City Of Arcata

2010 Government Operations

Greenhouse Gas Emissions Inventory

Narrative Report

Supported by Pacific Gas and Electric Company
In Collaboration with Redwood Coast Energy Authority and
ICLEI-Local Governments for Sustainability USA

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Pacific Gas and Electric Company provides comprehensive climate planning assistance to local governments, from providing energy usage data and assistance with greenhouse gas inventories, to training and guidance on climate action plans.

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The Purpose of Conducting an Inventory

Each day, local governments operate buildings, vehicle fleets, street lights, traffic signals, water systems, and wastewater plants; local government employees consume resources commuting to work and generate solid waste which is sent for disposal. All of these activities directly or indirectly cause the release of carbon dioxide and other greenhouse gases (GHG) into the atmosphere. This report presents the findings and methodology of a local government operations (LGO) greenhouse gas emissions inventory for Arcata. The inventory measures the greenhouse gas emissions resulting specifically from Arcata's government operations, arranged by sector to facilitate detailed analysis of emissions sources. The inventory addresses where and what quantity of emissions are generated through various local government activities. Through analysis of a local government's emissions profile, the City of Arcata can tailor strategies to achieve the most effective greenhouse gas emission reductions.

Strategies by which local governments can significantly reduce emissions from their operations include increasing energy efficiency in facilities and vehicle fleets, utilizing renewable energy sources, reducing waste, and supporting alternative modes of transportation for employees. The benefits of these actions include lower energy bills, improved air quality, and more efficient government operations, in addition to the mitigation of local and global climate change impacts. By striving to save taxpayer money through efficient government operations, Arcata is working to improve government services in a smart and targeted way that will benefit all of the City's residents.

Arcata recognizes that climate change resulting from the GHG emissions of human activities is a reality. Global average surface temperatures are rising due to intensification of activities that release carbon dioxide and other GHGs into the atmosphere. Potential impacts of climate change include rising sea levels, more severe and frequent storms, increased flooding, greater rates of coastal erosion, loss of critical habitat and ecosystems, more severe heat waves, increased precipitation, extended drought conditions, larger wildfires, shortages in water supply, formation of ground level ozone, and heightened exposure to vector born diseases.

By conducting this inventory, Arcata is acting now to limit future impacts that threaten the lives and property of Arcata's residents and businesses, make government operations more efficient, and improve the level of service it offers to the residents of Arcata.

Inventory Results

The following figures summarize the results of the LGO greenhouse gas emissions inventory for Arcata, by sector and source.

Figure 1: 2010 Government Operations CO_2e Emissions by Sector

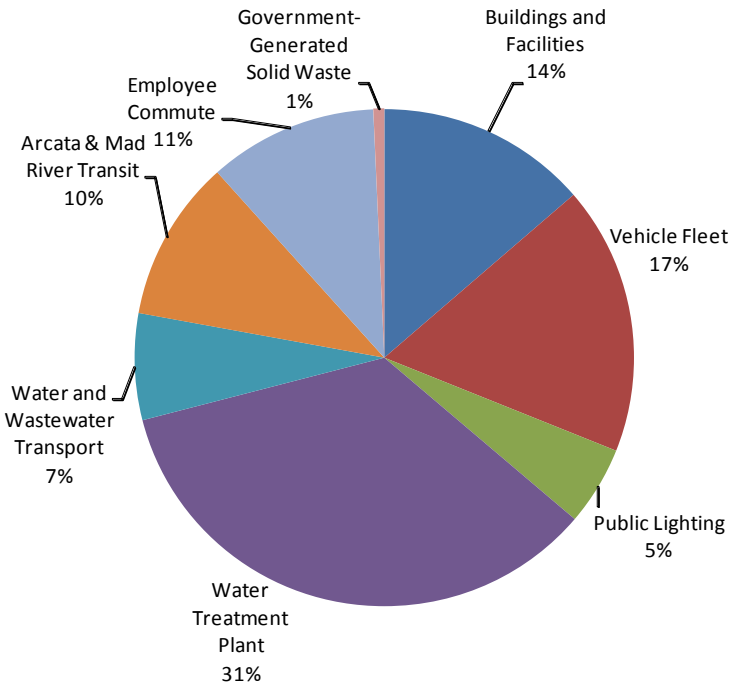


Figure 2: 2010 Government Operations CO_2e Emissions by Source

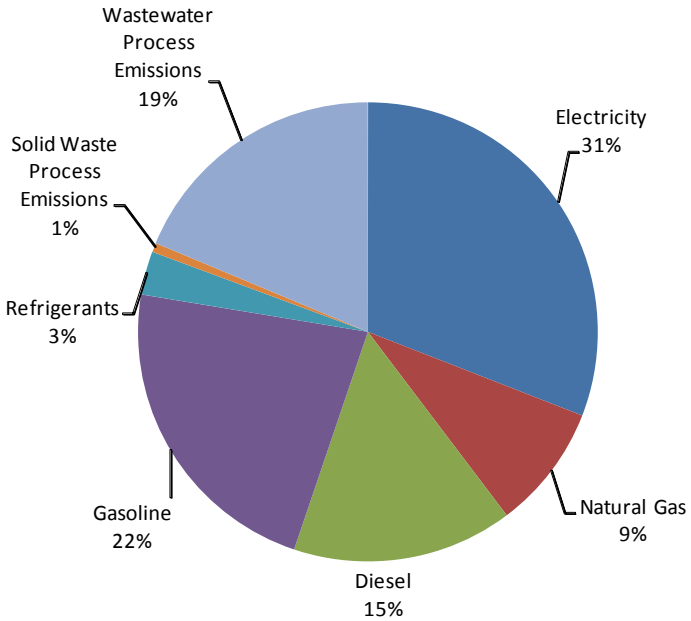


Table 1: LGO Protocol Report - Overall Emissions by Scope

Total Emissions (Metric Tons)							
	CO_2e	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
Scope 1	1,406.314	868.219	2.392	1.333	0.058		
Scope 2	757.794	752.771	0.040	0.013			
Scope 3	286.046	267.026	0.770	0.009			
Information Items	209.790	209.790	0.000	0.000			

For more detail on the concepts of scopes, sources, and sectors, and to review more granular data produced through the inventory study, please refer to the full report on the following pages.

Regional and Local Context

Climate Change Mitigation Activities in California

Since 2005, the State of California has responded to growing concerns over the effects of climate change by adopting a comprehensive approach to addressing emissions in the public and private sectors. This approach was officially initiated with the passage of the Global Warming Solutions Act of 2006 (AB 32), which requires the state to reduce its greenhouse gas emissions to 1990 levels by 2020. The AB 32 Scoping Plan was developed to identify strategies for meeting the AB 32 goal, and was adopted by ARB in December 2008. Among many other strategies, it encourages local governments to reduce emissions in their jurisdictions by 15 percent below current levels by 2020. In addition, it identifies the following strategies that will impact local governance:

- Develop a California cap-and-trade program
- Expand energy efficiency programs
- Establish and seek to achieve reduction targets for transportation-related GHG emissions
- Expand the use of green building practices
- Increase waste diversion, composting, and commercial recycling toward zero-waste
- Continue water efficiency programs and use cleaner energy sources to move and treat water
- Reduce methane emissions at landfills
- Preserve forests that sequester carbon dioxide

Other measures taken by the state include mandating stronger vehicle emissions standards (AB 1493, 2002), establishing a low-carbon fuel standard (EO # S-01-07, 2007), mandating a climate adaptation plan for the state (S-EO # 13-08, 2008), establishing a Green Collar Job Council, and establishing a renewable energy portfolio standard for power generation or purchase in the state. The state also has made a number of legislative and regulatory changes that have significant implications for local governments:

- SB 97 (2007) required the Office of Planning and Research to create greenhouse gas planning guidelines for the California Environmental Quality Act (CEQA). In addition, ARB is tasked with creating energy-use and transportation thresholds in CEQA reviews, which may require local governments to account for greenhouse gas emissions when reviewing project applications.
- AB 811 (2007) authorizes all local governments in California to establish special districts that can be used to finance solar or other renewable energy improvements to homes and businesses in their jurisdiction.
- SB 375 (2008) revises the process of regional transportation planning by metropolitan planning organizations (MPOs), which are governed by elected officials from local jurisdictions. The statute calls on ARB to establish regional transportation-related greenhouse gas targets and requires the large MPOs to develop regional "Sustainable Communities Strategies" of land use, housing and transportation policies that will move the region towards its GHG target. The statute stipulates that transportation investments must be consistent with the Sustainable Communities Strategy and provides CEQA streamlining for local development projects that are consistent with the Strategy.

Pacific Gas and Electric Company Supported Inventory Project

With the administrative support of Pacific Gas and Electric Company (PG&E) and funding from California utility customers under the auspices of the California Public Utilities Commission, ICLEI - Local Governments for Sustainability ("ICLEI") was contracted to work with Redwood Coast Energy Authority (RCEA) to assist in the quantification of GHG emissions in Arcata. ICLEI is a nonprofit association of local governments that provides information, delivers training resources, organizes conferences, facilitates networking and city-to-city exchanges, carries out research and pilot projects, and offers technical services and consultancy related to climate planning. Throughout 2011, ICLEI provided training and technical assistance to participating regional organizations, interns, and local government staff and facilitated the completion of this report.

Climate Change Mitigation Activities in Arcata

Arcata has taken significant steps towards inventorying both municipal and community-wide emissions. Two other GHG emissions inventories have been conducted in the years 2000 and 2006 along with this report. In addition, the City's Energy Program has been active in energy- and climate change-related activities since 2000. One of the main tasks of the Energy Program is to assist with the implementation of the Community Greenhouse Gas Reduction Plan. The Energy Program promotes energy efficiency and conservation, renewable energy, water-use efficiency, and sustainability. The Energy Program also serves as an informational resource for residents and business owners interested in seeking ways to include energy efficient practices in their daily lives.[1] Refer to Appendix A for a more detailed description of Arcata's actions and activities associated with their Energy Plan and GHG Reduction Plan.

[1] Review of Arcata's activities was taken from the city website http://www.cityofarcata.org/departments/environmental-services


Arcata Community Center
http://crowclay.com/Crow-Clay-&-Associates-Projects-Community-Centers-Arcata.html

Introduction

General Methodology

Local Government Operations Protocol

A national standard called the Local Government Operations Protocol (LGO Protocol) has been developed and adopted by the California Air Resources Board (ARB) in conjunction with ICLEI, the California Climate Action Registry, and The Climate Registry. This standard provides accounting principles, boundaries, quantification methods, and procedures for reporting greenhouse gas emissions from local government operations. The LGO Protocol forms the basis of ICLEI's Clean Air & Climate Protection Software (CACP 2009), which allows local governments to compile data and perform the emissions calculations using standardized methods.

Greenhouse Gases and Carbon Dioxide Equivalent

In accordance with LGO Protocol recommendations, CACP 2009 calculates and reports all six internationally recognized greenhouse gases (GHG) regulated under the Kyoto Protocol (Carbon Dioxide, Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons, and Sulfur Hexafluoride). Emissions summaries found throughout this report also use CACP 2009's ability to combine emissions from the various greenhouse gases into carbon dioxide equivalent, CO_2e. Since equal quantities of each greenhouse gas have more or less influence on the greenhouse effect, converting all emissions to a standard metric, CO_2e, allows apples-to-apples comparisons amongst quantities of all six emissions types. Greenhouse gas emissions are reported in this inventory as metric tons of CO_2e ($MTCO_2e$).

Table 2 exhibits the greenhouse gases and their global warming potential (GWP), a measure of the amount of warming a greenhouse gas may cause compared to the amount of warming caused by carbon dioxide.

Table 2: Greenhouse Gases

Gas	Chemical Formula	Activity	Global Warming Potential (CO_2e)
Carbon Dioxide	CO_2	Combustion	1
Methane	CH_4	Combustion, Anaerobic Decomposition of Organic Waste (Landfills, Wastewater), Fuel Handling	21
Nitrous Oxide	N_2O	Combustion, Wastewater Treatment	310
Hydrofluorocarbons	Various	Leaked Refrigerants, Fire Suppressants	12–11,700
Perfluorocarbons	Various	Aluminum Production, Semiconductor Manufacturing, HVAC Equipment Manufacturing	6,500–9,200
Sulfur Hexafluoride	SF_6	Transmission and Distribution of Power	23,900

Calculating Emissions

In general, emissions can be quantified in two ways.

1. Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions from a monitoring system. Emissions measured this way may include those emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility. This method is the most accurate way of inventorying emissions from a given source, but is generally available for only a few sources of emissions.

2. Calculation-based methodologies refer to an estimate of emissions calculated based upon measurable ***activity data*** and ***emission factors***. Table 3 provides examples of common emissions calculations.

Table 3: Basic Emissions Calculations

Activity Data x	Emissions Factor =	Emissions
Electricity Consumption (kilowatt hours)	CO_2 emitted/kWh	CO_2 emitted
Natural Gas Consumption (therms)	CO_2 emitted/therm	CO_2 emitted
Gasoline/Diesel Consumption (gallons)	CO_2 emitted /gallon	CO_2 emitted
Waste Generated by Government Operations (tons)	CH_4 emitted/ton of waste	CH_4 emitted

The Scopes Framework

This inventory reports greenhouse gas emissions by sector and additionally by "scope", in line with the LGO Protocol and WRI/WBCSD GHG Protocol Corporate Standard.

Scope 1: Direct emissions from sources within a local government's operations that it owns and/or controls, with the exception of direct CO_2 emissions from biogenic sources. This includes stationary combustion to produce electricity, steam, heat, and power equipment; mobile combustion of fuels; process emissions from physical or chemical processing; fugitive emissions that result from production, processing, transmission, storage and use of fuels; leaked refrigerants; and other sources.

Scope 2: Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.

Scope 3: All other emissions sources that hold policy relevance to the local government that can be measured and reported. This includes all indirect emissions not covered in Scope 2 that occur as a result of activities within the operations of the local government. Scope 3 emission sources include (but are not limited to) tailpipe emissions from employee commutes, employee business travel, and emissions resulting from the decomposition of government-generated solid waste.

ICLEI and the LGO Protocol provide standard methodologies for calculating emissions from the sources shown in the following table. Other sources of emissions, such as those associated with the production of consumed products do not yet have standard calculation methodologies and are thus excluded from this inventory.

Table 4: Inventoried Emissions Sources by Scope

Scope 1	Scope 2	Scope 3
Fuel consumed at facilities	Purchased electricity consumed by facilities	Solid waste generated by government operations
Fuel consumed by vehicle fleet and mobile equipment	Purchased electricity consumed by electric vehicles	Fuel consumed by vehicles during employee commuting
Fuel consumed to generate electricity	Purchased steam	
Leaked refrigerants from facilities and vehicles	Purchased cooling (chilled water)	
Leaked / deployed fire suppressants		
Solid waste in government landfills		
Wastewater decomposition and treatment at a municipal wastewater treatment plant		

Organizational Boundaries

The organizational boundary for the inventory determines which aspects of operations are included in the emissions inventory, and which are not. Under the LGO Protocol, two control approaches are used for reporting emissions: operational control or financial control. A local government has operational control over an operation if it has full authority to introduce and implement policies that impact the operation. A local government has financial control if the operation is fully consolidated in financial accounts. If a local government has joint control over an operation, the contractual agreement will have to be examined to see who has authority over operating policies and implementation, and thus the responsibility to report emissions under operational control.

LGO Protocol strongly encourages local governments to utilize operational control as the organization boundary for a government operations emissions inventory. Operational control is believed to most accurately represent the emissions sources that local governments can most directly influence, and this boundary is consistent with other environmental and air quality reporting program requirements. For this reason, this inventory was conducted according to the operational control framework.

Types of Emissions

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

Stationary or mobile combustion: These are emissions resulting from on-site combustion of fuels (natural gas, diesel, gasoline, etc.) to generate heat, electricity, or to power vehicles and mobile equipment.

Purchased electricity: These are emissions produced by the generation of power from utilities outside of the jurisdiction.

Fugitive emissions: Emissions that result from the unintentional release of greenhouse gases into the atmosphere (e.g., leaked refrigerants, methane from waste decomposition, etc.).

Process emissions: Emissions from physical or chemical processing of a material (e.g., wastewater treatment).

Significance Thresholds

Within any local government's own operations there will be emission sources that fall within Scope 1 and Scope 2 that are minimal in magnitude and difficult to accurately measure. Within the context of local government operations, emissions from leaked refrigerants and backup generators may be common sources of these types of emissions. For these less significant emissions sources, LGO Protocol specifies that up to 5 percent of total emissions can be reported using methodologies that deviate from the recommended methodologies in LGO Protocol. In the context of registering emissions with an independent registry (such as the California Climate Action Registry), emissions that fall under the significance threshold are called *de minimis*.

In this report, the following emissions fell under the significance threshold and were reported using best available methods:

- Scope 1 fugitive emissions from leaked refrigerants from HV/AC and refrigeration equipment. Vehicle refrigerant leak rates were estimated. Building HV/AC systems are not included in this inventory
- Scope 1 fugitive emissions from leaked/deployed fire suppressants as they were not included in this inventory as it was assumed that the majority are powder-based suppressants
- Scope 1 CH_4 and N_2O emissions from vehicle and transit fleet

Information Items

Information items are emissions sources that are not included as Scope 1, 2, or 3 emissions in the inventory, but are reported here separately in order to provide a more complete picture of emissions from Arcata's government operations.

A common emission that is categorized as an information item is carbon dioxide emitted in the combustion of biogenic fuels. Local governments will often burn fuels that are of biogenic origin (wood, landfill gas, organic solid waste, biofuels, etc.) to generate power. Common sources of biogenic emissions are the combustion of landfill gas from landfills or biogas from wastewater treatment plants, as well as the incineration of organic municipal solid waste at incinerators.

Carbon dioxide emissions from the combustion of biogenic fuels are not included in Scope 1 based on established international principles. Methane and nitrous oxide emissions from biogenic fuels are considered Scope 1 stationary combustion emissions and are included in the stationary combustion sections for the appropriate facilities. These principles indicate that biogenic fuels (e.g., wood, biodiesel), if left to decompose in the natural environment, would release CO_2 into the atmosphere, where it would then enter back into the natural carbon cycle. Therefore, when wood or another biogenic fuel is combusted, the resulting CO_2 emissions are akin to natural emissions and should therefore not be considered as human activity-generated emissions. The CH_4 and N_2O emissions, however, would not have occurred naturally and are therefore included as Scope 1 emissions.

Information items quantified for this inventory include:

- Ozone depleting R-12 used as refrigerants in older vehicles

The emissions categorized as information items in this inventory are presented below in Table 5.

Table 5: Information Items

INFORMATION ITEMS		
	CO_2e	
Emissions From R-12 Vehicle Refrigerant	65.610	
R-12 Emissions From Food Works Refrigeration	144.180	Two of the refrigerators in this number are assumed to be R-12
Total Information Items	209.790	

Information items not quantified for this inventory include:

- Scope 1 CO_2 emissions from flared methane from biogas emitted during wastewater treatment because the percent composition of methane is not currently known
- Ozone depleting halons from fire suppressant systems that are possibly halon systems. These include systems at City Hall and the Police Department. These systems may use halon suppressants, the blend of which is unknown.

Understanding Totals

It is important to realize that the totals and sub-totals listed in the tables and discussed in this report are intended to represent all-inclusive, complete totals for Arcata's operations. However, these totals are only a summation of inventoried emissions using available estimation methods. Each inventoried sector may have additional emissions sources associated with them that were unaccounted for, such as Scope 3 sources that could not be estimated.

Also, local governments provide different services to their citizens, and the scale of the services (and thus the emissions) is highly dependent upon the size and purview of the local government. For these reasons, comparisons between local government totals should not be made without keen analysis of the basis for figures and the services provided.

It is important to understand that in the case where a local government operates a municipal utility that generates electricity for government facilities, the associated emissions should be considered Scope 1 emissions within the Power Generation Facilities sector, and not Scope 2 emissions within each of the other facilities sectors, when calculating a total. This is advised by the LGO Protocol and done to avoid reporting the same emissions twice, also known as double counting.


http://www.city-data.com

Inventory Results

Emissions Total

In 2010, Arcata's greenhouse gas emissions from government operations totaled 2,450 metric tons of CO_2e. This number represents a roll-up of emissions. While the roll-up is a valuable figure, information on the breakdown of emissions from local government operations by scopes, sources, and sectors allows the comparative analysis and insight needed for effective decision-making on target setting, developing GHG reduction measures, or monitoring. The LGO Protocol and ICLEI identify reporting by scopes, sources, and sectors as the strongly preferred form of reporting a greenhouse gas inventory. For more details on the breakdown of Jurisdiction's emissions by scopes, sources, and sectors, refer to subsequent sections within Inventory Results in this report.

Buildings and Other Facilities

Facility operations contribute to greenhouse gas emissions in two major ways. First, facilities consume electricity and fuels such as natural gas. This consumption is associated with the majority of greenhouse gas emissions from facilities. In addition, fire suppression, air conditioning, and refrigeration equipment in buildings can emit hydrofluorocarbons (HFCs) and other greenhouse gases when these systems leak refrigerants or fire suppressants. Refrigerants and fire suppressants are very potent greenhouse gases, and have Global Warming Potential (GWP) of up to many thousand times that of CO_2. For example, HFC-134a, a very common refrigerant, has a GWP of 1300, or 1300 times that of CO_2. Therefore, even small amounts of leaked refrigerants can have a significant effect on greenhouse gas emissions.

Arcata operates 10 major facilities, not including the Arcata Waste Water Treatment Plant. Many city operations are coordinated within a Joint Powers Authority (JPA) such as the Humboldt Waste Management Authority. All emissions associated with JPA operations are not included in this inventory since Arcata does not have direct control over these organizations. Essentially, all facilities included in this inventory were determined by the PG&E utility charges billed to the City Of Arcata. Emissions associated with these buildings are summarized in the following tables and figures.

Figure 3: Buildings and Other Facilities Emissions by Department

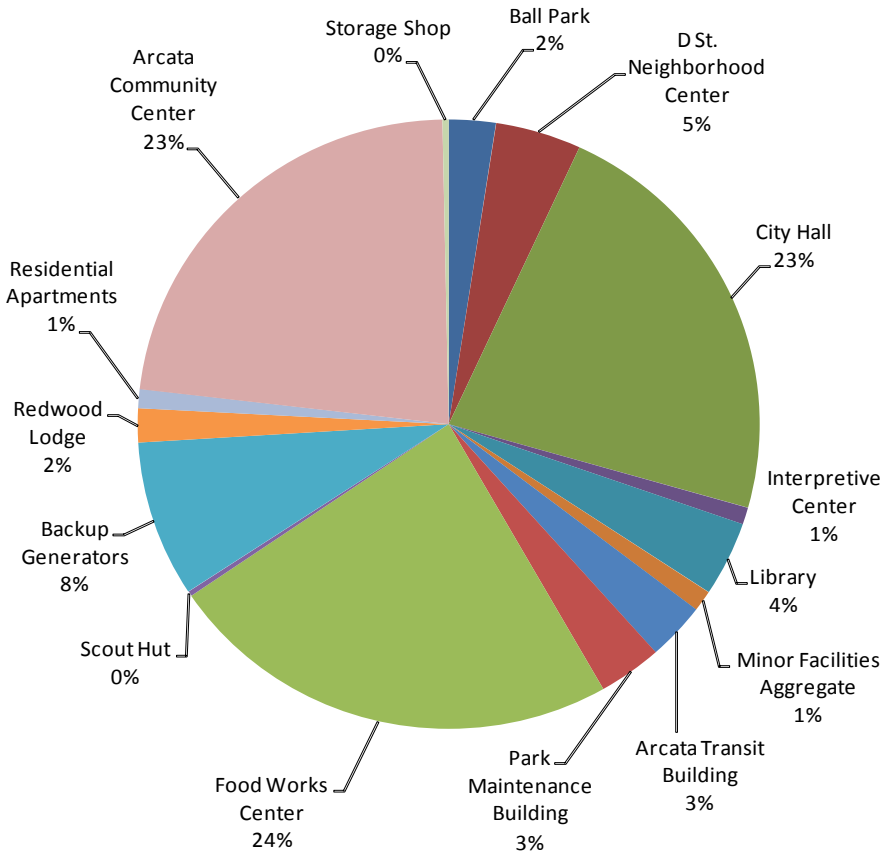


Table 6: Buildings and Other Facilities Emissions by Department

Department	metric tons CO_2e	Cost ($)
Ball Park	8.19	$3,680
D St. Neighborhood Center	14.91	$4,514
City Hall	75.51	$34,073
Interpretive Center	3.00	$823
Library	13.29	$6,341
Minor Facilities Aggregate	3.70	$3,179
Arcata Transit Building	10.18	$5,594
Park Maintenance Building	11.03	$2,737
Food Works Center	79.65	$27,586
Scout Hut	0.88	$462
Backup Generators	27.81	$9,199
Redwood Lodge	5.99	$2,021
Residential Apartments	3.39	$972
Arcata Community Center	76.53	$27,412
Storage Shop	1.07	$420
Totals	**335.12**	**$129,013**

Figure 4: Buildings and Other Facilities Emissions by Source

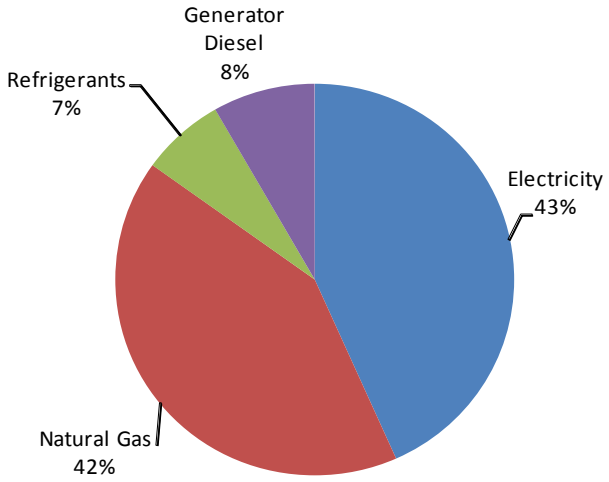


Table 7: Buildings and Other Facilities Emissions by Source

Source	metric tons CO2e	Cost ($)
Electricity	145.19	$92,538
Natural Gas	139.37	$25,333
Refrigerants	22.75	---
Generator Diesel	27.81	$9,199
Totals	**335.12**	**127,070**

Figure 5: Top 5 Largest Contributors to Emissions from Buildings Sector

Facility	% of Total Buildings/ Facilities Emissions from Electricity	% of Total Buildings/Facilities Emissions from Natural Gas	% of Total Buildings/Facilities Emissions from Other Sources	CO_2e Emissions from Electricity	CO_2e Emissions from Natural Gas	CO_2e Emissions from Other Sources	Total CO_2e Emissions
Food Works Center	10%	8%	7%	31.50	25.40	22.75	79.65
Arcata Community Center	9%	15%	0%	29.26	47.27	0.00	76.53
City Hall	18%	6%	0%	57.03	18.48	0.00	75.51
Backup Generators	0%	0%	9%	0.00	0.00	27.81	27.81
D ST. Neighborhood Center	1%	4%	0%	3.58	11.32	0.00	14.91
Totals	**39%**	**33%**	**16%**	**121.37**	**102.47**	**50.56**	

Table 8: LGO Protocol Report - Buildings Sector Emissions by Scope and Emission Type

BUILDINGS & OTHER FACILITIES											
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**									
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFC-134a	HFC_2	HFC_3	PFC_1	PFC_2	SF_6
	Stationary Combustion	167.178	166.652	0.017	0.001	---	---	---	---	---	---
	Fugitive Emissions	22.750	0.000	0.000	0.000	0.018	---	---	---	---	---
	Total Direct Emissions	**189.928**	**166.652**	**0.017**	**0.001**	**0.018**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SCOPE 2		CO_2e	CO_2	CH_4	N_2O						
	Purchased Electricity	145.194	144.231	0.008	0.003						
	Purchased Steam	N/A	N/A	N/A	N/A						
	District Heating & Cooling	N/A	N/A	N/A	N/A						
	Total Indirect Emissions	**145.194**	**144.231**	**0.008**	**0.003**						
SCOPE 3		CO_2e									
	None Reported	---									
INDICATORS	Operating Hours	?									
	Square Footage	?									
	Number of Employees	?									

Streetlights, Traffic Signals, and Other Public Lighting

Like most local governments, Arcata operates a range of public lighting including park lighting, street lighting and holiday lighting. The majority of emissions associated with the operation of this infrastructure are due to electricity consumption. Data relating to electricity consumption for public lighting was obtained from PG&E. Note that streetlights in Arcata are owned by and rented from PG&E. As a result they are categorized as Scope 3 emissions.

Figure 6: Public Lighting Emissions by Subsector

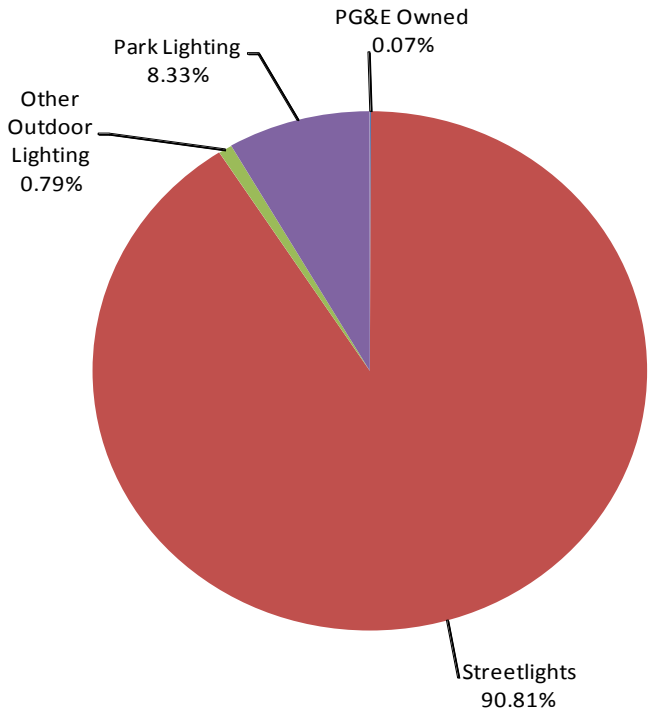


Table 9: Public Lighting Emissions by Subsector

Subsector (Light Type)	metric tons CO2e	% of Sector Emissions	Electricity Use (kWh)	Cost ($)
PG&E Owned	0.09	0.07%	353	$192
Streetlights	113.83	91%	445,952	$57,374
Other Outdoor Lighting	1.00	1%	3,901	$846
Park Lighting	10.44	8%	40,903	$8,412
Totals	**125.36**	**100%**	**491,109**	**$66,824**

Table 10: LGO Protocol Report – Public Lighting Emissions by Scope and Emission Type

STREETLIGHTS, TRAFFIC SIGNALS, AND OTHER PUBLIC LIGHTING					
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**			
SCOPE 2		CO_2e	CO_2	CH_4	N_2O
	Purchased Electricity	125.265	124.435	0.007	0.002
	Total Indirect Emissions	125.265	124.435	0.007	0.002
SCOPE 3		CO_2e			
	PG&E Owned Streetlights	0.090			
INDICATORS					

Water Delivery Facilities

This sector includes emissions from equipment used for the distribution or transport of water, including drinking water, sprinkler systems and irrigation. Arcata operates a range of water transport equipment, including drinking water and storm water pumps, water storage tanks and irrigation systems. Electricity consumption is the significant source of greenhouse gas emissions from the operation of Arcata's water transport equipment, although the combustion of some natural gas is also involved.

Figure 7: Water Delivery Facilities Emissions by Subsector

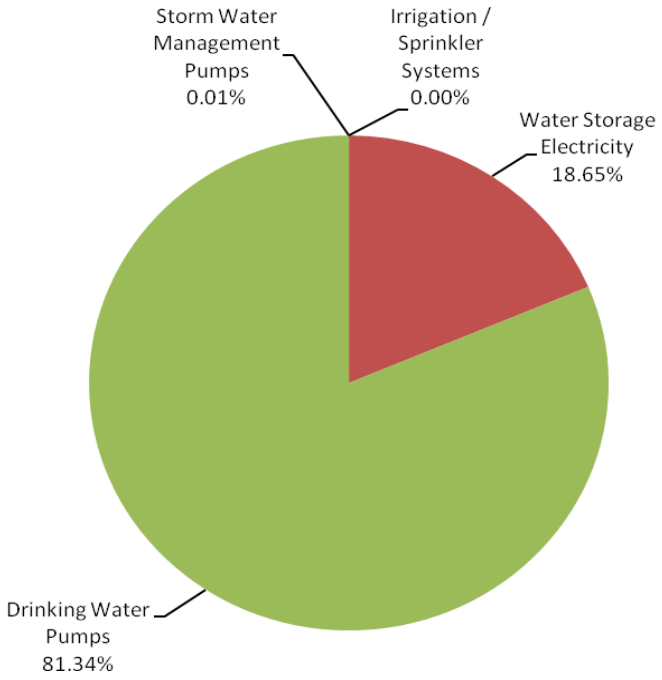


Table 11: Water Delivery Facilities Emissions by Subsector

Subsector (Equipment Type)	metric tons CO_2e	% of Sector Emissions	Electricity Use (kWh)	Cost ($)
Storm Water Management Pumps	0.01	0.01%	40	$ 169
Water Storage Electricity	25.09	19%	98,314	$ 20,528
Drinking Water Pumps	109.45	81%	418,289	$ 70,202
Irrigation / Sprinkler Systems	0.00	0.00%	0	$ 217
Totals	**134.55**	**100%**	**516,643**	**$ 91,116**

Table 12: LGO Protocol Report - Water Delivery Facilities Emissions by Scope and Emission Type

WATER TRANSPORT FACILITIES											
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**									
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFC_1	HFC_2	HFC_3	PFC_1	PFC_2	SF_6
	Stationary Combustion	2.679	2.672	0.000	0.000	---	---	---	---	---	---
	Fugitive Emissions	---	---	---	---	---	---	---	---	---	---
	Total Direct Emissions	**2.679**	**2.672**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SCOPE 2		CO_2e	CO_2	CH_4	N_2O						
	Purchased Electricity	131.873	130.999	0.007	0.002						
	Purchased Steam	N/A	N/A	N/A	N/A						
	District Heating & Cooling	N/A	N/A	N/A	N/A						
	Total Indirect Emissions	**131.873**	**130.999**	**0.007**	**0.002**						
SCOPE 3		CO_2e									
	None Reported	---									
INDICATORS	Gallons of Drinking Water Treated	?									
	Gallons of Water Transported	?									

Wastewater Treatment Facilities

Wastewater coming from homes and businesses is rich in organic matter and has a high concentration of carbon and nitrogen (along with other organic elements). As wastewater is collected, treated, and discharged, chemical processes in aerobic and anaerobic conditions lead to the creation and emission of two greenhouse gases: methane and nitrous oxide. Local governments that operate wastewater treatment facilities, including treatment plants, septic systems, collection lagoons, and other facilities, must therefore account for the emission of these gases.

Arcata has operated the Arcata Wastewater Treatment Plant since 1949. This facility serves the entire population of Arcata which is approximately 17,230 people. A minor number of residents in unincorporated areas are also served.

Carbon dioxide emissions from flared methane were not included in this inventory as the methane content in the flared gas is currently not known. However, flared methane emissions are not counted towards total emissions within the LGO protocol as they are considered to be equivalent to the gases produced from natural decomposition processes. Because of this, they are considered an "Information Item"

Figure 8: Wastewater Treatment Facilities Emissions by Subsector

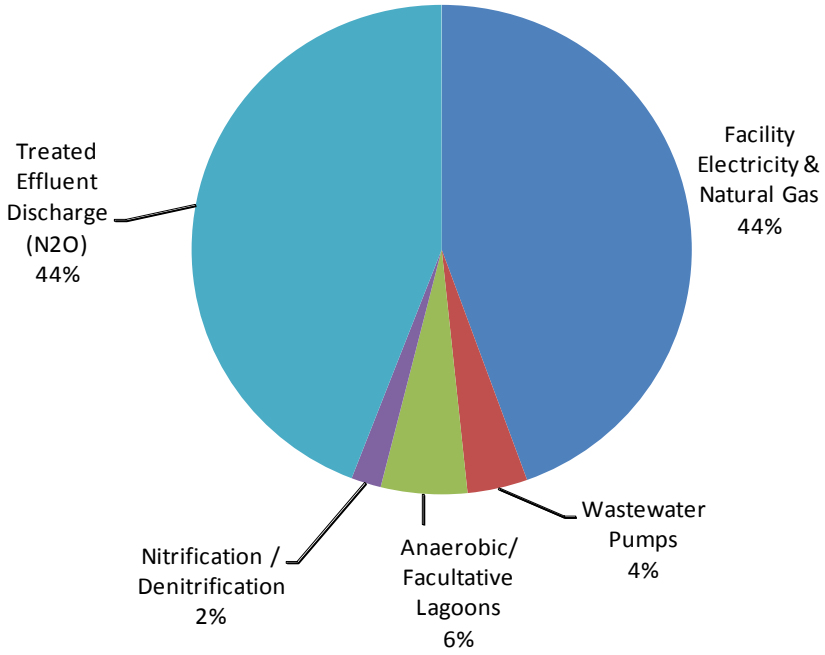


Table 13: Wastewater Treatment Facilities Emissions by Subsector

Subsector	metric tons CO2e
Facility Electricity & Natural Gas	394.09
Wastewater Pumps	34.47
Anaerobic/ Facultative Lagoons	49.48
Nitrification / Denitrification	17.08
Treated Effluent Discharge (N2O)	391.31
Totals	**886.43**

Table 14: LGO Protocol Report - Wastewater Treatment Facilities Emissions by Scope and Emission Type

WASTEWATER TREATMENT FACILITIES											
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**									
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFC_1	HFC_2	HFC_3	PFC_1	PFC_2	SF_6
	Stationary Combustion	73.095	72.908	0.007	0.000	---	---	---	---	---	---
	Fugitive Emissions	---	---	---	---	---	---	---	---	---	---
	Process Emissions	457.878	0.000	2.356	1.317	---	---	---	---	---	---
	Total Direct Emissions	**530.973**	**72.908**	**2.363**	**1.318**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SCOPE 2		CO_2e	CO_2	CH_4	N_2O						
	Purchased Electricity	355.461	353.105	0.019	0.006						
	Purchased Steam	N/A	N/A	N/A	N/A						
	District Heating & Cooling	N/A	N/A	N/A	N/A						
	Total Indirect Emissions	**355.461**	**353.105**	**0.019**	**0.006**						
SCOPE 3		CO_2e									
	None Reported	---									
INDICATORS	Gallons of Wastewater Treated	?									
	Gallons of Wastewater Transported	?									

Vehicle Fleet and Mobile Equipment

The vehicles and mobile equipment used in Arcata's daily operations, including maintenance trucks used for parks and recreation to police cruisers and buses, burn gasoline, diesel, and other fuels, which results in greenhouse gas emissions. In addition, vehicles with air conditioning or refrigeration equipment use refrigerants that can leak from the vehicle.

In 2010, Arcata operated a vehicle fleet with 104 passenger cars, trucks and SUVs. An additional 85 vehicles such as lawnmowers, road work equipment and tractors were also operated. Arcata's vehicle fleet performed a number of essential services such as park maintenance, police operations, road maintenance, and administrative tasks. In 2010, the majority of vehicles in the fleet (23 percent) were used by the Police Department.

Refrigerants used by air conditioners in passenger vehicles and trucks were also included in this inventory. The default method described by the LGO protocol was used to estimate the amount of refrigerants that may have leaked from these air conditioners. Leaks are likely to occur from use and maintenance, and are therefore reported as Scope 1 fugitive emissions. From a volume perspective leaked refrigerants are relatively small compared to other GHG sources. However, the GWP of many refrigerants is quite large such that even a small volume of leaked refrigerant can have a significant impact. It must be noted that the default method described by the LGO Protocol uses default emissions

factors which are highly uncertain and are likely to result in a significant overestimate of emissions. Therefore, emissions results from vehicle refrigerants should be quoted with appropriate discretion.

Figure 10: Vehicle Fleet Emissions by Source

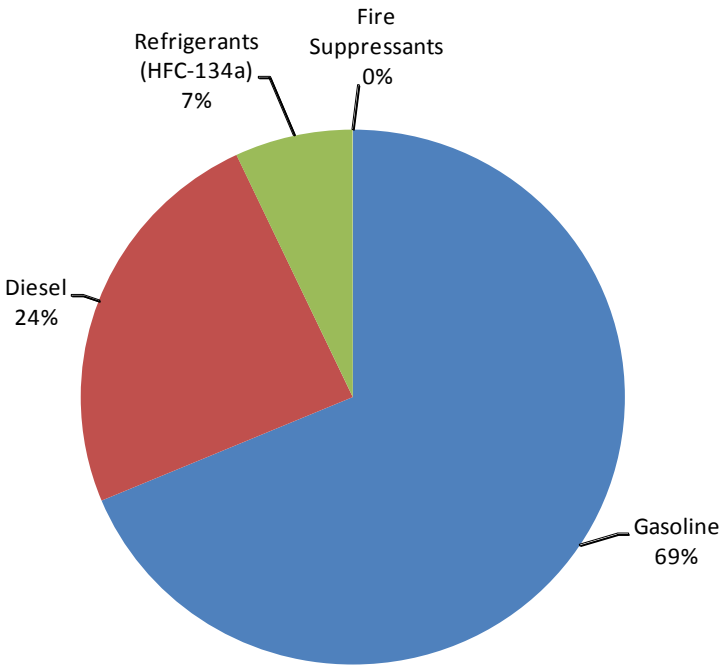


Table 20: Vehicle Fleet Emissions by Source

Source	metric tons CO_2e	Consumption (Gallons)	Cost ($)
Gasoline	292.97	32,895 gallons	100,958
Diesel	103.35	18,893 gallons	32,924
Refrigerants (HFC-134a)	30.03	51 lbs	0
Fire Suppressants	0.00	0	0
Totals	**426.35**		**133,882**

Figure 11: Vehicle Fleet Emissions by Department

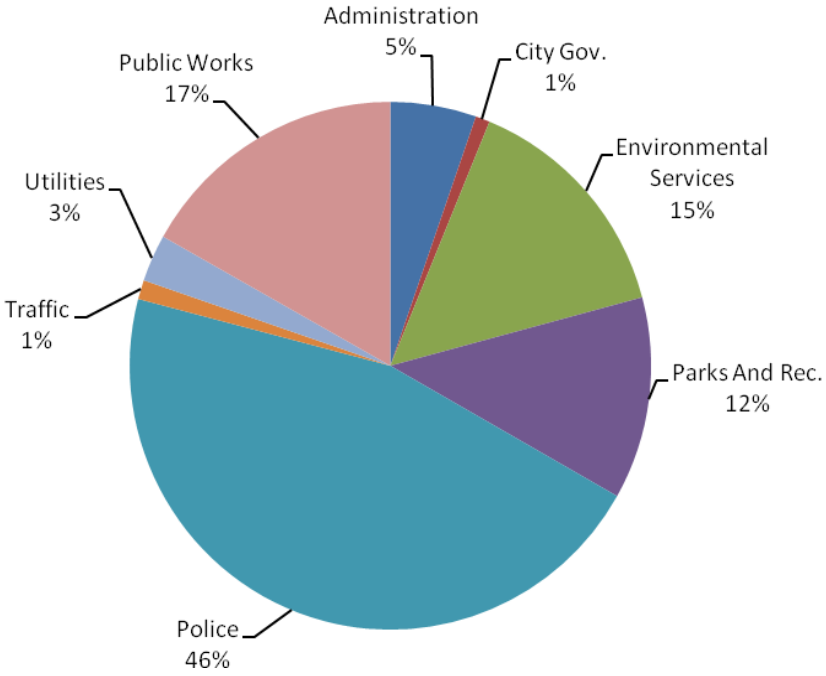


Table 21: LGO Protocol Report - Vehicle Fleet Emissions by Scope and Emission Type

VEHICLE FLEET											
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**									
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFC-134a	HFC_2	HFC_3	PFC_1	PFC_2	SF_6
	Mobile Combustion	396.323	391.810	0.011	0.014	---	---	---	---	---	---
	Fugitive Emissions	30.030	0.000	0.000	0.000	0.023	---	---	---	---	---
	Total Direct Emissions	**426.353**	**391.810**	**0.011**	**0.014**	**0.023**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SCOPE 2		CO_2e	CO_2	CH_4	N_2O						
	Purchased Electricity for Electric Vehicles	---	---	---	---						
	Total Indirect Emissions	**0.000**	**0.000**	**0.000**	**0.000**						
SCOPE 3		CO_2e									
	None Reported	---									
INDICATORS	Number of Vehicles	104	All passenger cars, light trucks, heavy trucks, SUVs, etc.								
	Vehicle Miles Traveled	503,504									
	Number of Pieces of Equipment	85	All other equipment in vehicle fleet data								
	Equipment Operating Hours	?									

Transit Fleet

The vehicles used in the Arcata & Mad River Transit System (A&MRTS), including buses, shuttles, and passenger cars, burn gasoline, diesel, and other fuels, resulting in greenhouse gas emissions. In addition, vehicles with air conditioning use refrigerants that can leak from the vehicle. A&MRTS is a small operation that compliments other local public transit systems including those organized under the Humboldt Transit Authority (HTA). A total of 9 vehicles were operated by A&MRTS in 2010. Four of these vehicles were large buses and two were large shuttles. All maintenance was outsourced to HTA.

Only these six vehicles were included in the Scope 1 emissions results as the other three passenger vehicles are primarily operated by employees for commute purposes. Fuel consumption data was not available for these three passenger vehicles and are ideally estimated by the employee commute results.

Refrigerants used by air conditioners in A&MRTS vehicles were also included in this inventory. The default method described by the LGO protocol was used to estimate the amount of refrigerants that may have leaked from these air conditioners. Leaks are likely to occur from use and maintenance, and are therefore reported as Scope 1 fugitive emissions. From a volume perspective leaked refrigerants are relatively small compared to other GHG sources. However, the GWP of many refrigerants is quite large such that even a small volume of leaked refrigerant can have a significant impact. It must be noted that the default method described by the LGO Protocol uses default emissions factors which are highly uncertain and are likely to result in a significant overestimate of emissions. Therefore, emissions results from vehicle refrigerants should be quoted with appropriate discretion.

Figure 12: Transit Fleet Emissions by Source

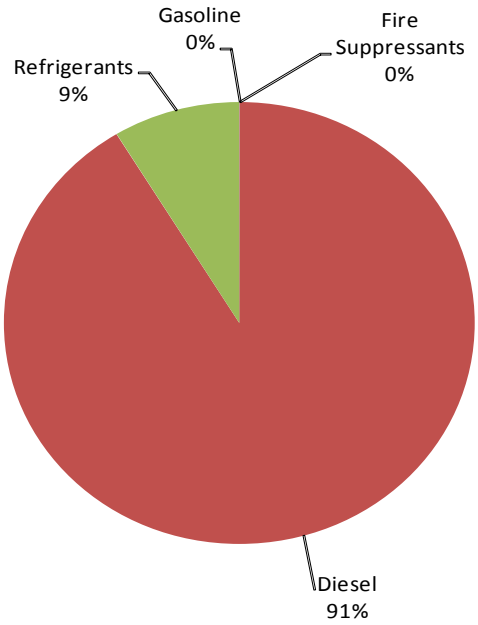


Table 22: Transit Fleet Emissions by Source

Source	metric tons CO2e	Consumption (Gallons)	Cost ($)
Gasoline	0.00	0	0
Diesel	234.38	22,936	54,650
Refrigerants	22.00	0	0
Fire Suppressants	0.00	0	0
Totals	**256.38**		**54,650**

Table 23: LGO Protocol Report - Transit Fleet Emissions by Scope and Emission Type

TRANSIT FLEET											
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**									
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFC-134a	HFC_2	HFC_3	PFC_1	PFC_2	SF_6
	Mobile Combustion	234.384	234.177	0.001	0.001	---	---	---	---	---	---
	Fugitive Emissions	21.996	---	---	---	0.017	---	---	---	---	---
	Total Direct Emissions	**256.380**	**234.177**	**0.001**	**0.001**	**0.017**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SCOPE 2		CO_2e	CO_2	CH_4	N_2O						
	Purchased Electricity for Electric Vehicles	---	---	---	---						
	Total Indirect Emissions	**0.000**	**0.000**	**0.000**	**0.000**						
SCOPE 3		CO_2e									
	None Reported	---									
INDICATORS	Number of Vehicles	10									
	Vehicle Miles Traveled	130,064									

Government-Generated Solid Waste

Many local government operations generate solid waste, much of which is eventually sent to a landfill. Typical sources of waste in local government operations include paper and food waste from offices and facilities, construction waste from public works, and plant debris from parks departments. Organic materials in government-generated solid waste (including paper, food scraps, plant debris, textiles, wood waste, etc.) generate methane as they decay in the anaerobic environment of a landfill. Emissions from the waste sector are an estimate of methane generation that will result from the anaerobic decomposition of all organic waste sent to landfill in the base year. It is important to note that although these emissions are attributed to the inventory year in which the waste is generated, the emissions themselves will occur over the 100+ year timeframe that the waste will decompose.

All waste generated in Arcata, including that generated from municipal operations, is trucked to the Humboldt Waste Management Authority (HWMA). Waste generated from different departments is not known as all municipal waste is aggregated at the Corp. Yard in a single 18yd^3 bin. This bin is transported to HWMA roughly 78 times per year, the

emissions from which are estimated in this report. HWMA then trucks all waste out of the county to either the Anderson Landfill or the Dry Creek Landfill. Operations associated with HWMA are not included in this inventory as Arcata does not have direct control over their activities. Therefore, all emissions associated with the shipment of waste out of the county are not reflected here. In addition, emissions from the transport of waste from the various departments to the Corp. Yard are not accounted for as this is not known. These emissions may be larger than the transport emissions reflected here.

Figure 13: Government Waste Emissions by Subsector

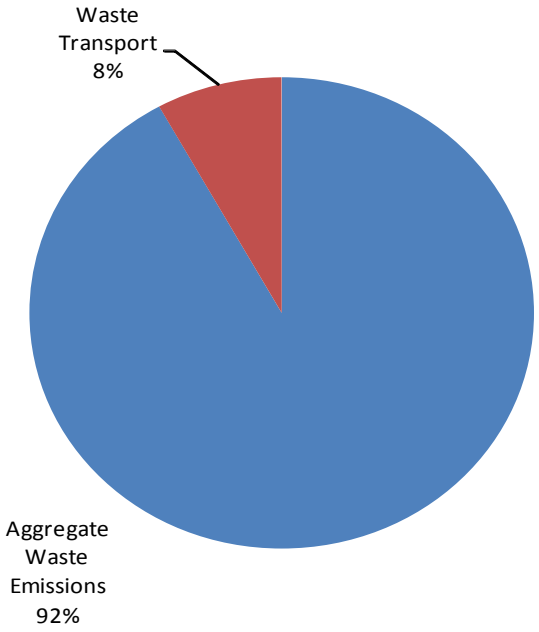


Table 24: Government Waste Emissions by Subsector

Source	metric tons CO2e
Aggregate Waste Emissions	15.85
Waste Transport	1.40
Totals	**17.25**

Table 25: LGO Protocol Report - Government Waste Emissions by Scope and Emission Type

SOLID WASTE GENERATION		
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**
SCOPE 3		CO_2e
	Aggregate Waste	15.851
	Waste Transport	1.395
INDICATORS	Short tons solid waste	62.500
	Short tons of recyclable materials	?

Employee Commute

Emissions in the Employee Commute sector are due to combustion of fuels in vehicles used by government employees for commuting to work at Arcata. Results from a survey designed by ICLEI and administered by Arcata are shown below. The survey was used to collect the data needed to calculate emissions and also capture other information that will help Arcata set effective policy addressing this sector.

Figure 14: Employee Commute Emissions by Vehicle Class

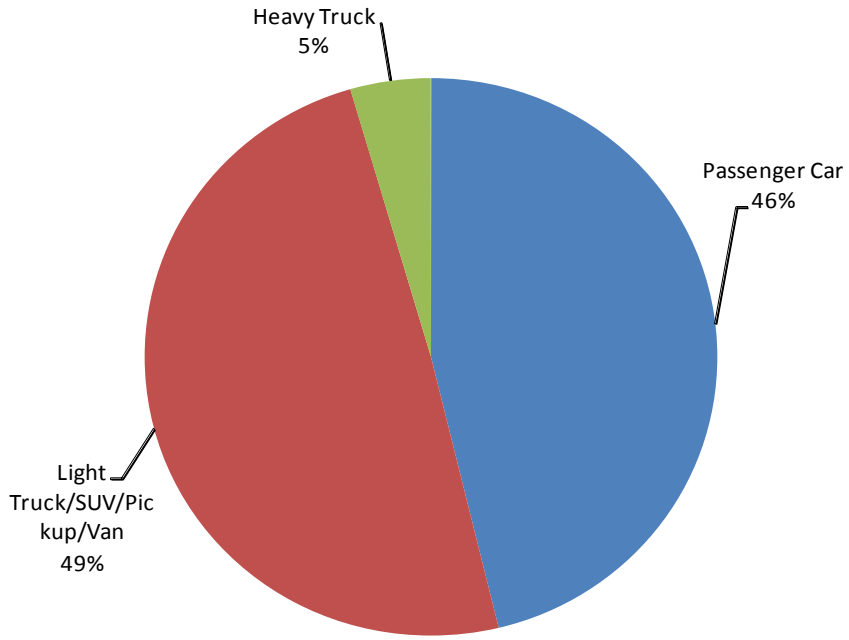


Table 26: Employee Commute Emissions by Vehicle Class

Vehicle Class	metric tons CO2e
Passenger Car	123.89
Light Truck/SUV/Pickup/Van	132.37
Heavy Truck	12.45
Totals	**268.71**

Table 27: LGO Protocol Report - Employee Commute Emissions by Scope and Emission Type

EMPLOYEE COMMUTE		
Scope	**Emission Type**	**Greenhouse Gas Emissions (metric tons)**
SCOPE 3		CO_2e
	Mobile Combustion	268.710
INDICATORS	Vehicle Miles Traveled	696,646
	Number of Vehicles	

Table 28: Employee Commute - Reasons for Not Carpooling Data

Reason	Percentage
Need to make stops on the way to work or home	61%
Other people do not match my schedule or route	45%
Work late or irregular hours	42%
Dislike being dependent on others	37%
Like the privacy when I'm in my own car	32%
Need my car on the job	21%
Difficult to find others to carpool/vanpool	18%
May not be able to get home quickly in an emergency	16%
Makes my trip too long	13%
Other	5%
I don't know enough about carpooling or vanpooling	3%
Never considered carpooling or vanpooling	0%

Table 29: Employee Commute - Reasons for Not Taking Transit

Reason	Percentage
Transit service doesn't match my route or schedule	55%
Need to make stops on the way to work or home	45%
It takes too long	42%
I work late or irregular hours	32%
Like the privacy when I'm in my own car	21%
May not be able to get home quickly during an emergency	16%
Need my car on the job	16%
Other	13%
It is not safe or easy to walk to work from the transit stop	8%
Not enough parking at the transit stop from which I'd depart	8%
It is too far to walk to work from the transit stop	8%
It costs too much	5%
Never considered using public transit	5%
I don't know enough about taking transit	0%

Table 30: Employee Commute - Reasons for Not Walking/Biking

Reason	Percentage
I live too far away	58%
Weather	53%
There isn't a safe or easy route for walking or biking	50%
Need to make stops on the way to work or home	37%
It's not easy to look good and feel comfortable for work after walking or biking	24%
May not be able to get home quickly in an emergency	13%
Other	11%
Workplace does not have adequate facilities for showering/changing	8%
No place at work to store bikes safely	3%
Never considered walking or biking to work	3%
I don't know enough about walking or biking to work	0%

Table 31: Employee Commute - Travel Mode Data

Mode	Percentage
Drive Alone	77%
Carpooling/Vanpooling	11%
Public Transportation	0%
Bicycling	9%
Walking	0%
Telecommute/Other	0%
Split Modes	3%

Table 32: Employee Commute - Miles from Work Data

Miles	Percentage
0-5	24%
6-10	57%
11-15	11%
15-20	5%
21-25	0%
26-30	0%
31-35	3%
36-40	0%
41-45	0%
46-50	0%
51-75	0%
76-100	0%
Over 100	0%

Table 33: Employee Commute - Time to Work Data

Time (Minutes)	Percentage
Less than 5	8%
6 to 15	63%
16 to 25	26%
26 to 35	0%
36 to 45	3%
Over 45	0%


http://www.city-data.com

Comparison with Past Inventories

While the methods used in this report deviate significantly from past inventories conducted by Arcata, it is still useful to compare with past results. While CO_2e results are compared, electricity, natural gas and vehicle miles traveled (VMT) are also shown which allow for a more direct comparison. Sewage gas emissions are not compared as the results from this inventory differ substantially due to differences in methodologies.

Looking solely at CO_2e results is not a good comparison as these numbers are highly dependent on the methodology of each report in addition to variations in PG&E grid mix emissions. All numbers for the 2000 and 2006 inventories were taken from the municipal emissions chapter in the 2006 inventory report. While not explicitly clear, it was assumed that the 2000 and 2006 inventories reported CO_2e in units of short tons. Therefore, those numbers have been converted to metric tons (i.e. tonnes) using a conversion factor of 1.1023 short tons / metric ton.

	Electricity (kWh)	Natural Gas (therms)	Municipal Fleet (VMT)	Public Transit (VMT)	Total Emissions (tonnes CO_2e)
2000 Inventory	2,049,015	37,584	452,796.90	101,538	1,353.6
2006 Inventory	2,725,751	33,533	514,035.20	120,000	1,696.4
2010 Inventory	2,584,690	32,271	503,503.60	130,064	2,308.5

An initial comparison reveals a general reduction in kWh and therms consumed, and the total number of municipal fleet miles traveled. However, total estimated CO_2e emissions are significantly higher by roughly 35%. This contradicts the trend in reduced consumption and so is likely explained by differences in inventory methodologies. Given this, it is recommended that Arcata rigorously follow the methodologies used here in order to better compare this inventory with future inventories.

All pictures from http://www.humboldt.edu/arcatamarsh/

Inventory Methodologies

For all electricity consumption, there were no emissions estimates for 2010 available from PG&E during the creation of this report. Therefore, estimated emissions factors associated with PG&E's grid mix was taken from http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/GHG_Emission_Factor_Guidance.pdf. The value used is 0.2536 metric tons CO_2 per megawatt-hour (MWh) which is an average of PG&E's 2005 to 2009 GHG emissions factors. This complies with the ClimateSmart guidelines for estimating emissions factors based on past emissions factors.

Estimated 2010 N_2O and CH_4 emissions factors from the PG&E grid mix were estimated using an average of 2003 – 2007 emissions values found in Table G.7 of the LGO Protocol version 1.1. While this method does not comply with ClimateSmart guidelines, emissions factors for 2008 and 2009 were not available when this report was written. Since these emissions factors do not change noticeably it was concluded that this method was sufficient. The values used were:

- CH_4: 0.03 lbs/MWh
- N_2O: 0.01 lbs/MWh

Refrigeration systems from the Food Works facility were included. However, there are no HVAC or other refrigeration systems included from any other facility in this inventory as information regarding these systems was not complied by the time this report was written. The percent contribution of emissions from these systems is expected to be small, especially considering the cool temperate climate of Arcata. However, it is recommended that future inventories account for these systems.

Emissions from the leakage of fire suppressants from fire extinguisher systems were not included in this inventory as well. There are 172 fire extinguishers in use between buildings and vehicles. The blends of all extinguishers are not known so it was assumed that all are powder-based suppressants which have zero global warming potential (GWP). However, from a conversation with Eureka Fire Extinguisher, there may be two halogen-based building-integrated systems in the police department and city hall. This has not been confirmed and so was not included in this report. However, if these systems are halon blends then they should be accounted for in future reports. Ideally, they should be replaced because of the significant GWP of halon compounds.

All raw data was entered into and conditioned in an Excel spreadsheet called the Master Data Workbook (MDW). The results from the categorization of this data within the MDW were then entered into Version 3.0 of the Clean Air and Climate Protection (CACP) software, a program created and provided by ICLEI. All results entered into CACP were

converted into estimated quantities of CO_2e, CO_2, CH_4, and N_2O by the program using emissions factors which are detailed in Appendix G in the LGO Protocol Report, Version 1.1. This report is available at http://www.theclimateregistry.org/downloads/2010/05/2010-05-06-LGO-1.1.pdf. In addition, estimates of SO_x, NO_x, CO, VOC, and PM10 emissions were calculated by the CACP software and are available in the Emissions Outputs, Detailed tab in the MDW. These emissions calculations were then exported from CACP and entered back into the MDW where they were conditioned into the Report Charts and Tables tab. The resulting figures and tables generated were then entered into this report for final presentation.

Buildings and Other Facilities

Emissions from electricity and natural gas consumption were taken directly from PG&E data. However, there are a few diesel backup power generators which consumed an unknown volume of diesel fuel. Only the cost of diesel was available from the Arcata Garage (Lori Reed: 825-2181). This data is shown in the FA-Other Fuel Raw Data tab in the Master Data Workbook (MDW). To estimate the volume of diesel fuel consumed, an average price of diesel was estimated. The following steps outline the method used since a reliable diesel price source for Humboldt County was not found:

- An average gasoline price per gallon of $3.33 was determined by averaging the prices from three different sources shown below. In addition, the average price for gas and diesel was determined for the state of California.

Gas: May 2010	$3.29	*www.bizjournals.com/sanfrancisco/stories/2010/05/10/daily33.html*
Gas: Oct 2010	$3.36	*www.tahoedailytribune.com/article/20101013/NEWS/101019947*
Gas: Nov 2010	$3.33	*www.times-standard.com/localnews/ci_16571713*
Average Eureka Gas	$3.327	Avg. of above three data points
Avg. CA Gas	$3.091	http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm
Avg. CA Diesel	$3.157	http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

- Since diesel is more expensive than gas, the ratio of diesel price to gas price of 1.0214 was found from the average state prices, and then multiplied by the average cost of gas in Eureka to obtain an estimated average cost of diesel of $3.40 per gallon. The cost of diesel for 2010 for each generator, provided by Arcata Garage, was then divided by the estimated average cost per gallon of diesel to obtain the number of gallons of diesel used in 2010.

- Any error in this method is likely to tend towards an underestimate since street prices are likely higher than what the city of Arcata pays. Therefore, the volume of diesel consumed may be higher than what is reported here.

In addition, the Food Works facility contains numerous commercial scale refrigeration units. Refrigerant emissions from these sources were estimated using the default emissions rates method. There are three fairly new Castino units that were acquired from College Of The Redwoods in 2011 and are listed in the MDW only for completeness but are not included in the emissions inventory. The True brand stand-up refrigerator was included as an information item, and the refrigerant blend and capacity were read directly from the unit. The Raeton refrigerator was assumed to be R-12, was included as an information item only, and the capacity was guessed to be 1kg based on the True refrigerator capacity. Since the Raeton capacity was listed as 235lbs, there was no way to convert this to kg as the volume of the compressor is not known. The Kalt and Kysor Panel Systems walk-ins were estimated to use R-12 and R-134a respectively blends based on their manufacture year of 1989 and 2000 respectively. Because the compressor models were not known for this inventory, their capacities were guessed to be the low end of the "Medium & Large Commercial Refrigeration" default capacity range as the high end seemed excessive. However, this was an intuitive decision. The Kalt walk-in was included as an information item only. The Kysor Panel Systems walk-in was the only refrigeration unit included in the Scope 1 emissions report.

Streetlights, Traffic Signals, and Other Public Lighting

All electricity consumed by street, traffic, and public lighting was gathered from PG&E records. Note that there are PG&E owned light sources which were cataloged as Scope 3. It is assumed that these are the traffic lights on Samoa Blvd. since there are no explicit entries for these lights.

Water Transport Facilities

All electricity consumption was gathered from PG&E records.

Wastewater Treatment Facilities

All electricity and natural gas consumption was gathered from PG&E records. Sewage lift pumps that are offsite from the treatment plant are also included in this section. Additional information was obtained from Erik Lust (825-2156) which is outlined below

- There is one small air conditioner in the facility laboratory that was not included
- There is no initiated nitrification process.

- The number of people served is estimated to be the population of Arcata from 2010 which was taken from http://quickfacts.census.gov/qfd/states/06/0602476.html. There are a few residents outside Arcata limits which are served but they are a small minority.

- N_2O process emissions are calculated with the assumption that there are no commercial inputs to the system. HSU is the primary commercial input which is a minor input.

- There is no site-specific measurement of CH_4 that is emitted from bio-digestion as of the time this report was written. However, it is planned to track this in the future. Bio-digester gas is currently flared but the emissions are considered carbon neutral by the LGO Protocol.

- The average BOD5 load is roughly 400 lbs/day. BOD5 removal is generally 95% and always above 85%. A value of 95% removal was used. This decision errors on the side of being an underestimate of CH_4 emissions.

- There are no septic systems within Arcata limits.

Vehicle Fleet and Mobile Equipment

All data relating to vehicle fuel consumption and miles traveled was obtained by the Arcata Garage and was broken down by vehicle / piece of equipment.

The actual volume of gasoline and diesel consumed was not available. Only the cost of consumed fuel was available from Arcata Garage. To estimate the volume of gasoline and diesel fuel consumed, an average fuel price was estimated. The following steps outline the method used since a reliable fuel price source for Humboldt County was not found:

- An average gasoline price per gallon of $3.33 was determined by averaging the prices from three different sources shown below. In addition, the average price for gas and diesel was determined for the state of California. The amount of money spent on gasoline per vehicle was divided by $3.33 to determine total amount of gallons consumed by that vehicle.

Gas: May 2010	$3.29	*www.bizjournals.com/sanfrancisco/stories/2010/05/10/daily33.html*
Gas: Oct 2010	$3.36	*www.tahoedailytribune.com/article/20101013/NEWS/101019947*
Gas: Nov 2010	$3.33	*www.times-standard.com/localnews/ci_16571713*
Average Eureka Gas	$3.327	Avg. of above three data points
Avg. CA Gas	$3.091	http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm
Avg. CA Diesel	$3.157	http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

- Since diesel is more expensive than gas, the ratio of diesel price to gas price of 1.0214 was found from the average state prices, and then multiplied by the average cost of gas in Eureka to obtain an estimated average

cost of diesel of $3.40 per gallon. The cost of diesel for each vehicle, provided by Arcata Garage, was then divided by the estimated average cost per gallon of diesel to obtain the number of gallons of diesel consumed.

- Any error in this method is likely to tend towards an underestimate since street prices are likely higher than what the city of Arcata pays. Therefore, the volume of diesel consumed may be higher than what is reported here.

Electricity used by electric vehicles was not explicitly included in this section as there is currently no method of separating vehicle electricity consumption from the aggregate PG&E bill. Therefore, electricity used by these vehicles is buried within the electricity consumption associated with buildings and facilities.

For mobile refrigerants, older vehicles use the R-12 refrigerant blend which has been phased out since 1994 in compliance with the Montreal Protocol. Newer vehicles use a replacement refrigerant called R-134a which has a much lower GWP than R-12. The type of refrigerant blend used by a particular vehicle was determined using information from the National Automotive Parts Association (NAPA) which can be found at http://napabeltshose.com/news/index.cfm?location_id=1078&id=1517&show=newsitem. The refrigerant blend is determined by the vehicle's model year. All vehicles which use R-134a were included as Scope 1 fugitive emissions. All vehicles using R-12 were included as an information item as dictated by the LGO Protocol.

It was assumed that all vehicles had air conditioners with a 1.5kg capacity. This is the high end of the default capacity range provided by ICLEI in the MDW. It was also assumed that the operating emissions factor for all vehicles was 20% of capacity per year as indicated in the MDW. This is likely to be an overestimate for two reasons: 1) the default capacity and emissions rates used are high estimates, and 2) there may be little refrigerant left to leak in older vehicles because there is not much air conditioner maintenance performed since air conditioners are not used much.

All HFC-134a contributions were entered in units of tonnes into CACP where they were then converted to CO_2e by the program. All R-12 contributions were converted to CO_2e in the MDW using the SAR 100 year GWP obtained from the IPCC website at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html. These values were then entered into CACP in units of tonnes of CO_2.

There a couple CNG trucks operated by the Environmental Services Department. The volume of CNG consumed is not directly known. However, the CNG consumed should be contained within the PG&E data associated with buildings and facilities, and so estimating this consumption amount here would be double counting.

Transit Fleet

All fleet data for the Arcata & Mad River Transit System (A&MRTS) was obtained from Jim Wilson at the Humboldt Transit Authority (HTA). This connection was initiated by Larry Pardi, transportation superintendent. HTA was able to

provide vehicle make, model, and year as well as fuel consumption volume and cost. The three passenger vehicles listed did not have fuel consumption data. They are vehicles used by employees as commute vehicles and so their consumption is ideally reflected in the employee commute section.

All refrigerant blends used by the A&MRTS fleet are HFC-134a. This was confirmed for all Gillig buses by the manufacturer. All other vehicles were determined by cross-referencing the vehicle year with information from the National Automotive Parts Association (NAPA) which can be found at http://napabeltshose.com/news/index.cfm?location_id=1078&id=1517&show=newsitem.

All Gillig buses have a 17lb = 7.71kg capacity as confirmed by the manufacturer. The leakage rate was assumed to be 50% per year for the Gillig buses as these are commercial units that are used frequently. It was assumed that all other vehicles had air conditioners with a 1.5kg capacity. This is the high end of the default capacity range provided by ICLEI in the MDW. It was also assumed that the operating emissions factor for all other vehicles was 20% of capacity per year as indicated in the MDW.

Government-Generated Solid Waste

Information regarding municipal waste was obtained from Rick at Arcata Garbage (822-0304). All municipal waste is aggregated into a single 18 cubic yard (yd^3) bin located at the Corp. Yard. The composition of this garbage is estimated using percentages provided by the California Integrated Waste Management Board (CIWMB) 1999 Waste Characterization Study -- Public Administration Group which is available at http://www.ciwmb.ca.gov/WasteChar/BizGrpCp.asp. These percentages are:

Paper Products	39.4%
Food Waste	9.8%
Plant Debris	17.0%
Wood / Textile	6.7%
All Other Waste	27.1%

Waste categories in the CIWMB report were bundled to fit the waste categories of the CACP software. These categories and percentages are used in both the MDW and CACP to calculate total landfill emissions. In addition, a waste density conversion factor of 89lbs/yd^3 is used, and is a factor tailored specifically to public administration waste profiles. This density value was also obtained by CIWMB and is available at http://www.calrecycle.ca.gov/wastechar/DispRate.htm.

The trash bin is picked up by Arcata Garbage roughly twice per week during the summer and roughly once per week during the winter. This results in an estimated 78 pickups per year for a total of 62.5 short tons of waste:

$$18yd^3 \times 78 \times 89lbs/yd^3 \div 2000lbs/ton = 62.5 \text{ tons}.$$

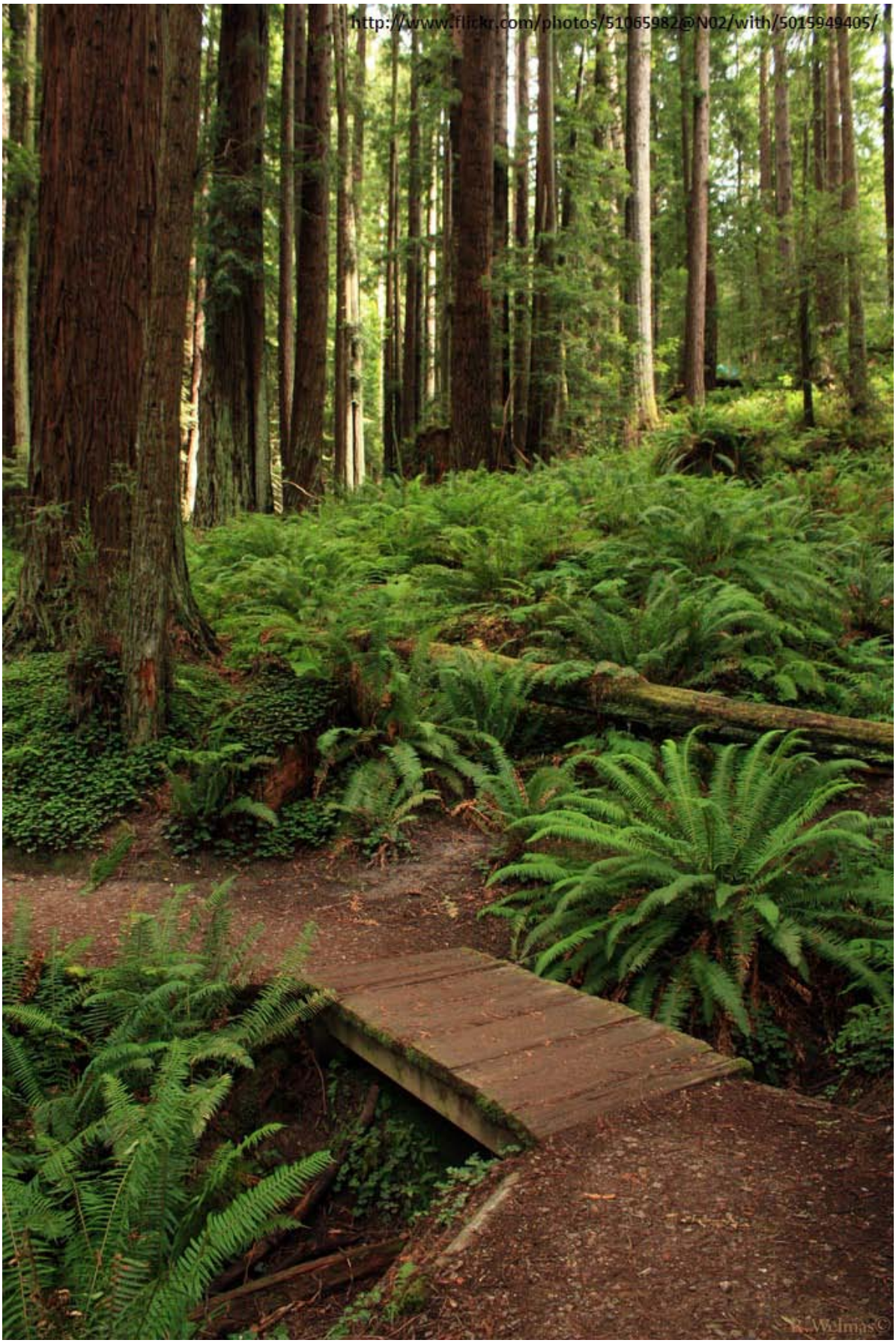
The diesel hauling truck used by Arcata Garbage is assumed to use 4 mpg, and the hauling distance from the Corp. Yard to Humboldt Waste Management Authority (HWMA) is roughly 7 miles. This results in 78 * 7 / 4 = 136.5 gallons of diesel per year and 78 * 7 = 546 miles driven per year. This is a contracted service. Emissions from hauling are calculated in CACP under the Vehicle Fleet tab and are categorized as Scope 3.

All trash is self-hauled by the various city departments to the single bin at the Corp. Yard. Emissions associated with this self-hauling is not explicitly accounted for here, but is reflected in the fuel consumption documented in the Vehicle Fleet section. In addition, emissions associated with the hauling of waste by the HWMA are not included because they are a joint powers authority and Arcata has little control over their actions. This is specified under the LGO Protocol.

Employee Commute

Data regarding employee commutes were collected from an online survey written by ICLEI. This survey was distributed to all municipal employees. A response rate of 38 people out of 185 employees, or 21%, was obtained. Responses were conditioned and entered into the MDW where total miles traveled and fuel consumed was aggregated for each vehicle and fuel type. These results were then divided by the response rate to estimate the total emissions from the commute of all employees.

All CO_2e calculations were done using emissions factors associated with the Alternate Method for the appropriate fuel type and vehicle type as specified in the LGO Protocol. This was done because the sample size was deemed too small to warrant breaking up the data by vehicle year. It likely would not have made the data more accurate.


http://www.flickr.com/photos/51065982@N02/with/5015949405/

Next Steps

ICLEI's Five Milestone Process

While Arcata has already begun to reduce greenhouse gas emissions through its actions, this inventory represents the first inventory utilizing the LGO Protocol. A systematic approach following this inventory to reducing Arcata's emissions, developed by ICLEI, is called the Five Milestones for Climate Mitigation. This Five Milestone process involves the following steps:

Milestone One: Conduct a baseline emissions inventory and forecast

Milestone Two: Adopt an emissions reduction target for the forecast year

Milestone Three: Develop a local climate action plan

Milestone Four: Implement the climate action plan

Milestone Five: Monitor progress and report results

Figure 15: ICLEI's Five Milestones for Climate Mitigation

ICLEI staff are available to local governments who are members and should be contacted to discuss the full range of resources available at each stage of the Milestone process. The following sections provide a glimpse at next steps and help capture the lessons learned in conducting this inventory.

Setting Emissions Reduction Targets

This inventory provides an emissions update that can be used to inform Milestone Two of ICLEI's Five-Milestone process—setting emissions reduction targets for Arcata's municipal operations. The greenhouse gas emissions reduction target is a goal to reduce emissions to a certain percentage below base year levels by a chosen planning horizon year. An example target might be a 30 percent reduction in emissions below 2005 levels by 2020. A target provides an objective toward which to strive and against which to measure progress. It allows a local government to quantify its commitment to fighting global warming—demonstrating that the jurisdiction is serious about its commitment and systematic in its approach.

In selecting a target, it is important to strike a balance between scientific necessity, ambition, and what is realistically achievable. Arcata should give itself enough time to implement chosen emissions reduction measures—noting that the farther out the target year is, the more Arcata should pledge to reduce. ICLEI recommends that regardless of the chosen long-term emissions reduction target (e.g., 15-year, 40-year), Arcata should establish linear interim targets for every two- to three-year period. Near-term targets facilitate additional support and accountability, and linear goals help to ensure continued momentum around local climate protection efforts. To monitor the effectiveness of its programs, Arcata should plan to re-inventory its emissions on a regular basis; many jurisdictions are electing to perform annual inventories. ICLEI recommends conducting an emissions inventory every three to five years.

The Long-Term Goal

ICLEI recommends that near-term climate work should be guided by the long-term goal of reducing its emissions by 80 percent to 95 percent from the 2005 baseline level by the year 2050. By referencing a long-term goal that is in accordance with current scientific understanding, Arcata can demonstrate that it intends to do its part towards addressing greenhouse gas emissions from its internal operations.

It is important to keep in mind that it will be next to impossible for local governments to reduce emissions by 80 to 95 percent without the assistance of state and federal policy changes that create new incentives and new sources of funding for emissions reduction projects and programs. However, in the next 15 years, there is much that local governments can do to reduce emissions independently. It is also important that Arcata works to reduce its emissions sooner, rather than later: the sooner a stable level of greenhouse gases in the atmosphere is achieved, the less likely it is that some of the most dire climate change scenarios will be realized. Additionally, cost saving projects can be undertaken now – why wait to increase the quality of local government service and operations, while reducing taxpayer costs?

State of California Targets and Guidance

An integral component of the State of California's climate protection approach has been the creation of three core emissions reduction targets at the community level. While these targets are specific to the community-scale, they can be used to inform emissions targets for government operations as well. On June 1, 2005, California Governor Schwarzenegger signed Executive Order S-3-05 establishing climate change emission reductions targets for the State of California. The California targets are an example of near-, mid- and long-term targets:

- Reduce emissions to 2000 levels by 2010
- Reduce emissions to 1990 levels by 2020
- Reduce emissions to 80 percent below 1990 levels by 2050

The AB 32 Scoping Plan also provides further guidance on establishing targets for local governments; specifically the Plan suggests creating an emissions reduction goal of 15 percent below "current" levels by 2020. This target has informed many local government's emission reduction targets for municipal operations—most local governments in California with adopted targets have targets of 15 to 25 percent reductions under 2005 levels by 2020.

Departmental Targets

If possible, ICLEI recommends that Arcata consider department-specific targets for each of the departments that generate emissions within its operations. This allows Arcata staff to do a more in-depth analysis of what is achievable in each sector in the near, mid and long-term, and also provides encourages department leaders to consider their department's impact on the climate and institute a climate-conscious culture within their operations.

Creating an Emissions Reduction Strategy

This inventory identifies the major sources of emissions from Arcata's operations and, therefore, where policymakers will need to target emissions reductions activities if they are to make significant progress toward adopted targets. For example, since waste water treatment was a major source of emissions from Arcata's operations, it is possible that Arcata could meet near-term targets by implementing a few major actions within the waste water treatment plant. Medium-term targets could be met by focusing emissions reduction actions on the municipal and public transit fleets as well as employee commutes. The long term (2050) target will not be achievable without major reductions in all of these sectors.

Please note that, whenever possible, reduction strategies should include cost-saving projects that both reduce costs (such as energy bills) while reducing greenhouse gas emissions. These "low hanging fruit" are important because they frequently represent win-win situations in which there is no downside to implementation. Selecting these projects in the

order of largest to smallest benefit ensures that solid, predictable returns can be realized locally. These projects lower recurring expenditures, save taxpayer dollars, create local jobs, and benefit the community environmentally.

Given the results of the inventory, ICLEI recommends that Arcata focus on the following tasks in order to significantly reduce emissions from its government operations:

- Investigate methods of reducing N_2O emissions as well as electricity and natural gas consumption from waste water treatment processes
- Implement a comprehensive municipal retrofit of existing buildings, particularly City Hall, the Police Department, and the Arcata Community Center
- Switch all public lighting, particularly associated with water storage, to energy efficient light bulbs
- Ensure vehicle procurement policy requires high fuel efficiency for each vehicle class within the existing Green Fleet Policy
- Reduce employee commute emissions. A first step could include an improvement in employee commute survey response rates.

Using these strategies as a basis for a more detailed overall emissions reductions strategy, or climate action plan, Arcata should be able to reduce its impact on global warming. In the process, it may also be able to improve the quality of its services, reduce costs, stimulate local economic development, and inspire local residents and businesses to redouble their own efforts to combat climate change.

Improving Emissions Estimates

One of the benefits of a local government operations emissions inventory is that local government staff can identify areas in their current data collection systems where data collection can be improved. For example, a local government may not directly track fuel consumption by each vehicle and instead will rely upon estimates based upon VMT or purchased fuel to calculate emissions. This affects the accuracy of the emissions estimate and may have other implications for government operations as a whole.

During the inventory process, this inventory identified the following gaps in data that, if resolved, would allow Arcata to meet the recommended methods outlined in LGO Protocol in future inventories.

- Catalog all HVAC, refrigeration and fire suppressant equipment including specific refrigerant and suppressant blends and capacities
- Document the volume of refrigerants recharged into HVAC and refrigeration equipment
- Track the volume of fire suppressants recharged into fire suppression equipment
- Add the volume and type of fuel consumed by individual vehicles to the cost which is already tracked. This includes vehicles using alternative fuels such as compressed natural gas and propane

- Add the volume and type of fuel consumed by mobile equipment to the cost which is already tracked
- Track the quantity of electricity used by electric vehicles so that it may be separated from building and facility electricity usage
- Track the volume of fuel consumed by diesel backup generators
- Track the quantity of refrigerants recharged into vehicles in the vehicle fleet during maintenance
- Document the volume of waste and recycling generated
- Track daily average nitrogen load from treated effluent discharge from the Waste Water Treatment Plant
- Track the percent volume of methane in digester gas produced from the Waste Water Treatment Plant
- Explicitly track fuel consumption and miles traveled from contracted services such as those from Arcata Garbage. This also includes tracking refrigerants from services such as on-site food vending machines.

ICLEI encourages staff to review the areas of missing data and establish data collection systems for this data as part of normal operations. In this way, when staff are ready to re-inventory for a future year, they will have the proper data to make a more accurate emissions estimate.

Project Resources

ICLEI created various tools for Arcata to use to assist with greenhouse gas emissions inventories. These tools are designed to work in conjunction with LGO Protocol, which is the primary reference document for conducting an emissions inventory. The following tools should be saved as resources and supplemental information to this report:

- The "Master Data Workbook", an Excel-based tool that contains most or all of the raw data (including emails), data sources, emissions, notes on inclusions and exclusions, and reporting tools
- The "Data Gathering Instructions", an instructions guide on the types of emissions and data collection methodology for each inventory sector.
- The "Quality Control Checklist for Master Data Workbook", a checklist which provides a list of items to review in the Master Data Workbook to ensure information was entered correctly.
- The "CACP 2009 Data Entry Instructions", an instructions guide on how to enter data collected in the Master Data Workbook into the Clean Air and Climate Protection Software (CACP 2009), ICLEI's greenhouse gas emissions calculator.
- The CACP 2009 "Backup" files, a group of files which contain the calculations of emissions based on inputs from the Master Data Workbook into CACP 2009. The CACP 2009 software is required to open the Backup files.
- The "Checklist for Reviewing the Government Analysis Inputs/Outputs, Details Export" a checklist which provides a list of items to review in this CACP 2009 export file to ensure information was entered correctly.

- CACP 2009 "Government Analysis Inputs/Outputs, Summary with Notes Export", an Excel-based export file which contains a summary report of all calculated emissions, with explanatory notes included.
- CACP 2009 "Government Analysis Inputs/Outputs, Details Export", an Excel-based export file which contains a detailed report of all calculated emissions.
- The "Completing the Inventory Report", an instructions guide from ICLEI on how to report greenhouse gas emissions according to the LGO Protocol.
- The "Charts and Tables Data Conditioning Sheet", an Excel-based tool created by ICLEI and completed by the author to aid in creating the charts and tables within the Master Data Workbook.
- A presentation with slides completed by the author to summarize findings from the greenhouse gas inventory

Appendix A

The City continuously works to implement energy saving features in its facilities and operations.[2] By implementing several simple and cost-effective measures, the City has effectively reduced energy consumption by as much as 30% in certain facilities since 2006. Some of these measures include:

- Replacing desk incandescent light bulbs with compact fluorescent bulbs in several City departments
- Upgrading water pump motors with energy efficient motors
- Installing skylights throughout City Hall to reduce the need for artificial lighting
- Installing programmable thermostats to control and reduce heating, particularly when a building is unoccupied
- Placing photocells in underutilized areas such as hallways to reduce unnecessary lighting
- Lighting upgrades:
    - Installation of high efficiency T-8 linear fluorescent lighting with low ballast factors
    - Installation of light-emitting diode (LED) exit signs
    - Installation of high-pressure sodium bulbs in exterior lighting

Other energy- and climate change-related activities that the City has undertaken are:

- Community Greenhouse Gas Reduction Plan (2006)
- Greenhouse Gas Inventory (2006)
- Pedestrian and Bicycle Master Plan (2010)
- Installation of electric vehicle charging station in downtown Arcata (2008)
- Installation of solar electric systems at City Hall and Arcata Marsh Interpretive Center (2005, 2008)
- Implementation of energy efficiency measures at City-funded low-income housing
- Installation of solar electric and solar hot water systems at City-funded low-income housing
- Waste reduction/diversion of 51 percent since 1990
- Participation in annual Plan It Green Conference
- Carbon Sequestration:
    - Arcata Community Forest management - Management Plan emphasizing carbon sequestration by growing trees on extended rotations, designating reserves and adding forest acres that could otherwise be developed.

[2] The majority of the text used in this review of Arcata's activities was taken from the city's website http://www.cityofarcata.org/departments/environmental-services.

- Riparian forest establishment - Established more than 100 acres of new riparian forest along creeks and bottomlands.
- Salt Marsh Project - The McDaniel Slough Marsh Restoration Project expects to sequester additional carbon on a 240-acre site. This project is a case study that will be used to help develop sequestration protocols for salt marsh restoration activities.
- Urban Forestry Program - Active program to expand planting of trees in the urban landscape including parks, roadside greenways, and the downtown area (i.e. The Plaza).

Arcata's Energy Policy

City policies that support energy efficiency, energy conservation, renewable energy, air pollution prevention, alternative transportation, and sustainable development:

- General Plan Chapter 4 Resource Conservation
- Land Use Code Energy Conservation and Solar Siting
- City of Arcata Community Greenhouse Gas Reduction Plan
- City of Arcata Energy Committee
- City of Arcata Green Fleet Policy
- City of Arcata Bicycle & Pedestrian Master Plan
- City of Arcata Anti-Idling Ordinance

Energy Committee

On April 5, 2000, the Arcata City Council adopted Ordinance No. 1305 creating the Energy Committee. The Committee's primary function is to make recommendations and provide information to the City Council and Commissions regarding energy efficiency, energy conservation and conversion to greener energy sources.

City of Arcata Greenhouse Gas Reduction Plan and Greenhouse Gas Inventory

A strong majority of the world's scientists have concluded that humans are changing the global climate primarily through the use of fossil fuels. This has serious consequences for all life on earth. In response, the City has joined an international effort to reduce greenhouse gas emissions and has committed to decrease locally generated greenhouse gas emissions by 20% below year 2000 levels by the year 2010.

To meet this goal, the City developed the *Community Greenhouse Gas Reduction Plan* in 2006 which set a greenhouse gas (GHG) emissions reduction target of 20% below 2000 GHG levels by 2010. The Plan was developed in part by analyzing an inventory of community-wide greenhouse gas emissions that was conducted in 2000, along with community-wide public input. The Plan focuses on six action areas:

- Energy efficiency
- Renewable energy
- Sustainable transportation
- Waste and consumption reduction
- Sequestration and other methods
- Cross-cutting approaches.

Greenhouse Gas Reduction Plan Update

Although the City has reduced emissions by 30% within the Municipal sector through energy efficiency upgrades and the installation of grid-tied, rooftop solar photovoltaic (PV) systems at City Hall and the Arcata Marsh Interpretive Center, overall energy use has not decreased within the residential, commercial, and industrial sectors, according to an update inventory of community-wide GHG emissions conducted in 2007. Despite this, the City continues to strive to reduce emissions and is developing additional GHG reduction targets to reflect the community's efforts.

- City of Arcata Community Greenhouse Gas Reduction Plan
- Community Greenhouse Gas Inventory

Cities for Climate Protection

The City worked closely with the Cities for Climate Protection Campaign of the International Council for Local Environmental Initiatives (ICLEI) on developing the climate program. The website for the ICLEI program inspired hundreds of cities across America to make commitments to reduce greenhouse gas emissions.

Arcata's Vehicle Fleet

The City of Arcata has been committed to 'greening' the municipal fleet since 2001 when the first "Green Fleet" Proclamation was passed. Today, the City has a total of fourteen alternative fuel vehicles running on compressed natural gas and electricity.

Additionally, in September of 2007 the City passed the "Green Fleet Policy," establishing fuel efficiency and alternative fuels as top priorities in vehicle procurement, and establishing a target fuel use reduction of 10% by 2015.

Solar Energy

The City of Arcata encourages its citizens to use renewable energy sources wherever possible. In an effort to lead by example, the City has installed two solar electric systems on City facilities. These include a 12.1 kilowatt (kW) grid-tied, rooftop solar photovoltaic (PV) system installed at City Hall and a 2.3 kW grid-tied, rooftop solar PV system at the Arcata Marsh Interpretive Center.