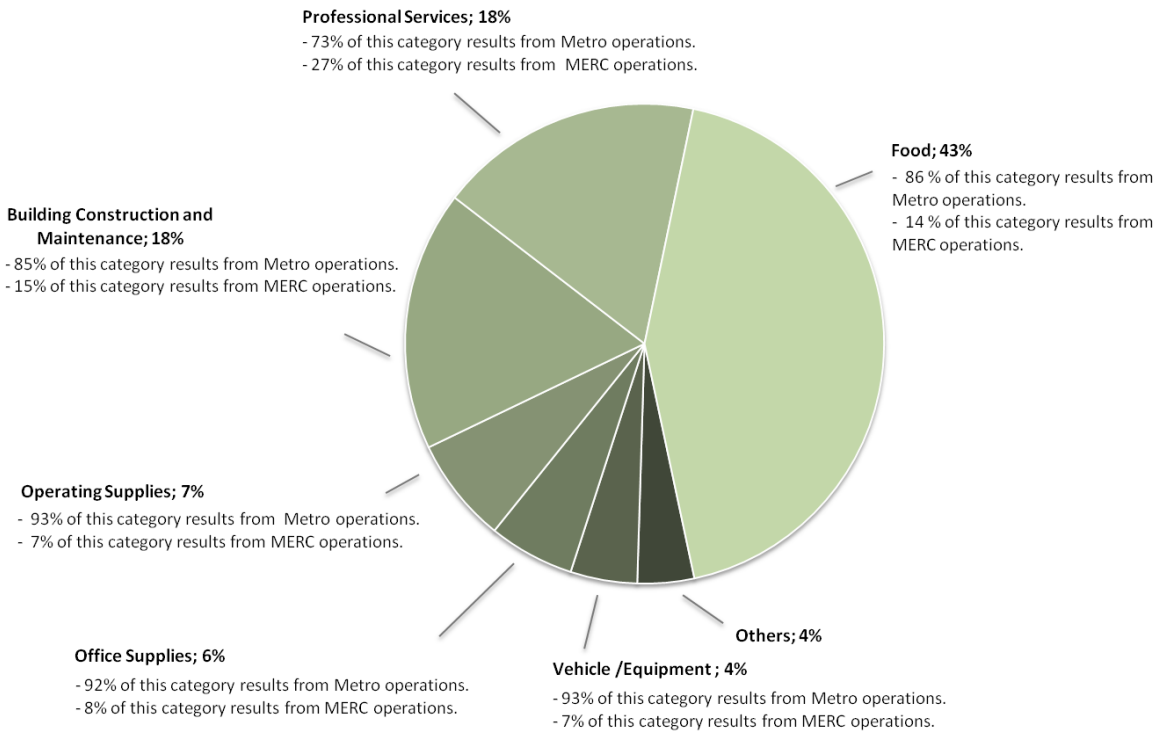


Figure 25 presents the results of the supply chain analysis in greater detail. The table shows CY2008 expenditures and emissions by Metro department and purchasing category.

Figure 25: Embodied emissions in purchased goods and services, comparison of MERC and Metro facilities (CY 2008)

Functional Area	Calendar Year 2008 Expenses (included in analysis)*	Food	Buildings (Construct and Maintain)	Professional Services	Operating Supplies	Office Supplies	Vehicles / Equipment (Buy, Rent, Maintain)	Others	Total Emissions
	Dollars ($)	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e
MERC	15,864,482	1,270	571	1,024	107	96	68	216	**3,351**
Metro	34,268,487	8,055	3,201	2,806	1,421	1,148	899	606	**18,135**
Total	**50,132,969**	**9,325**	**3,772**	**3,830**	**1,528**	**1,243**	**967**	**821**	**21,486**
Percent		**43%**	**18%**	**18%**	**7%**	**6%**	**4%**	**4%**	**100%**

Metro: Embodied Emissions in Purchased Goods and Services

The following is an analysis of all Metro functional areas (MRC, Oregon Zoo, Parks and Solid Waste); MERC data is analyzed separately in the following section. Due to the organizational separation of Metro and MERC accounting offices, expenditure data for calendar year 2008 was collected separately. Given the size and complexity of these data sets the supply chain analysis was conducted separately for Metro and MERC facilities. However, the same emission categories and factors were used for both data sets.

Figure 26 shows that food-related embodied emissions are the largest aggregated category, contributing 44% of Metro's embodied emissions (excluding the previously mentioned "community-owned" solid waste emissions). All of this category is attributed to the Zoo and is the result of the large quantities of food purchased to feed its many visitors.

This category is 100% attributable to the Zoo and includes food purchased for resale as well as animal feed.[28]

It's important to note that the production of food items is relatively carbon intensive (compared to other categories) due to the energy intensive nature of agriculture and specifically the production of fertilizers. Ninety percent of the food related emissions come from food purchased for retail at the Zoo and operations contracts for food services while the majority of the remaining ten percent is the result of animal food production.

The next largest category is buildings construction (and maintenance) at 18% of total supply chain emissions, which is typical for organizations with large building portfolios, such as higher education institutions or municipal governments.

The next largest category is professional services at 16%, which is not surprising considering that Metro spent over $12 million on a variety of professional services including: engineering, legal, real estate agents, environmental consultants, etc.

The rest of the purchasing categories each contribute less than 10% of Metro's total supply chain emissions and include: operating supplies (8%), office supplies (6%), vehicles and equipment (5%) and finally the other goods and services category (3%).

[28] Meeting expenses for MRC are grouped in the Other Goods and Services category. These expenses likely include food, but the data did not provide clear differentiation between food and other meeting related expenses.

Figure 26: Metro functional groups supply chain emissions (18,000 MT CO_2e), by purchasing category (CY 2008)[29]

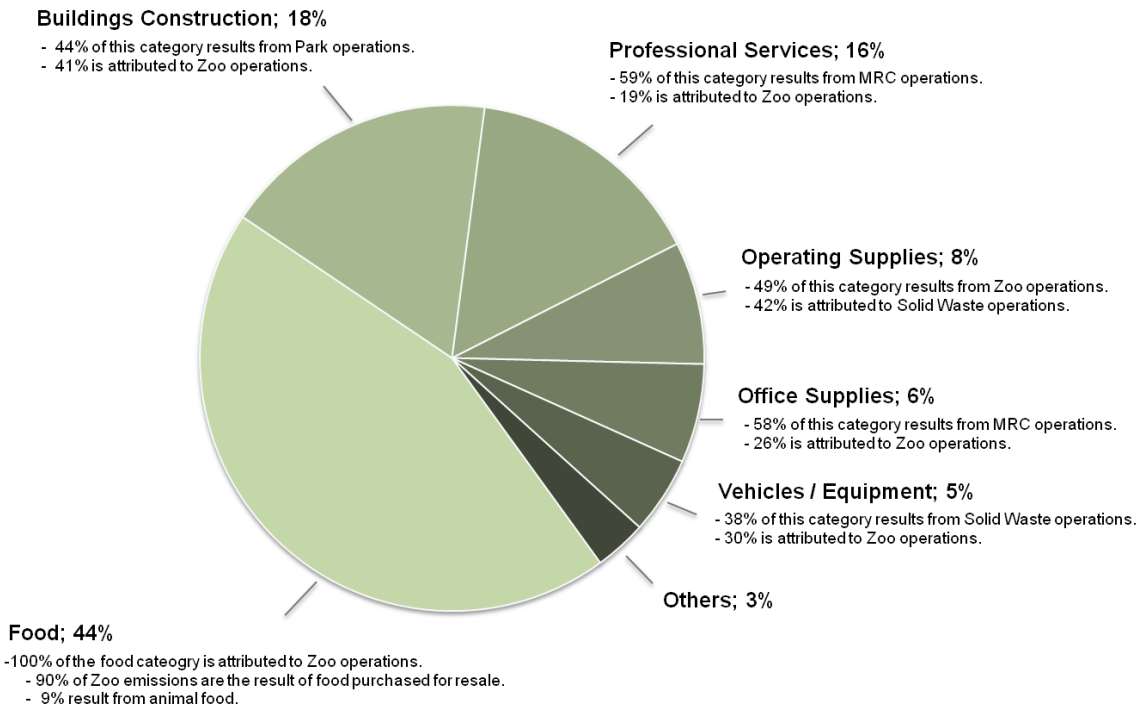


Figure 27 presents the results of the supply chain analysis in greater detail. The table shows CY2008 expenditures and emissions by Metro functional area and purchasing category.

Figure 27: Embodied emissions in purchased goods and services, by functional area and purchasing category (CY 2008)

Functional Area	Calendar Year 2008 Expenses (included in analysis)*	Food	Buildings (Construct and Maintain)	Professional Services	Operating Supplies	Office Supplies	Vehicles / Equipment (Buy, Rent, Maintain)	Others	Total Emissions
	Dollars ($)	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e
MRC	11,589,695	0	247	1,648	65	670	201	273	**3,103**
Zoo	12,923,895	8,055	1,307	537	692	301	269	280	**11,442**
Parks	5,355,303	0	1,400	275	74	123	93	40	**2,005**
Solid Waste	4,399,595	0	247	346	590	53	337	12	**1,585**
Totals	**34,268,487**	**8,055**	**3,201**	**2,806**	**1,421**	**1,147**	**899**	**605**	**18,134**
Percent		**44%**	**18%**	**15%**	**8%**	**6%**	**5%**	**3%**	**100%**

[29] Figure 26 does not included solid waste contracts for waste disposal at Arlington Landfill or the operation of the transfer stations. See figures 19 and 20 in the solid waste functional area section for a presentation of the emissions associated with these contracts.

MERC: Embodied Emissions in Purchased Goods and Services

Figure 28 provides similar results for the MERC supply chain analysis results food-related embodied emissions are the largest aggregated category, contributing 38% of MERC's embodied emissions. All of emissions this category is the result of the large quantities of food purchased through Aramark to feed the many visitors at MERC facilities.

The next largest category is professional services at 31%, and is the result of over $4.8 million spent on a variety of professional services including: marketing, advertising, management consulting, engineering, etc.

The next largest category is buildings construction (and maintenance) at 17% of total supply chain emissions, which is typical for organizations with large building portfolios, such as higher education institutions or municipal governments. A large portion of this category went to maintaining and repairing stage facilities and equipment.

The rest of the purchasing categories each contribute less than 10% of MERC's total supply chain emissions and include: the other goods and services category (6%), operating supplies (3%), office supplies (3%), and finally vehicles and equipment (2%). It is not surprising the smallest supply chain emissions category is associated with maintaining MERC's fleet given the small number of vehicles at each of the facilities.

Figure 28: MERC functional groups supply chain emissions (3,000 MT CO_2e), by purchasing category (CY 2008)

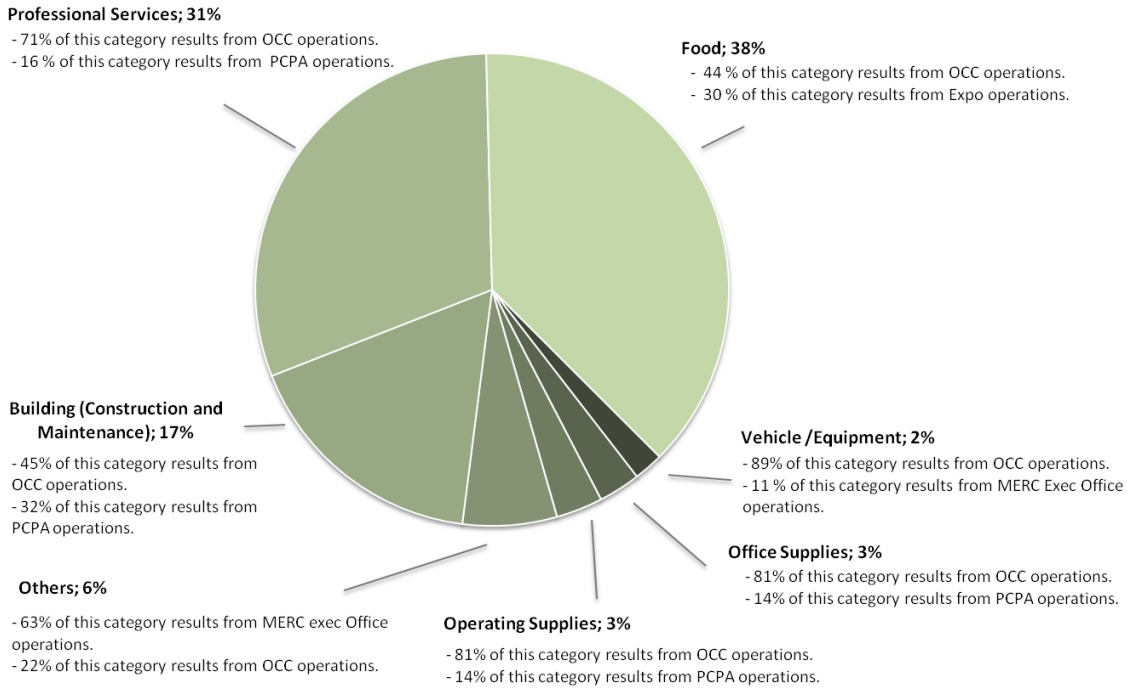


Figure 29 presents the results of the supply chain analysis in greater detail. The table shows CY2008 expenditures and emissions by MERC facility and purchasing category.

Figure 29: Embodied emissions in purchased goods and services, by institution and purchasing category.

Functional Area	Calendar Year 2008 Expenses (included in analysis)*	Food	Buildings (Construct and Maintain)	Professional Services	Operating Supplies	Office Supplies	Vehicles / Equipment (Buy, Rent, Maintain)	Others	Total Emissions
	dollars ($)	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e
EXPO	2,913,848	376	125	99	3	3	0	10	**615**
OCC	8,330,094	555	260	731	87	19	61	47	**1,759**
PCPA	3,521,752	335	180	165	15	23	1	24	**744**
MERC Executive Office	1,098,788	3	6	29	2	51	6	135	**232**
Totals	**15,864,482**	**1,270**	**571**	**1,024**	**107**	**96**	**68**	**216**	**3,351**
Percent		**38%**	**17%**	**31%**	**3%**	**3%**	**2%**	**6%**	**100%**

COST OF CARBON

Assembling a GHG inventory is an opportunity to analyze a particular kind of financial risk, i.e., the implications of a "cost of carbon" – a direct or indirect cost associated with GHG emissions, as a result of policy. Many analyses of proposed legislation have indicated a likely range of this cost, and we can see examples in countries that have already capped CO_2 emissions.

Recent EPA analysis of proposed climate policy suggests that, within a few years of implementing a cap-and-trade system, the cost of carbon could be around $15 per MT CO_2e.[30] One proposed "reserve price" (or price floor) is $10, while short-term "escape hatch" prices (or price ceilings) have been around $30. This range provides a sense of Metro's total direct and indirect financial exposure related to a cost of carbon.

This total financial risk is unlikely to be borne entirely by Metro. Indeed, just as various parts of the emissions sources identified in this inventory are shared with others – from employees who commute to vendors that supply the organization with goods and services – the cost-of-carbon risk will likely be shared. This rough calculation is an approximation of the financial risk that could emerge under likely climate policy scenarios.

Regardless of the carbon market policy scenarios that will likely play out over the coming years, it makes sense for Metro to reduce its vulnerability for future costs by reducing emissions from operations sooner rather than later.

[30] EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress (presentation given on 6/23/09) http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf

SUSTAINABILITY EFFORTS AND CLIMATE ACTION AT METRO

Sustainability Plan

This inventory has provided a clear understanding of greenhouse gas emission sources from Metro's operations and informed creation of the Metro Sustainability Plan. Three guiding principles frame Metro's work in the area of reduction greenhouse gas emissions from operations: to reduce energy demand, address emissions from all three scopes, and use most current climate science to guide actions.

Guiding Principles for Greenhouse Gas Emission Reduction at Metro

- **Reduce Energy Demand First**. Metro should work to increase energy efficiency of its facilities to the fullest extent feasible as a top priority for reducing GHG emissions. Purchase and/or on-site generation of renewable energy should be a second priority. Procurement of carbon offsets should not be considered until these avenues have been fully pursued, and then only if the offsets meet certain criteria.
- **Address Emissions from all Three Scopes.** Metro should be comprehensive and address all of Metro's greenhouse gas emission sources: energy, transport, and materials. In other words, address all Scope I, II and III emissions.
- **Use Most Current Climate Science to Guide Actions.** The findings from the IPCC (Intergovernmental Panel on Climate Change) outline what is needed in terms of the scale of emission reductions needed to avoid catastrophic climate change (change beyond the point that we can't adapt).

With these principles in mind, a planning team representing all of Metro's different operation types convened to select strategies and actions aimed at reducing GHG emissions from Metro's operations over time and work toward the goal of an 80 percent reduction in GHG emissions below 2008 levels (as defined by this inventory report) by 2050. Due to the unique services that Metro provides and the facility types in Metro's portfolio, this is a significant challenge. Despite these challenges, there are great opportunities for increasing efficiency and use of resources, reduction in operational costs over time, and providing for multiple benefits to the Metro region's community through green jobs and local product sourcing of low-climate-impact materials and services called for in the Sustainability Plan.

Next Steps

With the adoption of Metro's Sustainability Plan, an implementation process will begin, including creation of an ongoing tracking system for the roughly 50 unique data sets required to track GHG emissions from Metro operations. Metro anticipates that this inventory will be updated on a regular basis, but no more than every three years due to the resource and time-intensive nature of the analysis.

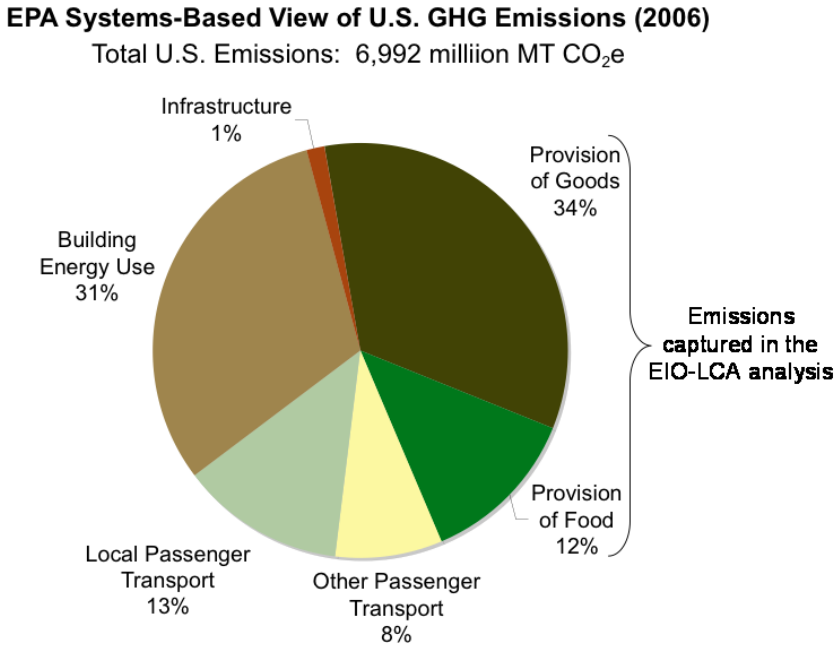
APPENDIX A: EIO-LCA ANALYSIS: MOTIVATION AND METHODS

Context and motivation

The emissions generated by the manufacture and distribution of goods, food and services are a large share of total emissions for the U.S. economy and for other economies, and the summary results above reflect this fact. This result will surprise some readers because common practice for GHG inventories has typically excluded these difficult-to-quantify emissions sources that lie beyond the day-to-day operations and direct control of entities that purchase these goods, food and services.

A recent EPA analysis provides the motivation for including the supply chain in GHG inventories. The accompanying graph (Figure 30) provides the core insight: the production of good and food together make up nearly half of all US GHG emissions.

Figure 30: Overview of U.S. GHG emissions in 2006[31]



This insight, however, poses a challenge. How does a purchaser – whether an individual, business, government agency or higher education institution – address this complex portion of the carbon footprint? Indeed, the analysis herein provides little guidance for action because of the complexity of this segment of Metro's carbon footprint.

[31] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (2008 draft). Opportunities to reduce greenhouse gas emissions through materials and land management practices, unpublished analysis.

The scale of these emissions requires that a thorough GHG inventory and climate action plan include supply chain specific mitigation strategies, despite the limited precision in current quantification models. Given that governments are part of the economy-wide systems that emit greenhouse gases, it is imperative that public agencies begin to assign a sense of scale to these emissions.

Description of Method

The analysis method used for this analysis follows the EIO-LCA method described in UC Berkeley's *Climate Action Partnership Feasibility Study 2006-2007 Final Report*, but refines UC Berkley's method by correcting for inflation.

The approach used for this estimate is Carnegie Mellon University – Green Design Institute's *Economic Input-Output Life Cycle Assessment* (EIO-LCA), U.S. 2002 Industry Benchmark model. Researchers at the Green Design Institute have developed this free online tool (available online at www.eiolca.net) to estimate life-cycle greenhouse gas emissions of economic activity in each of 428 sectors of the U.S. economy.

The model is valuable for simple, cost-effective emissions *estimates*. The strength of the model is its ability to provide comprehensive estimates by using aggregate values for all goods and services in the 428 sectors. Its weakness is that it cannot provide a detailed estimate for specific processes. In order to accurately estimate embodied emissions for a specific purchase, that product's specific supply chain must be assessed. This alternative is typically extremely time-consuming and often relies on data from many private sources.

The model has several significant sources of uncertainty. The first is that it is based on United States industry averages. These averages do not include the influence of major U.S. trading partners such as China on emissions factors, nor does the model have the ability to account for specific sourcing practices such as a higher than average percentage of post-consumer recycled content in paper products. Second, the model relies on a relatively old data set from 2002, which will not capture recent efficiency improvements or best practices that result in lower emissions for specific industrial sectors. This data set also requires adjustments to be made to account for inflation (see below). Finally, organizational accounting codes don't always directly map to the economic sectors included in the model.

In broad terms, the EIO-LCA method consists of utilizing the following equation to estimate total CO_2e emissions for various areas of expenditure:

$$\frac{\quad}{\quad}$$

In other words, the estimate stems from multiplying the carbon intensity of a given economic sector per dollar of output (the first term in the equation) by the quantity of purchases (the second term in

the equation). This product is summed across purchasing categories, which differ in both carbon intensity and total dollars spent.

It is noted that the EIO-LCA model asks for the production cost of each item, but the retail price (price paid for any given item) is what is readily available and was used in the 2008 Inventory. It is also noted that this calculator is last updated in 2002 and means that some simple refinements need to be made in the method. The initial calculations suffer from the distortions of price level, as described above. While this is rarely a problem over a short period (a year or two), the decade between the EIO-LCA database's creation and this inventory's calculations created an issue. We therefore attempt to correct for this change in price level.

Price-level refinements to EIO-LCA model

The initial calculations suffered from the distortions of price level, as described above. While this is rarely a problem over a short period (a year or two), the decade between the EIO-LCA database's creation and this inventory's calculations created an issue. We therefore attempted to correct for this change in price level.

Specifically, two corrections were made. First, for the large bulk of purchases (excluding those related to construction), we adjusted the calculations by the Consumer Price Index[32], the standard and official measure of retail inflation for the US economy. Second, we adjusted all construction expenditures (one of the largest areas of procurement) by a construction price index (Turner Building Cost Index[33]) that, while not official government data, is well known and has decades of history.

The results of these corrections made a significant difference, lowering the general (non-construction) procurement footprint estimate by more than 10% and lowering the construction-related procurement footprint by ~30%. Because of the central role of prices for purchased goods in using the EIO-LCA methodology, these corrections are likely to bring the overall estimate much closer to the truth.

[32] More information on the Consumer Price Index may be found on the Bureau of Labor Statistics website, available at: http://www.bls.gov/CPI/.

[33] More information on the Turner Building Cost Index may be found on the Turner Building Cost Index website, available at: http://www.turnerconstruction.com/corporate/content.asp?d=20.