City of Livermore

Greenhouse Gas Emissions Analysis

2005 Community Emissions Inventory
&
2005 Municipal Operations Emissions Inventory

LIVERMORE
CALIFORNIA

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ICLEI
Local Governments for Sustainability

With generous support from the Stopwaste.org

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1. Introduction

1.1. Introduction and History

In 2007, the Livermore City Council adopted a resolution to join the Alameda County Climate Protection project, thereby committing the City of Livermore to taking action for climate protection. In doing so, the City joined all of the other local governments in Alameda County in committing to becoming a member of ICLEI. The project was launched by ICLEI in partnership with StopWaste.Org and the Alameda County Conference of Mayors.

Through this action, the City recognized that climate disruption is a reality and that human activities are largely responsible for increasing concentrations of global warming pollution. Through energy efficiency in its facilities and vehicle fleet, clean alternative energy sources, sustainable purchasing and waste reduction efforts, land use and transportation planning, preparing for sea level rise, and other activities, the City of Livermore can achieve multiple benefits, including lower energy bills, improved air quality, economic development, reduced emissions, and a better quality of life throughout the community.

This greenhouse gas emissions inventory represents completion of the first step in Livermore's climate protection process. As advised by ICLEI, it is essential to first quantify recent-year emissions to establish: 1) a baseline, against which to measure future progress, and 2) an understanding of where the highest percentages of emissions are coming from, and, therefore, where the greatest opportunities for emissions reductions are. Presented here are estimates of greenhouse gas emissions in 2005 resulting from the community as a whole, and from the City's government operations.

1.2. Climate Change Background

A balance of naturally occurring gases dispersed in the atmosphere determines the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Modern human activity, most notably the burning of fossil fuels for transportation and electricity generation, introduces large amounts of carbon dioxide and other gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface temperature to rise, which is in turn expected to affect global climate patterns.

Overwhelming evidence suggests that human activities are increasing the concentration of greenhouse gases in the atmosphere, causing a rise in global average surface temperature and consequent climate change. In response to the threat of climate change, communities worldwide are voluntarily reducing greenhouse gas emissions. The Kyoto Protocol, an international effort to coordinate mandated reductions, went into effect in February 2005 with 161 countries participating. The United States is one of three industrialized countries that chose not to sign the Protocol.

In the face of federal inaction, many communities in the United States are taking responsibility for addressing climate change at the local level. The City of Livermore might be impacted by changes to local and regional weather patterns and species migration. Beyond Livermore's borders, scientists also expect changing temperatures to result in more frequent and damaging storms accompanied by flooding and land slides, summer water shortages as a result of reduced snow pack, and disruption of ecosystems, habitats and agricultural activities.

Although one jurisdiction cannot independently resolve the issue of climate change, local governments can make a positive impact through cumulative local action. This is the impetus of the Alameda County Climate Protection Project. Cities and counties have the ability to reduce greenhouse gas emissions

through effective land use and transportation planning, wise waste management, and the efficient use of energy.

1.3. ICLEI Membership and the Five Milestones

By adopting a resolution committing the City to advancing climate protection locally, Livermore has joined an international movement of local governments. More than 800 local governments, including over 450 in the United States, have joined ICLEI. In addition to Livermore, all other Alameda municipalities and the County are ICLEI members, part of the 120 member California network (approximately 80 members are located in the Bay Area).

The Five Milestone Process provides a framework for local communities to identify and reduce greenhouse gas emissions, organized along five milestones:

(1) Conduct an **inventory** of local greenhouse gas emissions;

(2) Establish a greenhouse gas emissions **reduction target**;

(3) Develop a **climate action plan** for achieving the emissions reduction target;

(4) **Implement** the climate action plan; and,

(5) **Re-inventory** emissions to monitor and report on progress.

This report represents the completion of the first CCP milestone, and provides a foundation for future work to reduce greenhouse gas emissions in Livermore.

1.4. Sustainability and Climate Change Mitigation Activities in Livermore

<Instruction to jurisdiction: Enter climate protection activities here. Update of table of contents may be necessary >

2. City of Livermore 2005 Greenhouse Gas Emissions Inventory

2.1. Methods

ICLEI assists local governments in systematically tracking energy and waste related activities within their jurisdiction, and in calculating the relative quantities of greenhouse gases produced by each activity and sector. The greenhouse gas inventory protocol involves performing two assessments: 1) a community-wide assessment, and 2) a separate inventory of municipal facilities and activities. The municipal inventory is a subset of the community inventory.

Once completed, these inventories provide the basis for policy development, the quantification of emissions reductions associated with proposed measures, the creation of an emissions forecast, and the establishment of an informed emissions reduction target.

2.1.1. CACP Software

To facilitate community efforts to reduce greenhouse gas emissions, ICLEI developed the Clean Air and Climate Protection (CACP) software package in partnership with the State and Territorial Air Pollution Program Administrators (STAPPA), the Association of Local Air Pollution Control Officials (ALAPCO)[1], and Torrie Smith Associates. This software calculates emissions resulting from energy consumption and waste generation. The CACP software determines emissions using specific factors (or coefficients) according to the type of fuel used. CACP aggregates and reports the three main greenhouse gas emissions (CO_2, CH_4, and N_2O) in terms of equivalent carbon dioxide units, or CO_2e. Converting all emissions to equivalent carbon dioxide units allows for the consideration of different greenhouse gases in comparable terms. For example, methane (CH_4) is twenty-one times more powerful than carbon dioxide on a per weight basis in its capacity to trap heat; so the CACP software converts one metric ton of methane emissions to 21 metric tons of carbon dioxide equivalents.[2] The CACP software is also capable of reporting input and output data in several formats, including detailed, aggregate, source-based and time-series reports.

The emissions coefficients and quantification method employed by the CACP software are consistent with national and international inventory standards established by the Intergovernmental Panel on Climate Change (1996 Revised IPCC Guidelines for the Preparation of National Inventories) and the U.S. Voluntary Greenhouse Gas Reporting Guidelines (EIA form1605).

The CACP software has been and continues to be used by over 400 U.S. cities, towns and counties to reduce their greenhouse gas emissions. However, it is worth noting that, although the software provides Livermore with a sophisticated and useful tool, calculating emissions from energy use with precision is difficult. The model depends upon numerous assumptions, and it is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by the model as an approximation of reality, rather than an exact value. It should also be understood by policy makers, staff, and the public that the final total may change as new data, emissions coefficient sets, and better estimation methods become available.

2.1.2. Creating the Inventory

The greenhouse gas emissions inventory consists of two distinct components: one for the Livermore community as a whole defined by its geographic borders, and the second for emissions resulting from the City of Livermore's municipal operations. The municipal inventory is effectively a subset of the community-scale inventory (the two are not mutually exclusive). This allows the municipal government,

[1] Now the National Association of Clean Air Agencies (NACAA)

[2] The potency of a given gas in heating the atmosphere is defined as its Global Warming Potential, or GWP. For more information on GWP see: IPCC Fourth Assessment Report, Working Group I, Chapter 2, Section 2.10.

which has formally committed to reducing emissions, to track its individual facilities and vehicles and to evaluate the effectiveness of its emissions reduction efforts at a more detailed level. At the same time, the community-scale analysis provides a performance baseline against which Livermore can build policies and demonstrate progress for the Livermore community.

Creating this emissions inventory required the collection of information from a variety of sources, including the Pacific Gas and Electric Company (PG&E), Stopwaste.org, the Bay Area Air Quality Management District, the Metropolitan Transportation Commission, CalTrans, the California Integrated Waste Management Board, the California Energy Commission, Association of Bay Area Governments.

2.2. Inventory Results

2.2.1. Community Emissions Inventory

There are numerous items that can be included in a community scale emissions inventory, as demonstrated above. This inventory includes sources from the following sectors:

- Residential
- Commercial / Industrial
- Transportation
- Waste

Emissions by Sector

The community of Livermore emitted approximately *691,589 metric tons of CO_2e in the year 2005*. As visible in Figure 1 and Table 1 below, vehicles on roads and state highways in Livermore are by far the largest source of Livermore's community emissions (62.6%). Emissions from the built environment (residential, commercial and industrial sectors) account collectively account for around one-third (32.7%) of community emissions. The rest of Livermore's emissions are from waste sent to landfill (4.7%) by Livermore residents and businesses.

Figure 1 – *Community GHG Emissions by Sector*

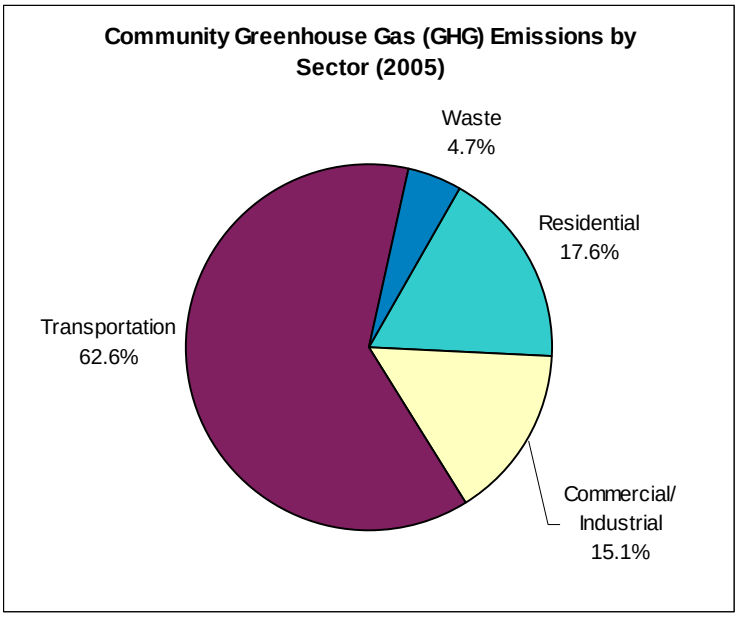


Table 1 – *Community GHG Emissions by Sector (metric tons CO_2e)*

2005 Community Emissions by Sector	Residential	Commercial/ Industrial	Transportation	Waste	TOTAL
CO_2e (metric tons)	121,572	104,183	433,051	32,783	**691,589**
Percent of Total CO_2e	17.6%	15.1%	62.6%	4.7%	**100.0%**
Energy Equivalent (MMBtu)	2,101,814	1,693,453	5,844,769	0	**9,640,036**

Transportation

Like the majority of jurisdictions in the Bay Area, the majority of the City of Livermore community emissions are from travel by motorized vehicles. This is also consistent with emissions across the State, as the California Air Resources Board has shown that passenger vehicles make up the single-largest source of emissions in the State.[3] As Table 1 and Figure 1 show, slightly less than two-thirds (62.6%) of the City's estimated emissions came from travel on local city roads and State highways. Overall, emissions from the transportation sector total 433,051 metric tons CO_2e.

Table 2 splits up emissions from the transportation sector into travel on local road and state highways. In 2005, the Metropolitan Transportation Commission (MTC) estimated that 448.4 million vehicle miles traveled (VMT) occurred on City of Livermore roads, emitting approximately 248,372 metric tons of CO_2e, or 57.4% of total emissions from the transportation sector. The 333.4 million vehicle miles traveled along state highways in the City accounted for 184,679 metric tons of CO_2e, or 42.6% of total emissions from the transportation sector.

Local Roads 2005 VMT data was obtained from CalTrans, which compiles and publishes statewide VMT data annually through the Highway Performance Monitoring System.[4] CalTrans obtains local roads VMT data from regional transportation planning agencies and councils of governments across the state. For the San Francisco Bay Area, CalTrans obtains data from the MTC. The MTC obtains data on local roads VMT either from the local governments within its jurisdiction or, if that data is unavailable, through a CalTrans model.

County level State Highways Vehicle Miles Traveled (VMT) 2005 data was obtained from the same CalTrans report listed above. This data was translated to the jurisdiction level data through a GIS analysis by ICLEI using an unpublished CalTrans dataset that was obtained from MTC.

The number of vehicles on the road, and the miles those vehicles travel, can be reduced by making it easier for residents to use alternative modes of transportation, including walking, bicycling, and riding public transportation. Please see the appendices for more detail on methods and emissions factors used in calculating emissions from the transportation sector.

Table 2 – *Transportation GHG Emissions by Road Type*

Transportation Road Type Emissions Sources 2005	Local Roads	State Highways	TOTAL
CO_2e (metric tons)	248,372	184,679	**433,051**
Percent of Total CO_2e	57.4%	42.6%	**100%**
Total Vehicle Miles Traveled	448,442,650	333,441,370	**781,884,020**

The Built Environment (Residential, Commercial, Industrial)

In 2005, 32.7 % of total community wide emissions came from the built environment, which is comprised of the residential, commercial and industrial sectors. Collectively, these sectors consumed about 555.1 million kWh of electricity and 19.0 million therms of natural gas, resulting in approximately 225,755 metric tons of CO_2e.

The City of Livermore receives its electricity from the Pacific Gas & Electric Company (PG&E). The 2005 emissions coefficients for electricity provided by PG&E are included in Appendix B. The types of

[3] California State Greenhouse Gas Emissions Inventory available at: http://www.arb.ca.gov/cc/inventory/data/tables/rpt_Inventory_IPCC_Sum_2007-11-19.pdf

[4] The 2005 report is available at: http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2005PRD.pdf.

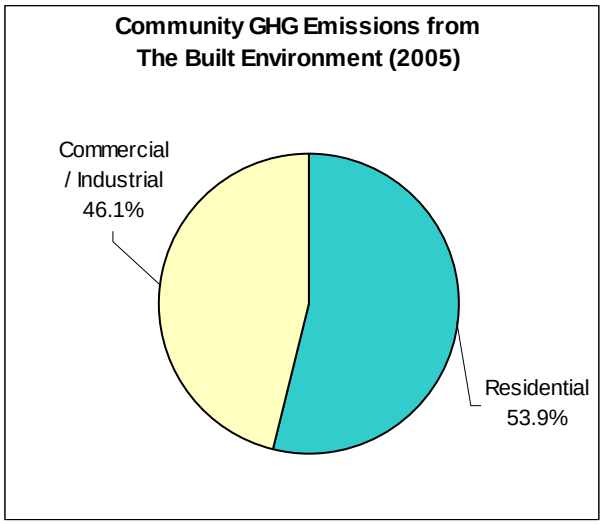
power sources that make up a utility's electricity generation mix have a significant impact on a city's greenhouse gas emissions. A coal fired power plant, for example, releases 1.3 tons of CO_2e per megawatt-hour of electricity generated versus 0.7 tons for gas turbines and 0 tons for renewable sources such as solar, wind, or hydroelectric power.

Livermore's emissions from the built environment are largely from the residential sector (53.9%), with the commercial and industrial sectors composing 46.1% of community stationary emissions (see Figure 2).

Residential

In 2005, Livermore's 78,000[5] residents consumed 223.3 million kWh of electricity, or about 8,125 kWh per household, and 13.4 million therms of natural gas, or about 488 therms per household[6]. When compared to the rest of Alameda County jurisdictions, energy consumption per household in the base year is significantly larger. While this is likely in part due to Livermore's location and more extreme temperatures, this suggests that Livermore may be able find significant reductions in greenhouse gas emissions by focusing on energy efficiency in its buildings. Overall, energy consumption in the residential sector resulted in a release of 121,572 metric tons of CO_2e. Major residential energy uses include refrigeration, lighting, air conditioning and heating, and water heating.

Figure 2 – *Stationary Sources Emissions*



Commercial/ Industrial

In 2005, Livermore's commercial and industrial sector buildings consumed 331.8 million kWh of electricity and 5.6 million therms of natural gas. This consumption resulted in a release of 104,183 metric tons of CO_2e into the atmosphere. Industrial natural gas and electricity consumption data is reported within this sector due to PUC confidentiality rules that prohibit the release of such data in certain cases.

Waste

In 2005, the City of Livermore sent approximately 119,385 tons of solid waste and 14,193 tons of alternative daily cover (ADC)[7] to landfill, resulting in a total of about 32,783 metric tons of CO_2e.

Emissions from the waste sector are an estimate of methane (CH_4) generation that will result from the anaerobic decomposition of the waste sent to landfill from community as a whole in the base year (2005). It is important to note that these emissions are not solely generated in the base year, but occur over the 100+ year timeframe in which the waste generated in 2005 will decompose. This "frontloading" of future emissions allows for simplified accounting and accurate comparison of the emissions impacts of waste disposed in each year. Therefore if the amount of waste sent to a landfill is significantly reduced in a future year, that year's emissions profile will reflect those reductions[8].

[5] Populations and household estimates are from ABAG's *Projections 2005.*

[6] Ibid.

[7] The California Integrated Waste Management Board defines ADC as "Alternative cover material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging."

[8] As the emissions reductions associated with decreasing the amount of waste being landfilled are real and there are usually few external variables that change those emissions levels later, this front-loading is considered to be an accurate practice for counting and reporting emissions that will be generated over time.

As some types of waste (e.g. paper, plant debris, food scraps, etc.) generate methane within the anaerobic environment of a landfill and others do not (e.g. metal, glass, etc.), it is important to characterize the various components of the waste stream. Alameda County is unique among California counties in that it conducted its own waste characterization study in the year 2000. ICLEI utilized this study to determine the average composition of the waste stream for all Alameda municipalities. The specific characterization of ADC tonnage was provided by the CIWMB via the Disposal Reporting System (DRS).

Most landfills in the Bay Area capture methane emissions either for energy generation or for flaring. The US EPA estimates that 60%-80%[9] of total methane emissions are recovered at the landfills to which the City sends its waste. Following the recommendation of the Alameda County Waste Management Authority, and keeping with general IPCC guidelines to err towards conservative estimation, ICLEI has adopted 60% as the methane recovery factor used in these calculations.

The tonnage of waste that is recycled, composted, or otherwise diverted from landfills is not directly inputted into CACP. The impact of such programs, however, is reflected in the CACP software model as a reduction in the total tonnage of waste going to the landfill (therefore reducing the amount of methane produced at that landfill). The CACP model does not capture the emissions reductions in "upstream" energy use from recycling (or any other emissions reduction practice) in the inventory. However, it should be noted that *recycling and composting programs can have significant additional impact on GHG emissions, as* manufacturing products with recycled materials avoids emissions from the energy that would have been used during extraction, transporting and processing of virgin materials.

Table 3 – *Community Waste Composition and Emissions by Waste Type*[10]

Waste Type	Paper Products	Food Waste	Plant Debris	Wood/ Textiles	All Other Waste	TOTAL
CO_2e (metric tons)	19,447	4,199	1,170	7,773	0	**32,589**
Percent of Total CO_2e	59.7%	12.9%	3.6%	23.9%	0.0%	**100%**
Percent of Total Tonnage Disposed	21.0%	8.0%	3.9%	29.6%	37.4%	**100%**

2.2.2. Community Emissions Forecast

Under a business-as-usual scenario, the City of Livermore's emissions will grow over the next decade and a half by approximately 30.6%, from 691,589 to 903,115 metric tons CO_2e. To illustrate the potential emissions growth based on projected trends in energy use, driving habits, job growth, and population growth from the baseline year going forward, ICLEI conducted an emissions forecast for the year 2020. Figure 3 and Table 4 show the results of the forecast. A variety of different reports and projections were used to create the emissions forecast.

Table 4 – *Community Emissions Growth Projections by Sector*

2005 Community Emissions Growth Forecast by Sector	2005	2020	Annual Growth Rate	Percent Change from 2005 to 2020
Residential	121,572	150,095	1.415%	23.5%
Commercial/ Industrial	104,183	170,450	3.336%	63.6%
Transportation	433,051	542,095	1.509%	25.2%
Waste	32,783	40,474	1.415%	23.5%
TOTAL	**691,589**	**903,115**	**--**	**30.6%**

[9] AP 42, section 2.4 Municipal Solid Waste, 2.4-6, http://www.epa.gov/ttn/chief/ap42/index.html
[10] Waste characterization study conducted by Stopwaste.org for the year 2000. This total does not include ADC.

Residential Forecast Methodology

For the residential sector, ICLEI calculated the compounded annual population growth rate[11] between 2005 and 2020, using population projections from ABAG's *Projections 2005.* The resulting growth rate (1.415%) was used to estimate average annual compound growth in energy demand. ABAG estimates that Livermore's population was 78,000 in 2005, and ICLEI's calculations predict a population of 96,300 in 2020, an overall population increase of nearly 25 percent.

Commercial / Industrial Forecast Methodology

Analysis contained within "California Energy Demand 2008-2018: Staff Revised Forecast[12]," a report by the California Energy Commission (CEC), shows that commercial floor space and the number of jobs have closely tracked the growth in energy use in the commercial sector. Using job growth projections for the City of Livermore from ABAG's *Projections 2005*, it was calculated that the compounded annual growth in energy use in the commercial sector between 2005 and 2020 will be 3.336%.

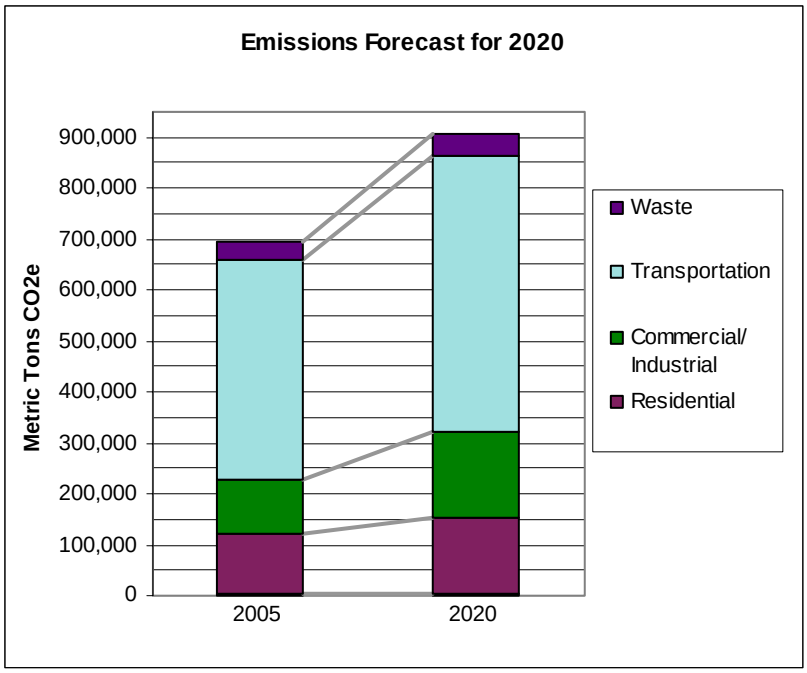
Transportation Forecast Methodology

In their report, "Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report," the CEC projects that on-road VMT will increase at an annual rate of 1.509% per year through 2020[13]. This is the number that was used to estimate emission growth in the transportation sector for the Livermore forecast. The recently passed federal Corporate Average Fuel Economy standards and the state of California's pending tailpipe emission standards could significantly reduce the demand for transportation fuel in Livermore. An analysis of potential fuel savings from these measures at a scale that would be useful for the purpose of this report has not been conducted, nor would such an analysis produce a true business-as-usual estimation. Regardless of future changes in the composition of vehicles on the road as a result of state or federal rulemaking, emissions from the transportation sector will continue to be largely determined by growth in vehicle-miles-traveled (VMT).

Waste Forecast Methodology

As with the residential sector, the primary determinate for growth in emission in the waste sector is population. Therefore, the compounded annual population growth rate for 2005 to 2020, which is 1.415%[14] (as calculated from ABAG population projections), was used to estimate future emissions in the waste sector.

Figure 3 – *Community Emissions Forecast*



[11] Compounded annual growth rate= ((2020 population/2005 population)^(1/15))-1

[12] http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF

[13] Report available at: http://www.energy.ca.gov/2007publications/CEC-600-2007-009/CEC-600-2007-009-SF.PDF. Compounded Annual growth rate for 2005-2020 is calculated from Table 4 on page 12. In light of recent fuel cost increases, the calculation assumes high fuel cost scenario.

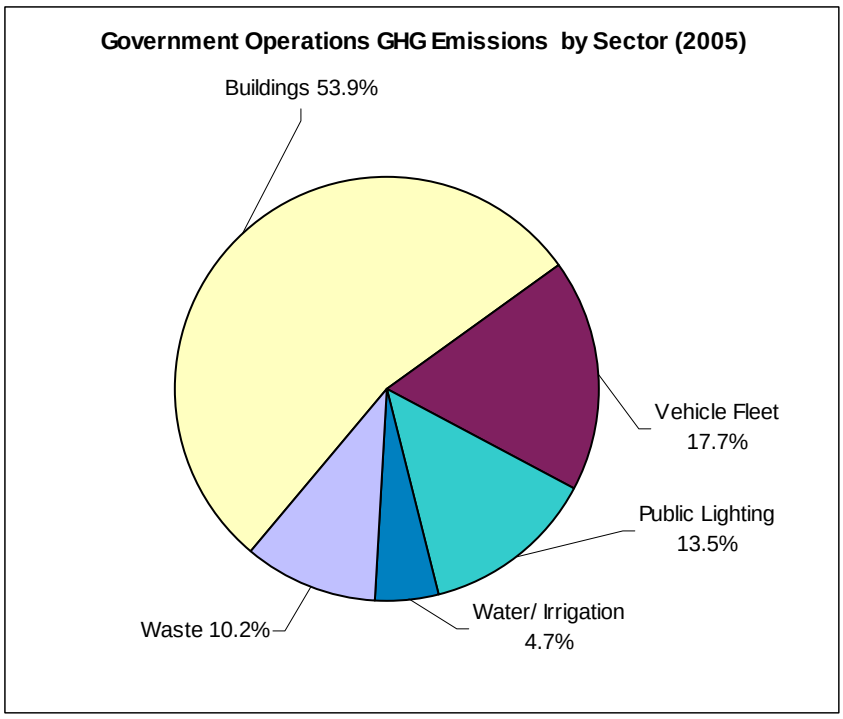
[14] Ibid

2.2.3. Government Operations Emissions Inventory

The sources of emissions that are being counted in the Government Inventory are facilities and equipment owned and operated by the City. The Government Operations Inventory includes sources from the following sectors:

- Facilities
- Vehicle Fleet
- Public lighting
- Water
- Solid Waste

Figure 4 – *Government GHG Emissions by Sector*



Emissions by Sector

Government operations in the City of Livermore emitted approximately *6,269 metric tons of CO_2e in the year 2005*.

As visible in Table 5 and Figure 4, the largest source of emissions from government operations is the City facilities, emitting (53.9%) of greenhouse gases. The City fleet is the second largest source of emissions, emitting about one-fifth (17.7%) of all emissions. [15] Emissions from electricity used for public lighting is also a significant source of emissions (13.5%), and waste created through government operations consists of 10.2% of the total emissions.. Electricity used for water pumps and irrigation controls makes up the remaining 4.7 % of total.

Table 5 – *Government GHG Emissions by Sector*

Government Emissions 2005	Buildings	Vehicle Fleet	Public Lighting	Water/ Irrigation	Waste	TOTAL
CO_2e (metric tons)	3,378	1,111	844	297	642	**6,272**
Percent of Total CO_2e	53.9%	17.7%	13.5%	4.7%	10.2%	**100.0%**
Energy Equivalent (MMBtu)	54,127	14,274	12,883	4,662	-	**85,946**
Cost ($)	$1,530,451	$255,034	$425,310	$136,972	-	**$2,347,767**

Energy Related Costs

In addition to generating estimates on emissions per sector, ICLEI has calculated the basic energy costs of various government operations. During 2005, the City of Livermore spent approximately $2.3 million on energy (electricity, natural gas, gasoline and diesel) for its buildings, public lighting and vehicles.[16] The large majority of costs were for energy usage by City facilities, with $1.5 million spent on natural gas and

[15] Due to the lack of available data, the majority of city vehicles were not included in this inventory. Actual emissions, fuel usage, and associated costs from the City fleet are therefore higher than reported in this report.
[16] See footnote 14. Due to lack of vehicle fleet data, $73,590 worth of fuel costs were not reported in the final totals.

electricity. Electricity for public lighting cost about $425,000 thousand, and fuel for the vehicle fleet roughly $255,000[17], while energy for water and irrigation cost just under $137,000.

Beyond reducing harmful greenhouse gases, any future reductions in municipal energy use have the potential to reduce these costs, enabling Livermore to reallocate limited funds toward other municipal services.

Facilities / Municipal Buildings

In 2005, Livermore municipal buildings and other facilities consumed about 11.8 million kWh of electricity and 138,378 therms of natural gas, which cost Livermore over $1.5 million and resulted in a release of 3,378 metric tons of CO_2e emissions into the atmosphere. As stated above, and as visible in Figure 4, emissions from municipal facilities constitute approximately 53.9% of total City emissions.

The City reported forty-five facilities, and a complete list of those facilities and their emissions is located in the Appendices. Table 6 shows energy consumption and emissions by facility groups. The Livermore Water Reclamation Plant was the largest energy consumer in the City, consuming nearly half of all the electricity of government facilities, and emitting 1,296 metric tons of CO_2e, or 38.4% of all facility emissions. The Livermore Police Station was also a significant source of greenhouse gases, emitting 30 % of all facility emissions. The libraries, airport buildings, administrative offices (including City Hall), corporation yards, and fire stations were also significant emitters.

Table 6 – *Energy Consumption and CO_2e Emissions from Facilities*

Facility Group	CO_2e (metric tons)	Percent of Total CO2e	Electricity Consumption (kWh)	Natural Gas Consumption (therms)	Energy Equivalent (MMBtu)	Total Cost ($)
Livermore Water Reclamation Plant	1,296	38.4%	5,797,231	0	19,785	$585,086
Police Department	1,013	30.0%	1,948,160	107,963	17,445	$367,282
Libraries	252	7.5%	1,056,209	2,859	3,891	$144,067
Airport Facilities	192	5.7%	826,872	1,293	2,951	$102,811
Administrative Buildings	169	5.0%	725,470	1,415	2,618	$96,530
City Yards	166	4.9%	508,960	9,673	2,704	$79,831
Fire Department Facilities	128	3.8%	274,252	12,563	2,194	$53,960
Golf Course/Park Facilities	24	0.7%	80,256	1,140	387	$13,652
All Other Facilities	138	4.1%	587,569	1,472	2,152	$87,232
TOTAL	**3,378**	**100%**	**11,804,979**	**138,378**	**54,127**	**$1,530,451**

City Vehicle Fleet and Mobile Equipment

As visible in Figure 4, in this inventory, the City's vehicle fleet was the second largest source of municipal emissions in 2005, with reported vehicles/equipment emitting 17.7% of the total emissions from government operations. The municipal fleet includes all vehicles owned and operated by the City of Livermore, as well as mobile equipment that uses fuel (such as trimmers, leaf blowers, etc.). For this inventory, direct fuel consumption data was not available. Fuel consumption was therefore estimated for 263 vehicles by using odometer readings for 2005 and calculating fuel consumption from fuel efficiency data and fuel costs per department. This inventory therefore did not include approximately 50 vehicles for which there was no mileage data, and approximately 180 pieces of mobile equipment (for which

[17] See footnote 14. Due to lack of vehicle fleet data, $73,590 worth of fuel costs were not reported in the final totals.

mileage data does not apply). It is therefore likely that emissions from the City fleet are much higher and may possibly account for the majority of the City's greenhouse gas emissions in 2005.

In 2005, vehicles included in the inventory traveled an estimated 1.5 million miles and emitted 1,111 metric tons CO_2e. Overall, fuel costs were $329,139 for all fleet and mobile equipment (including the $75,309 spent for fuel for vehicles and equipment not reporting CO_2e emissions). No breakdown of emissions is available per department. In addition, since not all departments did a complete reporting of their vehicles' mileage, it would not be appropriate to compare emissions from the various departments. Instead, ICLEI encourages Livermore to develop a common record keeping practice across City departments, and directly track fuel consumption per vehicle and equipment type in addition to odometer readings of vehicles. This can help the City to better understand its emissions, formulate appropriate emissions reductions policies, and possibly lead to cost reductions

Public Lighting

The category of public lighting includes all traffic signals, all sidewalk and other outdoor lighting, mixed lighting/irrigation accounts, and telephone booths in the City. In 2005, public lighting consumed about 3.77 million kWh of electricity at a cost of $425,310. This energy consumption resulted in a release of 844 metric tons of CO_2e emissions into the atmosphere. Table 7 breaks down energy use and emissions from public lighting by type. Over all categories of energy, across all sectors of municipal operation, public lighting generated about 13.5 % of emissions (Figure 4).

Table 7 – *2005 Public Lighting Emissions and Energy Use*

Lighting Type	CO_2e (metric tons)	Electricity Consumption (kWh)	Energy Equivalent (MMBtu)	Cost ($)
Traffic Signals/Controllers	118	528,573	1,804	$77,608.00
Streetlights	726	3,246,046	11,079	$347,702.00
TOTAL	**844**	**3,774,619**	**12,883**	**$425,310**

Water

The category of water includes all electricity used for pumping water and irrigation control. It does not include the Livermore Water Reclamation Plant; energy usage and emissions are reported in the Facilities section above. In 2005, the water infrastructure consumed about 1.2 million kWh of electricity and 7,244 therms of natural gas, which cost the City $136,972 and resulted in a release of 309 metric tons of CO_2e emissions into the atmosphere. Table 8 breaks down energy use and emissions from water and irrigation by type. As can be seen, electricity used for pumping water accounted for the significant majority of emissions from the water sector. Over all categories of energy, across all sectors of municipal operation, water and irrigation generated about 4.7 % of emissions (Figure 4).

Table 8 – *2005 Water Emissions and Energy Use*

Water Infrastructure Type	CO_2e (metric tons)	Electricity Consumption (kWh)	Energy Equivalent (MMBtu)	Cost ($)
Water pumps*	289	1,118,060	4,540	$123,923
Irrigation / Sprinkler Systems	8	35,773	122	$13,049
TOTAL	**309**	**1,153,833**	**4,662**	**$136,972**

*Water pumps also used some natural gas. See report text for details.

Solid Waste

Solid waste generated by City-owned facilities and infrastructure produced an estimated 10.2% (Figure 4) of the total emissions from government operations. As in the community analysis, these emissions are an estimate of future methane generation over the full, multi-year decomposition period of the waste generated in the year 2005.

In 2005, the City of Livermore sent approximately 1,591 tons of solid waste to landfill, resulting in a total of 642 metric tons of CO2e.

In the absence of a centralized disposal record like the CIWMB Disposal Reporting System, waste generation figures from government operations, as well as the characterization of government waste, were estimated by City of Livermore staff. Additionally, the final emissions number generated by the CACP software used the 60% methane recovery factor discussed above.

2.2.4. Government Operations Emissions Forecast

While the community emissions growth forecast is based upon known per capita energy consumption, workforce expansion, and population growth projections, the forecast of growth within municipal operations is based upon the expansion of City services or infrastructure. It was not within the scope of this project to estimate growth of City infrastructure or services, and, therefore, the government operations emissions forecast is not included. ICLEI advises that the City conduct such a forecast to be included in this report at a later date, and to inform the process of selecting an emission reduction target for City operations.

3. Conclusion

In passing a resolution to endorse the U.S. Conference of Mayors Climate Protection Agreement, the City of Livermore made a formal commitment to reduce its greenhouse gas emissions. This report lays the groundwork for those efforts by estimating baseline emission levels against which future progress can be demonstrated.

This analysis found that the Livermore community as a whole was responsible for emitting *691,589 metric tons of CO_2e in the base year 2005*, with the transportation sector contributing the most (62.6%) to this total. The City of Livermore's own municipal operations were responsible for *6,269 metric tons of CO_2e in the year 2005*, with the greatest percentage of emissions coming from City facilities.

In addition to establishing the baseline for tracking progress over time, this report serves to identify the major sources of Livermore emissions, and therefore the greatest opportunities for emission reductions. In this regard, the emissions inventory ought to inform the areas of focus within the Livermore Climate Action Plan.

Following the ICLEI methodology, we also recommend that the City of Livermore utilize the inventory to begin to consider potential greenhouse gas reduction targets for the community and for municipal operations.

4. Appendices

4.1. Appendix A: Forecast Data from ABAG's *Projections 2005*

Forecast Table 1 – ABAG Projections on Job Growth in Livermore

TOTAL JOBS					
JURISDICTIONAL BOUNDARY	**2000**	**2005**	**2010**	**2015**	**2020**
ALAMEDA	27,380	27,960	34,750	37,990	41,080
ALBANY	5,190	4,940	5,560	5,650	5,670
BERKELEY	78,320	76,890	79,080	80,580	81,690
DUBLIN	16,540	19,950	24,770	29,170	32,030
EMERYVILLE	19,860	20,140	21,460	21,750	21,900
FREMONT	104,830	96,530	105,060	119,360	136,770
HAYWARD	76,320	73,670	80,030	84,330	88,790
LIVERMORE	32,820	33,660	40,420	46,170	55,070
NEWARK	21,420	21,180	23,310	23,810	24,230
OAKLAND	199,470	207,100	223,490	235,030	250,260
PIEDMONT	2,120	2,120	2,140	2,160	2,190
PLEASANTON	58,670	58,670	66,050	72,020	73,410
SAN LEANDRO	44,370	42,790	44,840	50,460	54,380
UNION CITY	19,310	19,920	24,000	29,010	34,900
UNINCORPORATED	43,540	41,980	43,880	47,480	50,940

Forecast Table 2 – ABAG Projections on Population Growth in Livermore

TOTAL POPULATION					
JURISDICTIONAL BOUNDARY	**2000**	**2005**	**2010**	**2015**	**2020**
ALAMEDA	72,259	75,400	77,600	79,900	82,300
ALBANY	16,444	16,800	17,200	17,400	17,800
BERKELEY	102,743	105,300	107,200	109,500	111,900
DUBLIN	29,973	40,700	50,000	57,000	63,800
EMERYVILLE	6,882	8,000	8,800	9,300	9,900
FREMONT	203,413	211,100	217,300	226,900	236,900
HAYWARD	140,030	146,300	151,400	156,600	160,300
LIVERMORE	73,345	78,000	84,300	90,200	96,300
NEWARK	42,471	44,400	46,000	47,400	49,000
OAKLAND	399,484	414,100	430,900	447,200	464,000
PIEDMONT	10,952	11,100	11,200	11,200	11,200
PLEASANTON	63,654	68,200	72,600	76,500	80,400
SAN LEANDRO	79,452	82,400	84,300	87,500	90,800
UNION CITY	66,869	71,400	75,100	78,600	82,600
UNINCORPORATED	135,770	143,900	150,600	153,600	157,300

4.2. Appendix B: Emissions Factors Used in the Alameda County Climate Protection Partnership

Emission Factors:

Emission Source	GHG	Emission Factor	Emission Factor Source
PG&E Electricity	CO_2e	0.492859 lbs/kwh	The certified CO_2 emission factor for delivered electricity is publicly available at http://www.climateregistry.org/CarrotDocs/19/2005/2005_PUP_Report_V2_Rev1_PGE_rev2_Dec_1.xls
Default Direct Access Electricity	CO_2	343.3 short tons/GWh	ICLEI/Tellus Institute (2005 Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Coefficients)
	CH_4	0.035 short tons/GWh	
	N_20	0.027 short tons/GWh	
PG&E Natural Gas	CO_2	53.05 kg/MMBtu	PG&E/CCAR. Emission factors are derived from: California Energy Commission, Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999 (November 2002); and Energy Information Administration, Emissions of Greenhouse Gases in the United States 2000 (2001), Table B1, page 140.
	CH_4	0.0059 kg/MMBtu	CCAR. Emission factors are derived from: U.S. EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000" (2002), Table C-2, page C-2. EPA obtained original emission factors from the Intergovernmental Panel on Climate Change, Revised IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (1996), Tables 1-15 through 1-19, pages 1.53-1.57.
	N_20	0.001 kg/MMbtu	

Alameda County Transportation Sector Emission Factors:

CH_4 Rates (grams/mile)		N_2O Rates (grams/mile)		VMT Mix		CO_2 Rates- (grams/gallon)		Fuel Efficiency (miles/gallon)	
Gas	Diesel	Gas	Diesel	Gas (Passenger Vehicles)	Diesel (Heavy Trucks)	Gas	Diesel	Gas	Diesel
0.062	0.042	0.070	0.050	92.8%	7.2%	8,599	10,092	19.1	6.4

Provided by the Bay Area Air Quality Management District EMFAC Model

Alameda County Waste Sector Emission Factors:

Waste Type	Methane Emissions (tonne/tonne of waste disposed)	Sequestration (tonne/tonne of waste disposed)
Paper Products	2.138262868	0
Food Waste	1.210337473	0
Plant Debris	.685857901	0
Wood/Textiles	.605168736	0
All Other Waste	0	0

Methane recovery factor of 60% derived from the US EPA AP 42 Emissions Factors report (http://www.epa.gov/ttn/chief/ap42/index.html).

4.3. Appendix C: Waste Calculation Methodology

Emissions Calculation Methods

CO_2e emissions from waste and ADC disposal were calculated using the *methane commitment method* in the CACP software, which uses a version of the EPA WARM model. This model has the following general formula:

$CO_2e = W_t * (1-R)A$

Where:
W_t is the quantify of waste type 't',
R is the methane recovery factor,
A is the CO_2e emissions of methane per metric ton of waste at the disposal site (the methane factor)

While the WARM model often calculates upstream emissions, as well as carbon sequestration in the landfill, these dimensions of the model were omitted for this particular study for two reasons:

1) This inventory functions on a end-use analysis, rather than a life-cycle analysis, which would calculate upstream emissions), and

2) This inventory solely identifies emissions sources, and no potential sequestration 'sinks'.

4.4. Appendix D: Detailed CACP Report: Government Operations Greenhouse Gas Emissions in 2005 *(attached)*

4.5. Appendix E: Detailed CACP Report: Community Greenhouse Gas Emissions in 2005 *(attached)*