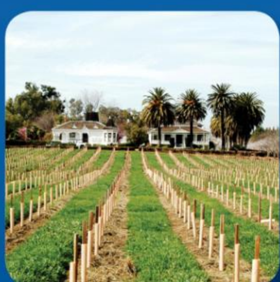
LIVERMORE CLIMATE ACTION PLAN

ADOPTED NOVEMBER 2012



LIVERMORE CALIFORNIA

ICF INTERNATIONAL

ICF International. 2012. *City of Livermore Climate Action Plan*. Adopted November 2012 (ICF 00079.10.) Sacramento, CA. Prepared for City of Livermore, Livermore, CA.

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EXECUTIVE SUMMARY

Introduction

In 2006, the California Legislature adopted Assembly Bill (AB) 32. AB 32, also known as the Global Warming Solutions Act of 2006, established a statewide reduction goal to reduce greenhouse gas (GHG) emissions back to 1990 levels by the year 2020. This goal was developed as a near-term 2020 reduction target in light of the understanding of the overall global reductions in GHG emissions needed to begin stabilizing carbon dioxide (CO_2) emissions by 2050. Based on the current understanding of climate science, substantive additional reduction effort will be required globally after 2020 in order to avoid the more catastrophic effects of climate change later in the century.

Consistent with the State of California's objectives outlined in AB 32, the City of Livermore (City) adopted Climate Change Goal CLI-1.1in its 2003 General Plan to reduce GHG emissions generated by the community to a level 15% less than 2008 levels in order to support State implementation of the Global Warming Solution Act (AB 32). Specifically, Policy CLI-1.1-P.1 requires the development of a Climate Action Plan (CAP) outlining a framework to reduce community GHG emissions in a manner that is supportive of AB 32.

> "The CAP shall include an inventory of the 2008 level of GHG emissions within the City. The CAP shall set out specific policies and actions to be undertaken by the City to reduce GHG emissions under the control of the City to a level 15% less than 2008 conditions[1] in order to support State implementation of AB 32. The policies and actions will include incentives, actions, and requirements to reduce the City's GHG emissions, the GHG emissions of the private sector, and actions that the City will take in concert with public agencies, the private sector, and other stakeholders to reduce GHG emissions. Development of the CAP will include a public and stakeholder process." (*2003 General Plan, page 12-12)*

This CAP represents the fulfillment of the initiative detailed in General Plan Policy CLI-1.1-P.1.

Overview of the Climate Action Plan

Purpose of the Climate Action Plan

The primary purpose of the CAP is to design a feasible strategy to reduce community-generated GHG emissions, consistent with statewide GHG reduction efforts for consideration and potential adoption by the City Council.

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[1] In 2008 the California Air Resource Board adopted the AB 32 Climate Change Scoping Plan (AB 32 Scoping Plan), which guides implementation of AB 32. The AB 32 Scoping Plan establishes a framework for reducing GHG emissions to 1990 levels by 2020, which is equivalent to approximately 30% below projected 2020 levels or about 15% below 2008 levels based on estimate emissions data available at the time of the Scoping Plan. Subsequent emissions inventory development by CARB indicates that 1990 levels are actually more equivalent to about 10% below 2008 levels. The Scoping Plan, however, still has an emission reduction target of 15% below 1990 levels by 2020 and still encourages local governments to adopt the same target to increase the likelihood of reaching it.

Development of the Climate Action Plan

In 2008, the City collaborated with the International Council for Local Environmental Initiatives (ICLEI) to develop a 2005 Community GHG Emission Inventory (2005 inventory). The 2005 inventory quantifies community emissions occurring in 2005 and forecasts those emissions, using "Business as Usual" (BAU) conditions, to 2020 based on expected population, employment, and housing growth. The Inventory informed development of the City's Climate Change Element, which identifies broad strategies to reduce GHG emissions under the control of, or that can be influenced by, the City. The Climate Change Element was adopted as a General Plan amendment by the City Council in March 2009 and includes a goal to reduce emissions by 15% below 2008 levels by 2020. This goal is still consistent with the statewide emission reduction targets established by the California Air Resources Board (CARB) even though subsequent inventory development by CARB indicates that 1990 levels are equivalent to 10% below statewide 2008 levels. The CARB Scoping Plan still recommends a 15% reduction for local communities.

In 2010, ICF International (ICF) updated the 2005 inventory to include several additional sectors, developed an estimate of 2008 emissions (2008 estimate) based on the 2005 inventory, and updated the 2020 forecast using the latest socioeconomic forecasts. The 2008 estimate was developed for the purpose of creating an emissions reduction goal consistent with the baseline year of 2008 described in General Plan Policy CLI-1.1-P.1. Because the City's goal is to reduce emissions by 15% below 2008 levels, the CAP needed a quantified estimate of emissions for the year 2008.

In 2010, the City began researching feasible measures that could be taken to reduce GHG emissions. An extensive list of GHG reduction measures was developed and reviewed by City staff and through public outreach in the spring and fall of 2011. A public meeting was held to solicit general feedback and targeted stakeholder outreach was conducted with a number of interest groups as well. Based on feedback provided by all parties, the City selected candidate measures to analyze in greater detail. The amount of GHG emissions that would be avoided in 2020 by each measure was subsequently calculated.

Costs associated with each measure were quantified, as feasible, to help identify the financial and economic impact of the measures. Other cobenefits, such as reduction in air pollution, were also identified for all measures. The City evaluated the methods of implementing different measures, including whether each measure should be implemented through incentive-based voluntary approaches or through new local mandates. Based on consideration of the GHG reduction effectiveness, financial and economic costs of measures, and cobenefits, the City identified a list of measures for inclusion in this CAP.

Livermore's Greenhouse Gas Emissions

GHG emissions from "community activities" include those occurring from activities within the City's jurisdictional boundary, and generally consist of sources of emissions that the City's community can influence or control. Emissions generated by the City's municipal operations (e.g., City-owned facilities, vehicle fleets) in 2005 are also subject to the CAP and subsumed in the overall 2005 community inventory. Municipal emissions represented approximately 2% of the City's emissions in 2005 (City of Livermore 2011).

The City inventoried GHG emissions from community activities occurring in 2005 and then forecasted those emissions to 2008 and 2020 based on population, housing, and employment growth (City of Livermore 2011). The 2005 inventory was developed using Clean Air and Climate Protection software and utilized methodologies and procedures approved by state and local air quality management agencies. The primary protocols consulted for the analysis are listed below.

- Local Governments Operations Protocol (LGOP) for the quantification and reporting of GHG emissions inventories (California Air Resources Board 2010a).
- 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC 2006).
- 2009 General Reporting Protocol (Version 3.1) for reporting entity-wide GHG emissions (California Climate Action Registry 2009).

The 2005 inventory includes GHG emissions that are either under the jurisdiction of the City or that occur in association with the land uses within the City limits. The 2005 inventory represents the *baseline* inventory, or the existing emissions level for CAP analysis purposes. As discussed above, the 2005 inventory was updated by ICF in 2011. All subsequent references to the 2005 inventory refer to the revised analysis (see Appendix B for additional details on the inventory revision).

The 2008 estimate is a projection of community emissions in 2008 based on the 2005 inventory calculations. Similar to a BAU scenario, the 2008 estimate does not include the effects of state and local action to reduce GHG emissions. The 2008 estimate was developed based on population, housing, and employment growth between 2005 and 2008. The CAP relies on the 2008 estimate to identify a GHG emissions reduction goal for the City.

The 2020 emissions projection is a prediction of how community emissions may change by 2020, in the absence of state and local actions to reduce greenhouse gases. The 2020 emissions projection is a BAU scenario and is based on the forecasted growth in City population, employment, and housing.

As is the standard practice, the annual GHG inventories are presented in metric tons (MT) of CO_2 equivalent (CO_2e) in all Livermore CAP figures and tables, unless otherwise denoted. Presenting inventories in CO_2e allows one to characterize the complex mixture of GHG as a single unit taking into account that each gas has a different global warming potential (GWP).

Baseline (2005) Greenhouse Gas Emissions

In 2005, the City 's community emissions were 411,937 MT CO_2e. This is equivalent to the annual GHG emissions generated by approximately 82,000 passenger vehicles[2] (U.S. Environmental Protection Agency 2011).

The largest source of emissions in 2005 is building energy emissions (including those from electricity and natural gas), of which 30% was from energy use in residential buildings and 25% was due to energy use in commercial and industrial buildings. The second largest source of community emissions in the 2005 inventory was transportation, which represented 36% of total community emissions in 2005 (see Table ES-1). Combined, transportation and energy emissions accounted for approximately 91% of total community emissions. The third largest source was solid waste

[2] Defined as 2-axle 4-tire vehicles, including passenger cars, vans, pickup trucks, and sport/utility vehicles.

management, with a contribution of 8% of the total 2005 emissions. The remaining sources included in the inventory were water conveyance (1%), and wastewater treatment (0.2%).

As a component of the 2005 inventory[3], the Livermore municipal government produced 7,095 MT CO_2e in 2005. This is equivalent to the annual GHG emissions generated by approximately 1,400 passenger vehicles (U.S. Environmental Protection Agency 2011). The largest source of emissions resulting from municipal operations was building energy use, which accounted for 48% of municipal emissions. The second largest source of municipal emissions was from transportation (i.e., the City's vehicle fleet), which represented 16% of municipal emissions in 2005. The third largest source was public lighting, with a contribution of 12% of the municipal emissions. Taken together, transportation and energy emissions from building use and public lighting accounted for 75% of total municipal emissions. The remaining sources in order of greatest contributions were wastewater treatment (12%), solid waste generation, (9%), and water conveyance (4%).

2008 GHG Emissions Estimate

The City's baseline community GHG emission inventory is for 2005. The City's GHG Policy CLI-1.1-P.1 sets a 2020 GHG reduction goal relative to the year 2008. An estimate of 2008 GHG emissions was performed by projecting the 2005 baseline inventory based on changes in jobs, population, and housing between 2005 and 2008. The 2008 GHG emissions estimate was used only to set the 2020 reduction goal; subsequent references to *baseline inventory* refer to the 2005 inventory.

2020 Business as Usual Forecast

By 2020, BAU community-wide emissions within the City are expected to reach 497,302 MT CO_2e, which is an increase of approximately 21% over 2005 levels and 17% over 2008 levels. The increase will occur primarily because of increases in VMT, building energy use, and solid waste generation. As population and employment in Livermore grow, transportation activity, energy consumption, and solid waste generation will consequently increase. As shown in Table ES-1, on-road transportation (37%), residential building energy use (28%), and commercial/industrial building energy use (26%) are expected to still be the largest emissions sources within the City in 2020.

The 2020 forecast was estimated using current land use data and projected data based on buildout of all potential development allowed for in the City's General Plan. This data was then compared with annual growth information from the most recent Association of Bay Area Governments projections. The forecast included growth in commercial, residential, and industrial square footage, housing types and units, households, and jobs. Although the forecast for 2020 includes current assumptions about growth that have factored in the economic downturn, it is possible that the 2020 forecast may still be somewhat optimistic. If population, employment and housing growth is less than that estimated at present, then the estimate of 2020 GHG emissions presented below may overestimate likely emissions levels in 2020.

Table ES-1 summarizes GHG emissions for each inventory sector in 2005 and 2020. Figure ES-1 provides a graphical representation of the values presented in Table ES-1. Additional detail on inventory assumptions and calculations are presented in Appendices A and B.

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[3] Municipal emissions are a subset of the larger community emissions and are included in the total emission values in the GHG Inventory.

Table ES-1. City of Livermore Community GHG Emissions: 2005 Inventory, 2008 Estimate, and 2020 BAU Forecast (MT CO_2e)[a, b]

	2005 Inventory		2008 Estimate		2020 Forecast	
Emissions Sector	**MTCO_2e**	**% of Total**	**MT CO_2e**	**% of Total**	**MT CO_2e**	**% of Total**
Transportation	147,327	36%	150,881	35%	182,643	37%
Water Conveyance	5,246	1%	5,374	1%	6,073	1%
Wastewater Treatment[c]	826	0.2%	846	0.2%	956	0.2%
Solid Waste Generation	32,783	8%	33,580	8%	37,948	8%
Residential Energy	121,572	30%	129,177	30%	140,726	28%
Commercial/Industrial	104,183	25%	106,320	25%	128,956	26%
Total Emissions	**411,937[d]**	**100%**	**426,177**	**100%**	**497,302**	**100%**

a. For more information, see Appendices A and B.

b. The calculations presented above contain a certain amount of uncertainty. Quantitative error analyses are complicated, require detailed statistical equations, and are outside the scope of the consultant's work. The U.S. Environmental Protection Agency (EPA) estimates an error range of -1% to 6% for the 2009 national inventory. Given that the City's 2005 inventory employed similar methods and analysis factors, a similar level of error can be expected, yielding an emissions range of 407,817 MTCO_2e to 436,653 MTCO_2e. Uncertainty associated with the 2020 forecast is likely higher due to the assumptions associated with future socioeconomic data.

c. Wastewater emissions include fugitive wastewater treatment emissions associated with incomplete combustion of digester gas and process emissions from effluent discharge. Emissions associated with export through the LAVWMA pipeline are included in the water conveyance sector.

d. Includes emissions generated from Municipal operations (see Table ES-2).

Although the emissions generated from Livermore municipal operations are included within the community emissions (Table ES-1), they have also been calculated separately in Table ES-2 for purposes of comparison and information.

Table ES-2. GHG Emissions from City of Livermore Municipal Operations: 2005 Baseline

	2005 (Municipal)		
Emissions Sector	**MT CO_2e**	**% of Total Municipal Emissions**	**% of 2005 Community Inventory**
Transportation	1,111	16%	0.26%
Water Conveyance	297	4%	0.07%
Wastewater Treatment[c]	826	12%	0.19%
Solid Waste Generation	642	9%	0.15%
Public Buildings	3,378	48%	0.80%
Public Lighting	844	12%	0.20%
Total Emissions	**7,095**	**100%**	**1.6%**

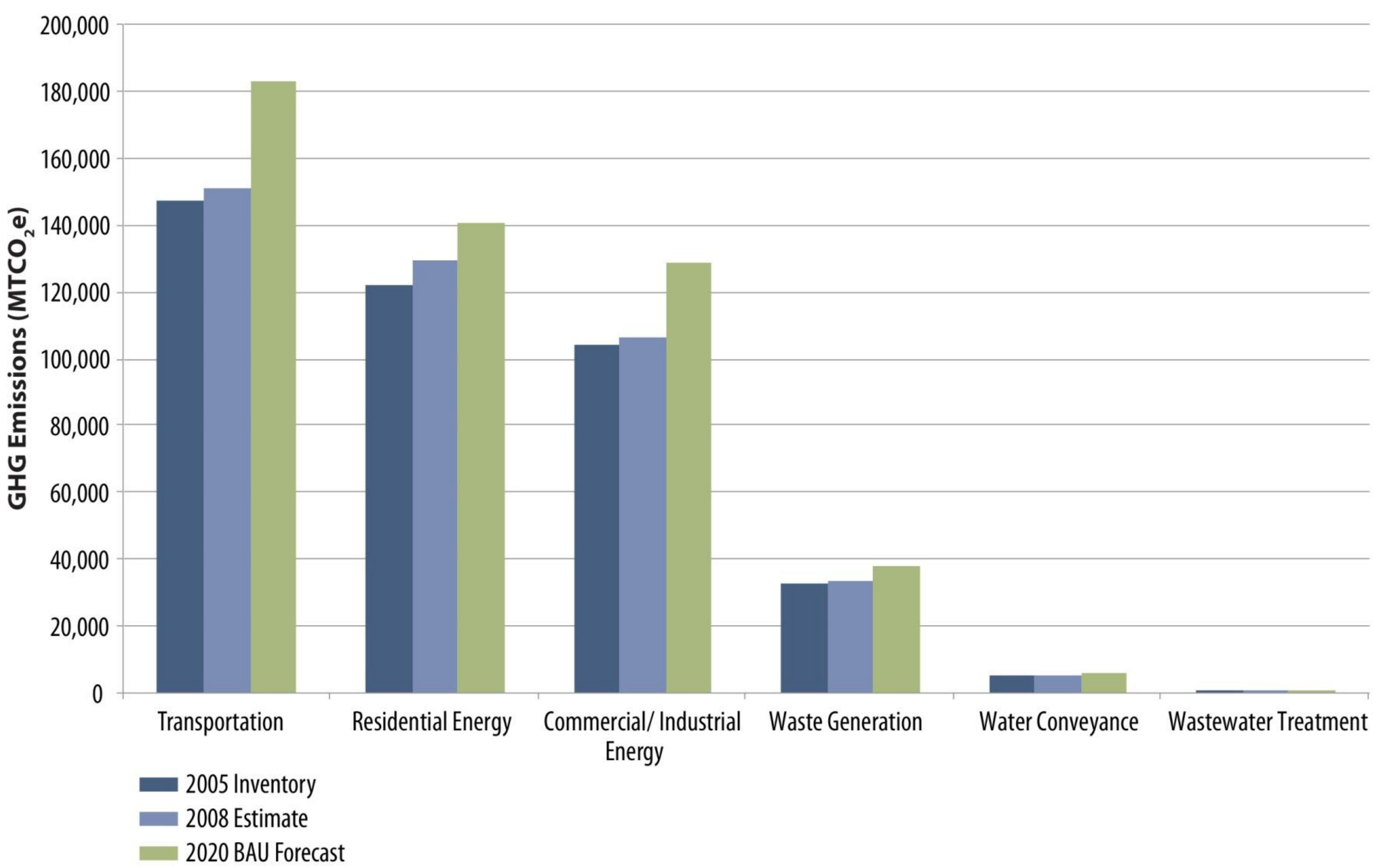


Figure ES-1. City of Livermore Community GHG Emissions: 2005 Inventory, 2008 Estimate, and 2020 BAU Forecast (MT CO_2e)

Livermore's Greenhouse Gas Emissions Reduction Target

CARB, which is the lead agency empowered to implement AB 32, adopted the AB 32 Scoping Plan in December 2008, which is a policy document outlining the State's approach to meeting the AB 32 GHG reduction targets. The AB 32 Scoping Plan recommends, but does not require, an emissions reduction goal for local governments of 15% below "current"[4] emissions to be achieved by 2020 (California Air Resources Board 2008). Based on this recommendation, the City identified a GHG emissions reduction goal of 15% below 2008 levels for the purposes of CAP development.

As shown in Table ES-1, the estimated community emissions level in 2008 is 426,177 $MTCO_2e$. To achieve the target of 15% below 2008 emissions, the City would need to limit emissions by 2020 to 362,251 $MTCO_2e$. Based on the 2020 BAU forecast of 497,302 MT CO_2e, Livermore will need to reduce community emissions by 135,051 $MTCO_2e$ over the next 8 years to achieve the emissions reduction target. Because there is some uncertainty in the precise levels of reduction that would be achieved in practice, it is considered wise to plan for a slightly higher reduction than the target to provide a higher level of confidence that the target can be achieved.

It should be noted that CARB made its recommendation in the AB 32 Scoping Plan based on emission estimates as they were available in 2008. Subsequent preparation of actual emissions inventories by CARB indicates that statewide emissions will need to be reduced by about 10% below 2008 levels to reach 1990 levels. CARB's Scoping Plan, which is the State's policy for implementing AB 32, still calls for reducing California's GHG emissions approximately 15% from 2008 levels, and encourages local governments to adopt a similar reduction target. A 15% reduction from 2008 levels will increase the likelihood of reaching the State's reduction target by 2020 given that there is some uncertainty in the level of economic growth by 2020 and some uncertainty in the precise effectiveness of state and local reduction efforts.

Livermore's Greenhouse Gas Reduction Plan

Overview of the Greenhouse Gas Reduction Measures

The City's CAP includes existing state and proposed local measures that would result in GHG emission reductions within the community.[5] The State mandates will result in GHG reductions without additional local legislative or administrative action, but may require local effort to implement. For example, the City already has adopted and implemented the Uniform Building Code, which includes statewide energy efficiency mandates that new buildings must include additional energy efficient improvements. State commercial recycling mandates will require greater effort in recycling for commercial and municipal buildings. The City could also pursue new state incentives for energy-efficient lighting..

[4] "Current" as it pertains to the AB 32 Scoping Plan is commonly understood as sometime between 2005 and 2008.

[5] At present, the only federal mandate that would specifically reduce GHG emissions in Livermore are the Corporate Average Fuel Economy (CAFE) standards. These standards were adopted to be consistent with previously passed California vehicle efficiency standards per AB 1493 (Pavley). As a result, these standards are subsumed in the state regulations.

To supplement statewide initiatives, the City has identified a series of local reduction measures that are either currently being implemented, or that would be implemented by the community. The reduction measures can be grouped into eight broad emission sectors, which would affect emissions throughout community activities. The measures include programs that improve building energy efficiency beyond statewide mandates, increase transit and alternatives to vehicular travel, increase use of renewable energy, reduce water conveyance and waste, and other measures. Table ES-3 summarizes the GHG reduction measures included in the CAP.

Table ES-3. Summary of City of Livermore Local GHG Reduction Measures

Measure Number	Measure Description
Building Energy	
Energy-1	Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings
Energy-2	Energy Efficiency Voluntary Programs for Existing Commercial Development
Energy-3	Exceed Title 24 Requirements for New Buildings
Energy-4	Streetlights
Renewable Energy	
Energy-5	Voluntary Residential and Non-Residential Rooftop Solar
Energy-6	Voluntary Solar Over Parking Areas Program
Land Use and Transportation	
On Road-1	Idling Restrictions
On Road-2	Transit Oriented Development
On Road-3	Transit Enhancements
On Road-4	Traffic Signal Synchronization
On Road-5	Bicycles and Pedestrian Improvements
On Road-6	Car Sharing Programs
Water Conveyance	
Water-1	Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels[a]
Wastewater Treatment	
Wastewater-1	Aeration Diffuser
Solid Waste Generation	
Waste-1	Waste Diversion
Urban Forestry and Conservation	
Urban Forestry-1	Urban Shade Trees
Municipal Programs[b]	
Mun-1	Municipal Energy-Efficiency Actions

[a] Water-1 will reduce water consumption, which will likewise contribute to reductions in building energy. For example, efficient faucets that use less water require less electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Emissions reductions achieved by Water-1 through reduced water conveyance are reported in the water sector.

[b] Emissions reductions achieved by Mun-1 are not included in the emissions reduction goal because the City is still evaluating potential measures. In addition, the benefit of these measures overlaps with other community reduction measures in the energy sector. See Chapter 3 for further discussion.

Greenhouse Gas Emissions Reductions

Approximately 69% of the reductions needed to achieve the City's GHG reduction goal are achieved through state-level programs, and 31% through local measures. The largest GHG reductions are identified in the areas of building energy (both energy efficiency and renewable energy), water, and waste (Table ES-4 and Figure ES-2).

Table ES-4. Summary of GHG Emissions Reductions Achieved through Measures (by Sector)

	Emission Reduction ($MT\ CO_2e$)	Percent of Total Reduction (%)
State Programs	**101,797**	**72.9%**
Local Programs		
Building Energy Use[a]	20,825	14.9%
Transportation and Land Use	3,421	2.4%
Water Conveyance	1,089	0.9%
Wastewater Treatment	38	0.03%
Solid Waste Generation	12,307	8.8%
Urban Forestry and Conservation	176	0.1%
Subtotal for Local programs	**37,857**	**27.1%**
Total Reductions	**139,654**	**100.0%**

[a] Includes both energy efficiency and renewable energy measures that would reduce GHG emissions associated with building energy use. In addition, emissions reductions associated with reduced water heating from water conservation measures (see Water-1) have been included in the building energy total.

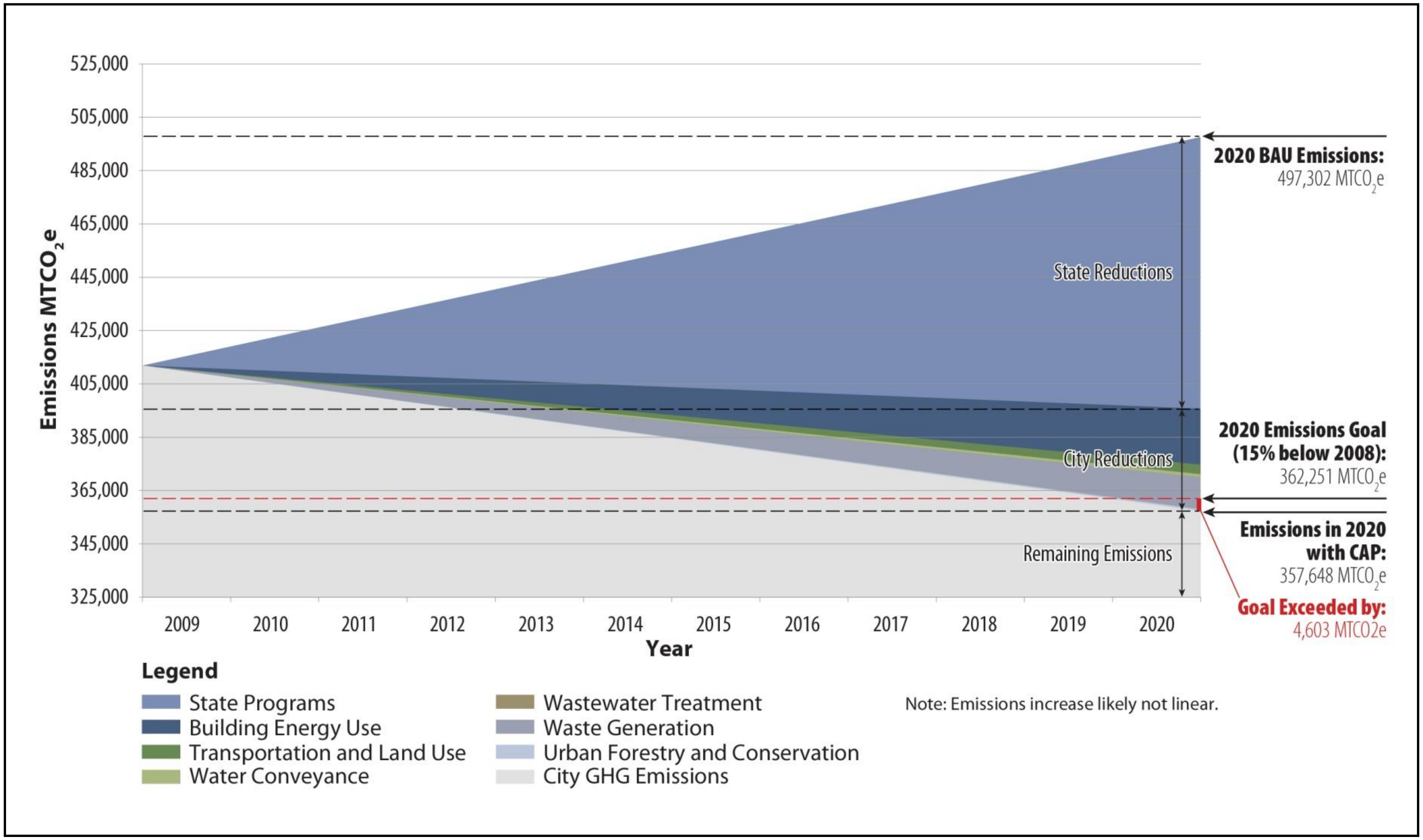


Figure ES-2. Summary of GHG Emissions Reductions Achieved through Measures (by Sector) (MT CO_2e)

The measures described in this CAP outline a path for reducing community emissions in conjunction with planned state actions. When combined with state efforts, the GHG reduction measures described in the City's CAP would enable the City to reduce its community GHG emissions by an estimated 139,654 $MTCO_2e$, which exceeds the emission reduction target of 15% below 2008 level of 135,051 $MTCO_2e$. Actions not currently quantified (see Chapter 4), as well as local effects of the state's cap-and-trade program,[6] may contribute additional reductions to the City's goal.

Local GHG reduction measures are discussed further in Chapter 3 of the CAP and the methodology used to quantify the measures is presented in Appendix C.

Cost-Benefit Assessment

A quantitative and qualitative cost/benefit assessment was done for the GHG reduction measures and is included in this Plan in Chapter 4. Wherever possible, operational costs and savings associated with implementation were identified for each reduction measure in order to present their cost effectiveness in terms of dollars per ton of GHG reduced. An analysis of additional benefits derived by implementing each GHG reduction measure was also done. Chapter 4 presents the estimated costs and savings for the City government and for the private sector.

The cost-benefit assessment is discussed further in Chapter 4, and the methodology used to develop the analysis is presented in Appendix C.

Costs and Savings

The City has designed the CAP to rely, for the most part, on voluntary, incentive-based measures for existing development, and only uses mandatory measures for new development where required by prior state or local mandates (such as for water conservation) or where consistent with prior City practice (such as in updating the Green Building Standards Code over time to "stay ahead" of state required minimums). By providing flexibility, the intent is that the City government, residences, and businesses would employ the most cost-effective methods to reduce GHG emissions.

The City of Livermore, private residents and businesses, and other public sector agencies (such as school districts) would incur costs to implement GHG reduction measures, but in many cases, they would also realize long-term savings resulting from reduced energy and maintenance costs that can help recoup initial investments. In the building energy sector, costs would be borne by building owners to upgrade to energy efficient technologies. In the transportation sector, many of the measures involve capital improvement projects and operational improvements that would be funded through a mix of local, state, and federal funding sources. Some of the proposed measures are already being implemented by staff, such as applying the Green Building Standards, and

[6] The effects of California's cap-and-trade system, which will take effect starting in 2013, are not analyzed in this CAP. However, it is expected that by 2020, the cap-and-trade system will result in additional reductions in the building energy and transportation sectors due to changes in energy prices directly (at the consumer level) or indirectly (at the producer level). It has been estimated that the cap-and-trade system might result in the following energy price changes by 2020: electricity (increase of 1% to 3%); natural gas (increase of 7% to 16%); gasoline (increase of 4% to 8%) and diesel (increase of 2% to 4%) (Source: CARB, Proposed Cap and Trade Regulation, Appendix N: Economic Analysis, 2010, Table N-3). Consumer response to these changes in energy prices might result in additional reductions in building energy and transportation fuel consumption beyond those included in this CAP, but the amount of reductions cannot be estimated at this time.

transitioning to energy-efficient street lighting. Capital costs associated with measures that are planned or are already being implemented by the City would be programmed into the City's CIP and therefore would not represent an additional cost to the City. To the greatest extent possible, CAP implementation would be folded into existing procedures and would use existing staff resources.

Implementation costs for the City government would be associated with staff time to complete the following.

- Evaluate new tasks and existing staff and resources available to assist.
- Develop policy, procedures and/or ordinance changes as needed for new programs.
- Identify potential private and funding sources that could be used to fund measures.
- Develop a community outreach and education program that uses existing resources wherever possible, such as the City's newsletter, website and other social media venues.
- Identify potential data sources for use in monitoring community progress towards meeting the GHG emission reduction target.

Some of the most cost-effective measures—and the biggest GHG reductions—can be found in the building energy sector. For example, investments to upgrade to energy efficient lighting and improve the energy efficiency of existing buildings can have immediate or short payback times through reduced energy bills. Other measures have longer-term payback periods but can still have a net savings overall (i.e., their costs can be fully recouped in a reasonable amount of time). Other measures would represent net costs in the long-term, based on current energy prices, but may have shorter payback periods if energy prices increase in the future.

Benefits

In addition to the expected GHG emission reductions, many of the measures included in the CAP would result in long-term economic, environmental, health and other co-benefits for the City and its residents and businesses.

Implementing the CAP would avoid the generation of approximately 139,654 $MTCO_2e$ in 2020, which is equivalent to the following actions (U.S. Environmental Protection Agency 2011).

- Removing over 27,000 passenger vehicles from the road each year.
- Reducing annual gasoline consumption by more than 15.6 million gallons (assuming a California average of $4.00/gallon of gasoline, this equates to over $62 million less spent on gasoline per year)[7].
- Consuming nearly 325,000 fewer barrels of oil each year.

Implementing the CAP would reduce the generation of criteria air pollutants in Livermore, including ozone, carbon monoxide, and fine particulates, which would improve public health for the community. Residences and businesses that implement energy efficiency upgrades as a result of this plan would see future savings due to lower future energy bills. Transportation improvements included in this plan would increase mobility and alternative modes of transportation for residents and visitors. Water improvements included in this plan promote wise use of limited water resources and enhance water quality. Waste reductions included in this plan would reduce the need for landfill

[7] Note that this value likely underestimates actual savings as the price of fuel is expected to increase in the future.

space. Other benefits of this plan includes reduction of electricity, natural gas, and gasoline usage which reduces consumer sensitivity to potential increases in future energy prices. Reduction of gasoline consumption also has an additional benefit of reducing dependence on foreign oil supplies. Adoption of the CAP would also promote a more streamlined environmental review process, as future projects would simply need to detail compliance with the CAP rather than Bay Area Air Quality Management District (BAAQMD) thresholds when documenting project impacts associated with GHG emissions.

Benefits are discussed further in Chapter 3 and identified for each measure in Appendix C. The cost-benefit analysis will also examine the potential for job creation as a result of Plan implementation.

Implementing the Plan

Meeting the City's emissions reduction target would require participation of both City government and the community at large. The CAP sets a path for achieving the City's target through a collective initiative that would support streamlining efforts and education and outreach efforts to promote integrating new policies into a variety of decisions affecting the City's future.

To facilitate implementation of the CAP, the City has outlined key priorities for three implementation phases starting in 2012 and ending in 2020. Measures to be implemented in each phase are described in Chapter 4.

Phase 1 (2012–2014). During this phase, the City would evaluate tasks needed and existing staff resources available to assist with implementation of measures. For any new programs, staff would develop key policies, procedures and ordinance revisions as needed. The funding sources identified in the CAP would also be reviewed for applicability and to link potential funding opportunities to identified tasks. Implementation priorities would also be established dependent on availability of resources. Staff would also begin developing an education and outreach program that identifies ways to promote CAP measures and generate community involvement using existing resources and social media opportunities.

The City would develop a CAP Implementation Team (CIT), consisting of City staff, to support implementation of the GHG reduction measures. The CIT would be composed of members of various City departments, including Community Development, Public Works, and others as appropriate. The primary function of the CIT Committee would be to create a streamlined approach to manage implementation of the CAP. The CIT would also coordinate periodic community outreach to leverage community involvement, interest, and perspectives.

Phase 2 (2015–2017). The City would update the community GHG inventory to monitor emissions trends during the latter part of this phase. As a member of ICLEI, the City will avail itself of the resources, software, and expertise of this organization to minimize costs and conduct the update in-house. The City would conduct a mid-course evaluation of CAP implementation to examine progress made toward meeting the City's reduction target, to examine the effectiveness of the measures in the CAP, and to examine the City's current economic condition to determine if additional or different measures should be adopted and whether the City's reduction target would need to be revised. During Phase 2, the City would continue to implement measures based on their prioritization during Phase 1.

Phase 3 (2018–2020). The City would continue to implement and support measures begun in Phases 1 and 2, and encourage implementation of all remaining CAP measures (Phase 3 measures). An analysis of the effectiveness of Phase 1 and 2 measures would be conducted, as well as an update to the community GHG inventory. The City would begin developing a plan for post-2020 actions.

Successful implementation of the CAP will require reallocation of existing staff time to implement measures that are not already underway. Specifically, the City would establish a timeline and prioritization scheme for measure implementation. Measure prioritization would be based on a number of factors, including cost effectiveness, GHG reduction efficacy, and general benefits to the community, and availability of funding. A cost analysis is included as part of this CAP and potential financial sources have been identified. As part of Phase I, the City will identify funding opportunities and available resources, leveraging as much as possible the participation and support of the private sector, non-governmental organizations, and regional, state, and federal partners to implement priority measures.

Citizen and business participation in Livermore are integral to the success of the CAP. Their involvement is essential, considering that several measures depend on the voluntary commitment, creativity, and participation of the community. The City would help to educate stakeholders, such as businesses, business groups, residents, developers, and property owners about the CAP and encourage participation in efforts to reduce GHG emissions.

Once the GHG reduction measures have been implemented, regular monitoring is important to ensure reduction measures are functioning as they were originally intended. Early identification of effective strategies and potential issues would enable the City to make informed decisions on future priorities, funding, and scheduling. Moreover, monitoring provides concrete data to document the City's progress in reducing GHG emissions.

It is anticipated that monitoring the achievement of reduction measures and utilizing the existing GHG inventory to analyze the overall effectiveness of the CAP would occur in Phases 2 and 3 (approximately 2017 and 2019, respectively). The results of this monitoring would be used to examine GHG reduction progress and would allow for adaptive management of the CAP. The City would develop a detailed protocol for monitoring the effectiveness of emissions reduction measures. The City would also establish guidelines for reporting and documentation, from which the CIT would make periodic reports to the City Council. Tools to assist in this effort, available at no cost to the City from the Statewide Energy Efficiency Collaborative (SEEC), would be utilized for this effort. The SEEC provides education and tools for climate action planning and technical assistance to local agencies seeking to reduce greenhouse gas emissions and energy use.

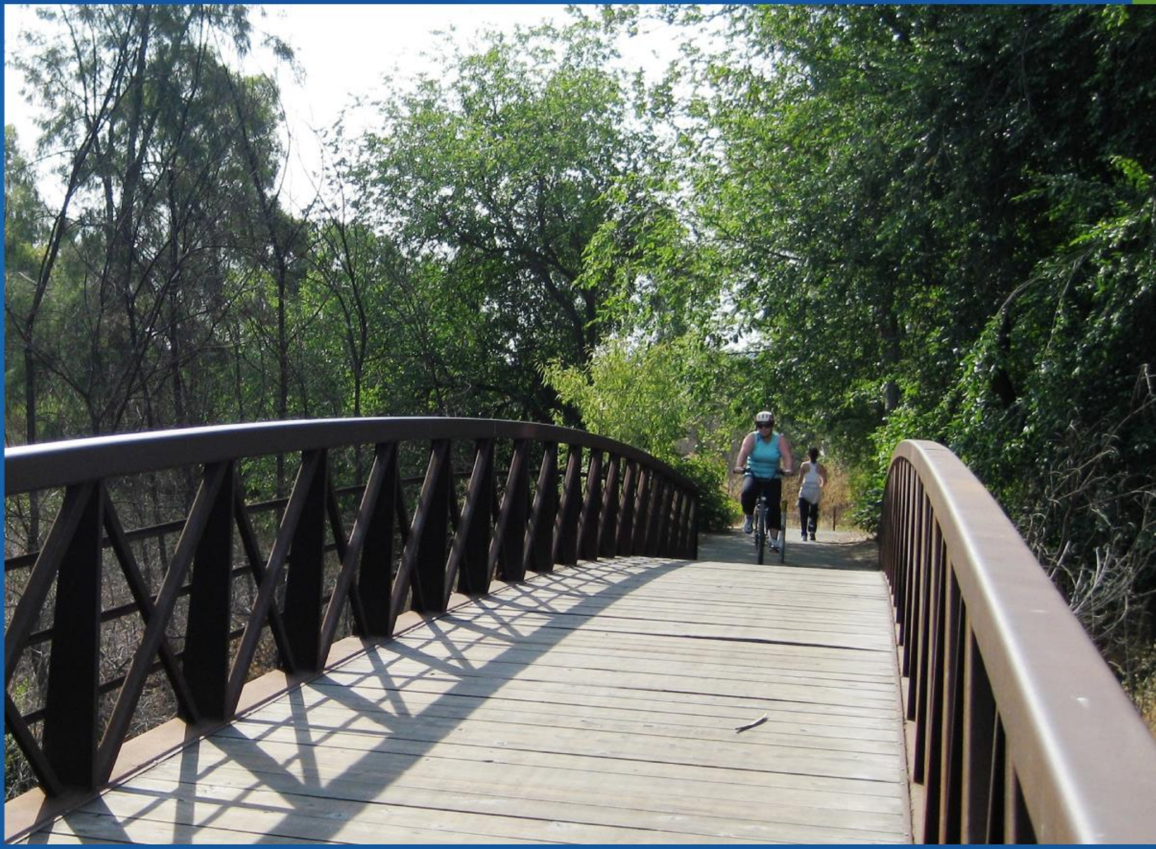
While AB 32 focuses on a 2020 target for California, the State has also adopted Executive Order (EO) S-03-05, which articulates a GHG reduction goal for the State to reduce GHG emissions to a level that is 80% below 1990s emissions by the year 2050. It is reasonably foreseeable that as California approaches its first milestone in 2020, focus will shift to the 2050 target. Consistent with statewide planning trends, the City would consider commencement of planning for the post-2020 period in Phase 3 (2018). By the time Phase 3 begins, the City would have implemented the first two phases of the CAP and would have a better understanding of the effectiveness and efficiency of different reduction strategies and approaches.

Organization of the Climate Action Plan

The City of Livermore CAP is organized into the following five chapters.

- **Introduction**. Provides an overview of climate change, global warming, and recent state and local legislation relevant to the City's CAP.
- **City of Livermore's GHG Emissions Inventories and Estimates.** Summarizes GHG emissions that were generated by community activities in 2005 and presents an estimate of emissions in 2008, and 2020.
- **City of Livermore's Emissions Reduction Plan**. Summarizes individual GHG reduction measures and presents estimates of their GHG reduction potential and cost effectiveness.
- **Implementation Strategies**. Includes a timeframe for future plan updates, recommendations for data collection and record keeping, and recommendations for long-term management.

1. INTRODUCTION



1.1 Overview of the Climate Action Plan

AB 32 codified the state's GHG emissions target by requiring that the state's global warming emissions be reduced to 1990 levels by 2020. The Scoping Plan for AB 32 identifies specific measures to reduce GHG emissions to 1990 levels by 2020, and articulates a key role for local governments, recommending they establish GHG reduction goals for both their municipal operations and the community consistent with those of the state. In support of AB 32, the City of Livermore has taken significant, voluntary steps towards tackling climate change. In 2007, the Livermore City Council adopted a resolution to join the Alameda County Climate Protection project.

The City of Livermore has conducted an inventory of local greenhouse gas emissions for 2005 and developed a forecast for "business as usual" emissions occurring in 2020. This Inventory was utilized to develop an estimate of 2008 emissions for the purpose of establishing a specific emission reduction target. In 2009 the City of Livermore took another step towards voluntary reduction of GHG by amending the General Plan to include a Climate Change Element. The Climate Change Element provides additional goals and policies to support AB 32 and the City's on-going efforts to reduce GHG emissions, and also highlights previously adopted General Plan policies and programs that would reduce greenhouse gas emissions associated with current and future development. The Climate Change Element includes Goal CLI-1, which established a GHG emission reduction target of 15% less than 2008 levels by 2020. Objective CLI-1.1 commits the City to adopt a Climate Action Plan (CAP) that would help the City address climate change. As stated in General Plan Policy CLI-1.1-P.1.

> "The CAP shall include an inventory of the 2008 level of GHG emissions within the City. The CAP shall set out specific policies and actions to be undertaken by the City to reduce GHG emissions under the control of the City to a level 15% less than 2008 conditions in order to support State implementation of AB 32. The policies and actions will include incentives, actions, and requirements to reduce the City's GHG emissions, the GHG emissions of the private sector, and actions that the City will take in concert with public agencies, the private sector, and other stakeholders to reduce GHG emissions. Development of the CAP will include a public and stakeholder process."

This CAP represents the fulfillment of General Plan Policy and a commitment made by the City to reduce GHG emissions. The CAP provides a foundation for future work to achieve Livermore's established GHG emission reduction target.

1.1.1 Purpose of the Climate Action Plan

The CAP includes an inventory of all GHG emissions resulting from community activities in 2005 and projected for 2020. Performing an inventory helps the City to identify sectors (e.g., transportation, building energy use) with the highest emissions. The City can then target emissions reductions measures to these sectors. For example, if emissions associated with building energy use represent the greatest source of emissions in the City, such emissions can then be targeted through measures involving energy efficiency, including development regulations ensuring all new buildings are more energy efficient and providing incentives to stimulate efficiency audits of older buildings. By using the inventory to focus its efforts on those sectors that contribute the most GHG emissions, the City can ensure that measures chosen to be implemented as part of the CAP have the greatest impact on the City's overall emissions.

In addition, the CAP seeks to analyze the costs associated with proposed measures. This analysis, alongside the GHG inventory, allows the City to balance the cost of a measure with its effect on overall emissions, ensuring a cost-effective path towards reducing GHG emissions.

The CAP identifies an emissions reduction target and measures for reducing future GHG emissions. The City's emissions reduction target is designed to support California's larger effort under AB 32 to reduce statewide emissions. Based on the City's existing and future emissions profile, the plan recommends specific actions the City can take to meet this target.

The CAP provides a roadmap for successfully implementing the emissions reduction measures selected by the City. Implementing the CAP involves multiple moving parts, including approving administrative and legislative approval of measures, ensuring measures are performing as expected, monitoring the City's GHG emissions to document reductions associated with adopted measures, and adapting to unforeseeable events that could impact emissions. Residents must also be given the tools and knowledge to support new policies and programs. Successes—and failures—need to be identified, monitored, and publicized. This plan outlines several recommendations to address these and other issues so that the City can make informed management decisions.

1.1.2 Development of the Climate Action Plan

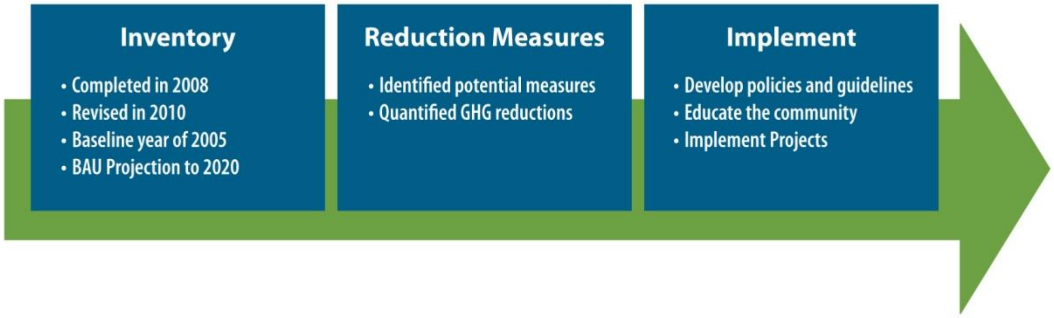
The City worked on an initial GHG inventory and forecast which were completed in 2008 and which supported the City's development of the Climate Change Element. The Climate Change Element identified broad strategies that could be implemented by the City to reduce GHG emissions under the control of the City or that could be influenced by the City. As noted above, the Climate Change Element was adopted by the City Council in March, 2009 and includes a City goal to reduce emissions by 15% under 2008 levels by 2020.

In 2010-2011, ICF updated the 2005 inventory by adding several sectors, prepared an estimate of 2008 emissions and updated the 2020 forecast using current socioeconomic forecast data.

Simultaneous with the inventory update work, the City began researching feasible measures that could be taken to reduce GHG emissions. An extensive list of GHG reduction measures was developed and reviewed by City staff as well as through public outreach in spring and fall of 2011. A public meeting was held to solicit general feedback and targeted stakeholder outreach was conducted with a number of interest groups as well. Based on feedback provided by all parties, the City selected candidate measures to analyze in greater detail. The amount of GHG emissions that would be avoided in 2020 by each measures were calculated. Costs associated with each measure were also quantified in order to inform final selection of measures for inclusion in the CAP itself.

Upon adoption by the City Council, the reduction measures identified in Chapter 3 of the CAP would be implemented. Reduction measures usually take the form of policies that are tailored to complement existing programs. Implementation includes identification of responsible parties for each measure, development of funding protocols, scheduling, ongoing monitoring, and progress reporting. Figure 1-1 provides a graphical representation of the City's CAP planning process.

Figure 1-1. The CAP Planning Process



1.2 The Science of Climate Change

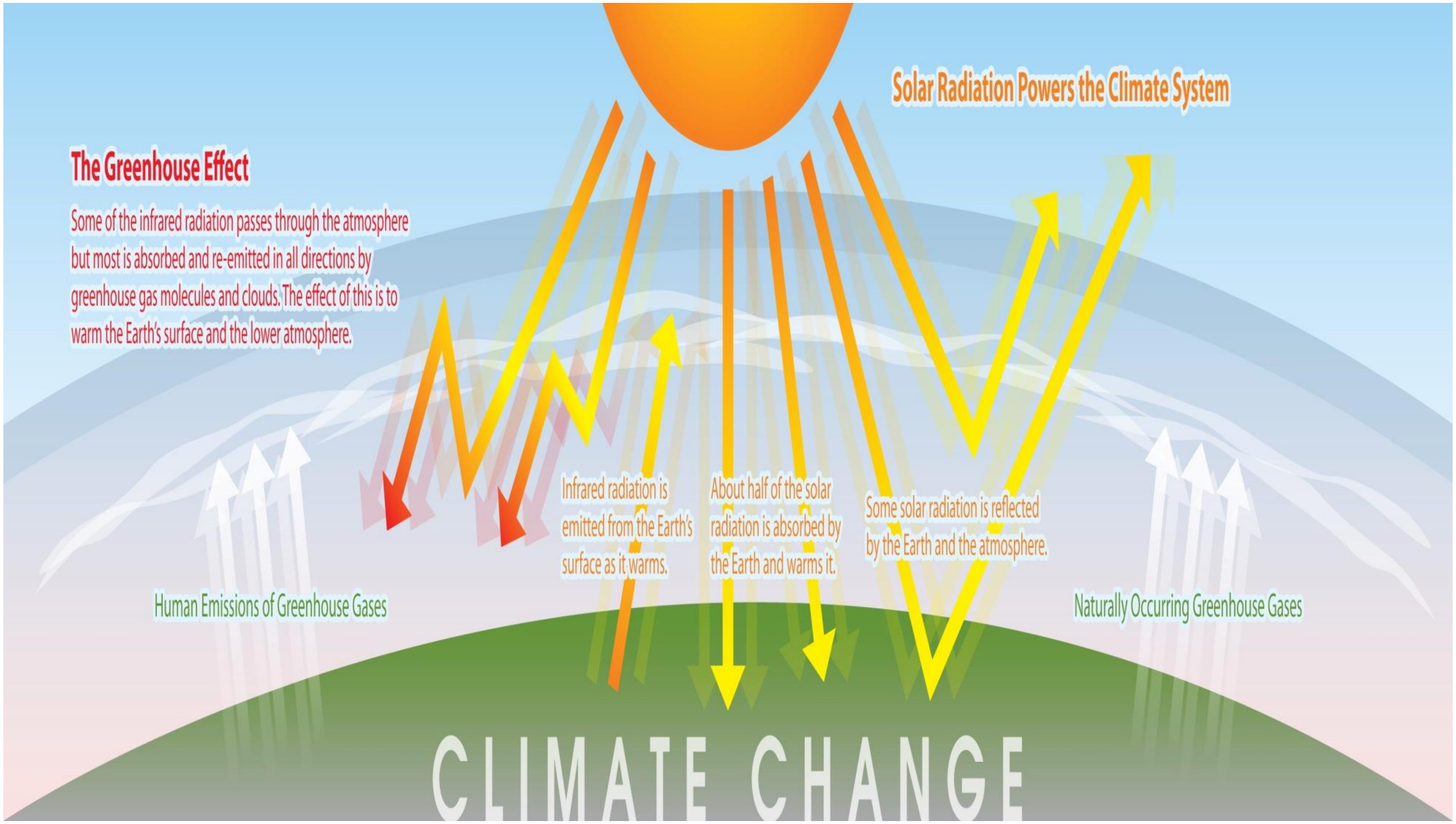
1.2.1 Global Warming

The phenomenon known as the *greenhouse effect* keeps the earth's atmosphere near the surface warm enough for the successful habitation by humans and other forms of life. GHGs present in the earth's lower atmosphere play a critical role in maintaining the earth's temperature as they trap some of the long wave infrared radiation emitted from the earth's surface, which otherwise would have escaped to space (Figure 1-2). The Kyoto Protocol, which was adopted in December 1997, addresses the following six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorinated carbons (PFCs), sulfur hexafluoride (SF_6), and hydrofluorocarbons (HFCs). Each is discussed in detail below (IPCC 2007a).

Increases in fossil fuel combustion and deforestation have exponentially increased concentrations of GHGs in the atmosphere since the industrial revolution. Rising atmospheric concentrations of GHGs in excess of natural levels enhance the greenhouse effect, which contributes to global warming. Warming of the earth's lower atmosphere induces large-scale changes in ocean circulation patterns, precipitation patterns, global ice cover, biological distributions, and other changes to the earth system that are collectively referred to as climate change (IPCC 2007a).

The IPCC has been established by the World Meteorological Organization and United Nations Environment Programme to assess scientific, technical, and socioeconomic information relevant to the understanding of climate change, its potential impacts, and options for adaptation and mitigation. The IPCC estimates that the average global temperature rise between the years 2000 and 2100 could range from 1.1° Celsius, with no increase in GHG emissions above year 2000 levels, to 6.4° C, with substantial increase in GHG emissions (IPCC 2007a). Large increases in global temperatures could have substantial adverse impacts on the natural and human environments on the planet and in California (as described below).

Figure 1-2. The Greenhouse Gas Effect



1.2.2 Principal Greenhouse Gases

The GHGs listed by the IPCC (2007a) (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) are documented in this section in order of abundance in the atmosphere. Water vapor, although the most abundant GHG in the atmosphere, is not included in this list because it's concentration is a feedback of changes in the radiative balance in the atmosphere rather than a cause of change[8]. The sources and sinks[9] of each of these gases are discussed in detail below. Generally, GHG emissions are quantified in terms of Metric Ton (MT) of CO_2e emitted per year. To simplify reporting and analysis, GHGs are commonly defined in terms of a Global Warming Potential (GWP). The IPCC defines the GWP of various GHG emissions on a normalized scale that recasts all GHG emissions in terms of CO_2e. The GWP of CO_2 is, by definition, one (IPCC 2007b).

The GWP values used in this report are based on the IPCC Second Assessment Report (SAR) and United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines, and are defined in Table 1-1. Although the IPCC Fourth Assessment Report (AR4) presents different GWP estimates, the current inventory standard relies on SAR GWPs to comply with reporting standards and consistency with regional and national inventories (IPCC 2007a).

Table 1-1. Lifetimes, Global Warming Potentials, and Abundances of Several Significant Greenhouse Gases[a]

Gas	Global Warming Potential (100 years)	Lifetime (years)[b]	Atmospheric Abundance
CO_2 (ppm)	1	50–200	379
CH_4 (ppb)	21	9–15	1,774
N_2O (ppb)	310	120	319
HFC-23 (ppt)	11,700	264	18
HFC-134a (ppt)	1,300	14.6	35
HFC-152a (ppt)	140	1.5	3.9
CF_4 (ppt)[c]	6,500	50,000	74
C_2F_6 (ppt)[c]	9,200	10,000	2.9
SF_6 (ppt)	23,900	3,200	5.6

[a] The GWP values presented are based on the IPCC SAR and UNFCCC reporting guidelines (IPCC 1996; UNFCCC 2006). Although the IPCC AR4 presents different GWP estimates, the current inventory standard relies on SAR GWPs to comply with reporting standards and consistency with regional and national inventories.

[b] Defined as the half life of the gas.

[c] CF4 and C2F6 are PFCs.

[8] Water vapor is the most abundant and important greenhouse gas in the atmosphere. However, human activities have only a small direct influence on the amount of atmospheric water vapor. Indirectly, humans have the potential to affect water vapor substantially by changing climate. For example, a warmer atmosphere contains more water vapor. Human activities also influence water vapor through CH4 emissions, because CH4 undergoes chemical destruction in the stratosphere, producing a small amount of water vapor. (IPCC 2007b). Water in the troposphere is a feedback effect, it is not a forcing agent. Artificial changes in water vapor concentrations is too short lived to change the climate. Too much in the air will quickly rain out, not enough and the abundant ocean surface will provide the difference via evaporation. But once the air is warmed by other means, such as man-made GHG emission, water concentrations will rise and stay high, thus providing feedback to atmospheric warming.

[9] A sink removes and stores GHGs in another form. For example, vegetation is a sink because it removes atmospheric CO_2 during respiration and stores the gas as a chemical compound in its tissues.

ppm = parts per million; ppb = parts per billion; ppt = parts per trillion.
Sources: IPCC 1996, 2001, 2007a.

Carbon Dioxide

CO_2 is the most important anthropogenic GHG and accounts for more than 75% of all GHG emissions caused by humans. Its atmospheric lifetime of 50 to 200 years ensures that atmospheric concentrations of CO_2 will remain elevated for decades even after mitigation efforts to reduce GHG concentrations are promulgated (IPCC 2007a). The primary sources of anthropogenic CO_2 in the atmosphere include the burning of fossil fuels (including motor vehicles), gas flaring, cement production, and land use changes (including deforestation).

Methane

CH_4, the main component of natural gas, is the second most abundant GHG and has a GWP of 21 (IPCC 1996). Sources of anthropogenic emissions of CH_4 include growing rice, raising cattle, combusting natural gas, landfill outgassing, and mining coal (National Oceanic and Atmospheric Administration 2005). Atmospheric CH_4 has increased from a pre-industrial concentration of 715 ppb to 1,774 ppb in 2005 (IPCC 2007b).

Nitrous Oxide

N_2O is a powerful GHG, with a GWP of 310 (IPCC 1996). Anthropogenic sources of N_2O include agricultural processes (e.g., fertilizer application), nylon production, fuel-fired power plants, nitric acid production, and vehicle emissions. N_2O also is used in rocket engines, racecars, and as an aerosol spray propellant. In the United States (U.S.) more than 70% of N_2O emissions are related to agricultural soil management practices, particularly fertilizer application. N_2O concentrations in the atmosphere have increased 18% from pre-industrial[10] levels of 270 parts per billion (ppb) to 319 ppb in 2005 (IPCC 2007b).

Hydrofluorocarbons

HFCs are human-made chemicals used in commercial, industrial, and consumer products and have high GWPs (U.S. Environmental Protection Agency 2006). HFCs are generally used as substitutes for ozone-depleting substances (ODS) in automobile air conditioners and refrigerants. As seen in Table 1-1, the most abundant HFCs, in descending order, are HFC-134a (35 parts per trillion [ppt]), HFC-23 (17.5 ppt), and HFC-152a (3.9 ppt) IPCC 1996, 2001, 2007a. Concentrations of HFCs have risen from zero to over 35 ppt since pre-industrial times (IPCC 2007b).

Perfluorocarbons

The most abundant PFCs are CF4 (PFC-14) and C2F6 (PFC-116). These human-made chemicals are emitted largely from aluminum production and semiconductor manufacturing processes. PFCs are extremely stable compounds that are destroyed only by very high-energy ultraviolet rays, which results in the very long lifetimes. The IPCC estimates that global concentrations of CF4 have risen to over 74 ppt (IPCC 2007b).

[10] Pre-industrial refers to the period prior to the Industrial Revolution, which is nominally defined as prior to 1750, subsequent to which industrial activity energy use utilizing fossil fuel sources (starting primarily with coal) started to contribute to changed in atmospheric carbon dioxide levels (IPCC 2007b).

Sulfur Hexafluoride

SF_6, a man-made chemical, is used as an electrical insulating fluid for power distribution equipment, in the magnesium industry, and in semiconductor manufacturing; and also as a tracer chemical for the study of oceanic and atmospheric processes (U.S. Environmental Protection Agency 2006). In 2005, atmospheric concentrations of SF_6 were 5.6 ppb and steadily increasing in the atmosphere. SF_6 is the most powerful of all GHGs listed in IPCC studies, with a GWP of 23,900 (IPCC 1996, 2007b).

1.2.3 Emission Sources in the United States and California

Over 97% of U.S. GHG emissions are the result of burning fossil fuels. Of these GHGs, 83% are in the form of CO_2, 10% are CH_4, and 4.5 % are N_2O. Fossil fuels are burned to power vehicles, create electricity, and generate heat. Vehicle emissions are the largest source of CO_2 emissions in California, representing 37% of statewide emissions in 2008. Electrical generation is the second largest source of emissions in California (California Air Resources Board 2010b). On a national level, electrical generation is the largest emissions sector and transportation is the second largest sector (U.S. Environmental Protection Agency 2010a). Other sources of GHG emissions generated within the U.S. and California include agriculture, land clearing, the waste disposal in landfills, refrigerants, and certain industrial processes.

Although many nations, including the U.S., regularly monitor and report GHG emissions, federal legislation to reduce global emissions has not been adopted and is the subject of much debate. The EPA is presently pursuing regulation of GHGs through the Clean Air Act (CAA), following a U.S. Supreme Court ruling clarifying that it has the authority under the CAA to do so. Many states, including California as a prominent leader, have passed legislation to reduce GHG emissions. California's GHG regulatory framework is discussed further below.

1.2.4 Impacts of Climate Change on the San Francisco Bay Area

Climate change is a complex global phenomenon that also has the potential to alter local climatic patterns and meteorology. Although modeling indicates that climate change will result globally and regionally in sea level rise as well as changes in climate and rainfall, among other effects, there remains uncertainty with regard to characterizing the precise *local* climate characteristics and predicting precisely how various ecological and social systems will react to any changes in the existing climate at the *local* level. Regardless of this uncertainty in precise predictions, it is widely understood that substantial climate change is expected to occur in the future although the precise extent will take further research to define. Consequently, the City will be impacted by changing climatic conditions.

Several recent studies have attempted to characterize future climatic scenarios for the State. While specific estimates and statistics on the severity of changes vary, sources agree that the San Francisco Bay Area will witness warmer temperatures, increased heat waves, changes in rainfall patterns, and increased sea levels. Specifically, the California Energy Commission (CEC) estimates that average annual temperatures in California will increase by approximately 3.6° Fahrenheit to 10° Fahrenheit by the end of the century. Climatic models also predict that the number of extreme heat days will increase in frequency, magnitude, and duration. Annual precipitation is expected to witness a declining trend, but remain highly variable, suggesting that the San Francisco Bay Area will be vulnerable to increased drought (IPCC 2007a; California Natural Resources Agency 2009; California Energy Commission 2009).

Sea level rise during the next 50 years is expected to increase dramatically over historical rates. The CEC predicts that by 2050, sea level rise, relative to the 2000 level, ranges from 30 centimeters (cm) to 45 cm. Coastal sea level rise could result in flooding of coastal communities and saltwater intrusion to inland rivers and associated biological impacts in the San Francisco Bay Area.

Based on the description of impacts to California described above, Livermore will likely be most affected by climatic changes that could comprise the structural integrity of developments and services and the health of residents. Such events could include extreme heat, potential changes in water supply (due to changes in the snowpack), destruction of coastal infrastructure that Livermore depends on due to sea level rises, and changes in air quality. Higher temperatures can also result in worsen air quality due to more favorable ozone formation conditions. (IPCC 2007a; California Natural Resources Agency 2009; California Energy Commission 2009).

1.3 Climate Change Regulation

1.3.1 Federal Regulation

Although there is currently no federal overarching law specifically related to climate change or the reduction of GHGs, the EPA is now issuing regulation under the federal Clean Air Act. Although periodically debated in Congress, no comprehensive federal legislation concerning greenhouse gas limitations is likely until at least 2013, if then. Figure 1-3 displays a timeline of key state and federal regulatory activity.

Massachusetts, et al. vs. U.S. Environmental Protection Agency (2007)

Twelve U.S. states and cities, including California, in conjunction with several environmental organizations, sued to force EPA to regulate GHGs as a pollutant pursuant to the CAA in *Massachusetts, et al. v. Environmental Protection Agency 549 US 497* (2007). The court ruled that the plaintiffs had standing to sue, GHGs fit within the CAA's definition of a pollutant, and the EPA's reasons for not regulating GHGs were insufficiently grounded in the CAA.

United States Environmental Protection Agency Endangerment Finding (2009)

In its "Endangerment Finding," the EPA Administrator found that GHGs, as described above, in the atmosphere threaten the public health and welfare of current and future generations. The Administrator also found that the combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution that threatens public health and welfare. Although the Finding of Endangerment does not place requirements on industry, it is an important step in EPA's process to develop regulation. This measure is a prerequisite to finalizing EPA's proposed GHG emission standards for light-duty vehicles, which were jointly proposed by EPA and the Department of Transportation's National Highway Safety Administration on September 15, 2009 (U.S. Environmental Protection Agency 2010a).

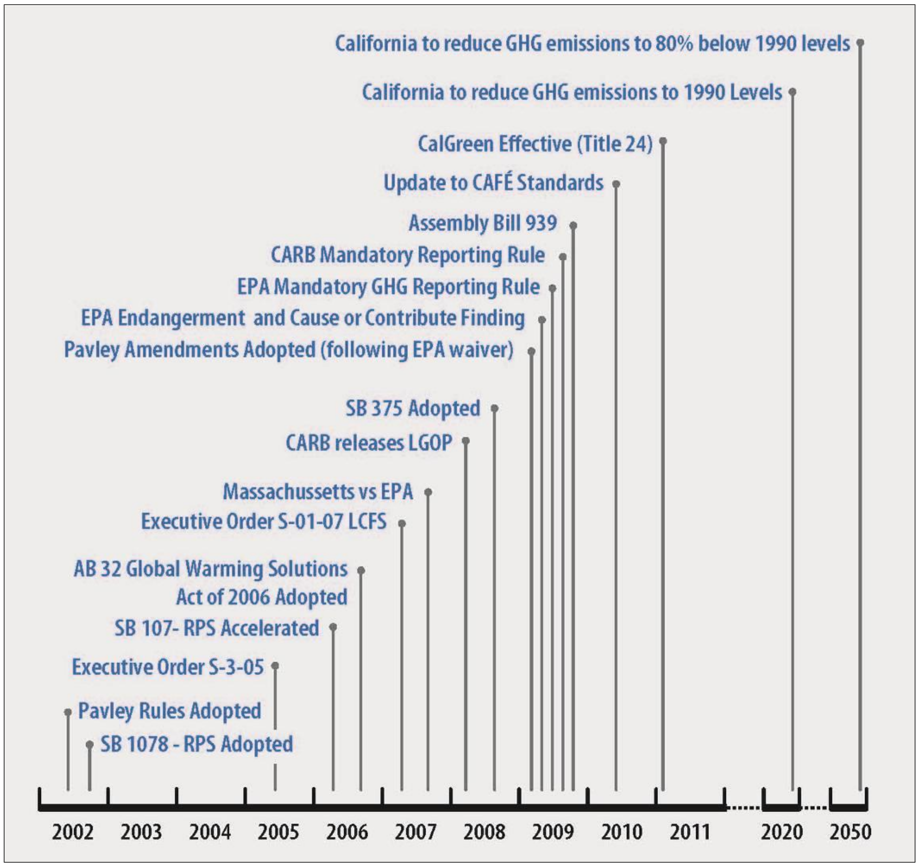


Figure 1-3. Key Milestones in Federal and State Climate Legislation

United States Environmental Protection Agency Mandatory Reporting Rule for Greenhouse Gas Emissions (2009)

Under the Mandatory Report Rule, suppliers of fossil fuels, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHGs are required to report annual emissions to the EPA. The first annual reports for the largest emitting facilities, covering calendar year 2010, will be submitted to the EPA in 2011. The mandatory reporting rule does not limit GHG emissions but establishes a standard framework for emissions reporting and tracking of large emitters (U.S. Environmental Protection Agency 2010a).

Update to Corporate Average Fuel Economy Standards (2009)

The new Corporate Average Fuel Economy (CAFE) standards incorporate stricter fuel economy standards promulgated by the State of California into one uniform standard. Additionally, automakers are required to cut GHG emissions in new vehicles by roughly 25% by 2016. Rule-making to adopt these new standards is still in process and thus they are not yet in effect. When the national program takes effect, California has committed to allowing automakers who show compliance with the national program to also be deemed in compliance with state requirements. (U.S. Environmental Protection Agency 2010a). Federal agencies are presently developing higher standards for the 2017 to 2025 period.

United States Environmental Protection Agency Cause or Contribute Finding (2010)

In its "Cause or Contribute Finding" the EPA Administrator found that the combined emissions of these well-mixed GHG from new motor vehicles and new motor vehicle engines contribute to the GHG pollution that threatens public health and welfare (U.S. Environmental Protection Agency 2010a). This action was a prerequisite to proposing new vehicle emission standards.

United States Environmental Protection Agency Regulation of GHG Emissions under the Clean Air Act (2010 – 2012, ongoing)

Under the authority of the Clean Air Act, the EPA is beginning to regulate GHG emissions starting with large stationary sources. In 2010, EPA set GHG thresholds to define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and Title V Operating Permit programs are required for new and existing industrial facilities. In 2012, EPA proposed a carbon pollution standard for new power plants.

1.3.2 State Legislation

California has adopted statewide legislation addressing various aspects of climate change and GHG emissions mitigation. Much of this legislation is not directed at citizens or jurisdictions specifically, but rather establishes a broad framework for the state's long-term GHG reduction and climate change adaptation program. The Governor has also issued several executive orders related to the state's evolving climate change policy. Of particular importance to local governments is the direction provided by the AB 32 Scoping Plan, which recommends local governments reduce their GHG emissions by a level consistent with state goals.

Summaries of key policies, legal cases, regulations, and legislation at the federal and state levels that are relevant to the City are provided below. Figure 1-3 displays a timeline of key state and federal regulatory activity.

Executive Order S-03-05 (2005)

EO S-03-05 established the following GHG emission reduction targets for California's state agencies:

- By 2010, reduce GHG emissions to 2000 levels.
- By 2020, reduce GHG emissions to 1990 levels.
- By 2050, reduce GHG emissions to 80% below 1990 levels.

Executive orders are binding only on state agencies. Accordingly, EO S-03-05 will guide state agencies' efforts to control and regulate GHG emissions but will have no direct binding effect on local government or private actions. The Secretary of the California Environmental Protection Agency (CalEPA) is required to report to the Governor and state legislature biannually on the impacts of global warming on California, mitigation and adaptation plans, and progress made toward reducing GHG emissions to meet the targets established in this executive order.

Assembly Bill 1493—Pavley Rules (2002, Amendments 2009)

Known as "Pavley I," AB 1493 standards are the nation's first GHG standards for automobiles. AB 1493 requires the CARB to adopt vehicle standards that will lower GHG emissions from new light duty autos to the maximum extent feasible beginning in 2009. AB 1493 will reduce GHG emissions from automobiles and light duty trucks by 30% from 2002 levels by the year 2016. Additional strengthening of the Pavley standards (referred to previously as "Pavley II", now referred to as the "Advanced Clean Cars" measure) has been proposed, and as a result the EPA and CARB are currently working together to on a joint rulemaking to establish GHG emissions standards for 2017 to 2025 model-year passenger vehicles. The Interim Joint Technical Assessment Report for the standards evaluated four potential future standards ranging from 47 and 62 miles per gallon in 2025 (U.S. Environmental Protection Agency et. al. 2010). In June 2009, the EPA granted California's waiver request enabling the state to enforce its GHG emissions standards for new motor vehicles beginning with the current model year. The EPA and CARB were still working on this proposal as of February 2012.

Senate Bills 1078/107/X 1-2 and Executive Order S-14-08—Renewable Portfolio Standard and Renewable Energy Resources Act (2002, 2006, 2011)

Senate Bills (SB) 1078 and 107, California's Renewable Portfolio Standard (RPS), obligated investor-owned utilities (IOUs), energy service providers (ESPs), and Community Choice Aggregations (CCAs) to procure an additional 1% of retail sales per year from eligible renewable sources until 20% is reached by no later than 2010. The California Public Utilities Commission (CPUC) and CEC are jointly responsible for implementing the program. EO S-14-08 set forth a longer range target of procuring 33% of retail sales by 2020. SB X 1-2, called the California Renewable Energy Resources Act, obligates all California electricity providers to obtain at least 33% of their energy from renewable resources by the year 2020.

Assembly Bill 32—California Global Warming Solutions Act (2006)

AB 32 codified the state's GHG emissions target by requiring that the state's global warming emissions be reduced to 1990 levels by 2020. Since being adopted, CARB, CEC, CPUC, and the Building Standards Commission have been developing regulations that will help meet the goals of AB 32 and EO S-03-05. The Scoping Plan for AB 32 identifies specific measures to reduce GHG emissions to 1990 levels by 2020, and requires CARB and other state agencies to develop and enforce regulations and other initiatives for reducing GHGs. Specifically, the Scoping Plan articulates a key role for local governments, recommending they establish GHG reduction goals for both their municipal operations and the community consistent with those of the state.

Executive Order S-01-07—Low Carbon Fuel Standard (2007)

EO S-01-07 essentially mandates: (1) that a statewide goal be established to reduce the carbon intensity of California's transportation fuels by at least 10% by 2020; and (2) that a Low Carbon Fuel Standard (LCFS) for transportation fuels be established in California. The executive order initiates a research and regulatory process at the CARB. Based on an implementation plan developed by the CEC, the CARB will be responsible for implementing the LCFS. On December 29, 2011, a federal judge issued a preliminary injunction blocking enforcement of the LCFS, ruling that the LCFS violates the federal regulation that says only Congress can regulate interstate commerce, as the LCFS discriminates against out-of-state fuel suppliers. CARB has appealed this ruling.

Assembly Bill 1109—Lighting Efficiency & Toxics Reduction Act (2007)

AB 1109 requires the CEC to ensure the reduction of lighting energy usage in indoor residences and state facilities by no less than 50% by 2018, as well as a 25% reduction in commercial facilities by that same date. To achieve these efficiency levels, existing CEC appliance efficiency standards would be applied to include lighting products, as well as require minimum lumen/watt standards for different categories of lighting products. The bill would also expand existing incentives for energy efficient lighting.

California Air Resources Board Local Governments Operations Protocol (2008)

On September 25, 2008, CARB adopted the LGOP. The protocol, prepared by CARB, California Climate Action Registry, ICLEI, and the Climate Registry, provides methods and techniques for the preparation of GHG emissions inventories for local government municipal operations. The adopted protocol does not contain recommendations for GHG reductions by local governments (California Air Resources Board 2008).

Senate Bill 375—Sustainable Communities Strategy (2008)

SB 375 provides for a new planning process that coordinates land use planning, regional transportation plans, and funding priorities in order to help California meet the GHG reduction goals established in AB 32. SB 375 requires regional transportation plans, developed by metropolitan planning organizations (MPOs) to incorporate a “sustainable communities strategy” (SCS) in their Regional Transportation Plans (RTPs). The goal of the SCS is to reduce regional vehicle miles traveled (VMT) through land use planning and consequent transportation patterns. The regional targets were released by CARB in September 2010. SB 375 also includes provisions for streamlined California Environmental Quality Act (CEQA) review for some infill projects such as transit-oriented development. However, those provisions will not become effective until an SCS is adopted.

MTC and ABAG are working on developing the Sustainable Communities Strategy for the Bay Area which is scheduled for completion in 2013.

California Energy Efficiency Standards for Residential and Non-residential buildings—Title 24 (2008)

The California Energy Commission periodically updates the energy efficiency requirements for residential and non-residential buildings. The currently applicable standards were adopted in 2008. The next standards were adopted in late May, 2012 and come into force in 2014.

California Green Building Standards Code—Title 24, Part 11 (2011)

On July 17, 2008, the California Building Standards Commission adopted the nation’s first green building standards. The California Green Building Standards Code (proposed Part 11, Title 24) was adopted as part of the California Building Standards Code (24 CCR). Part 11 establishes voluntary standards that became mandatory in the 2010 edition of the code, including planning and design for sustainable site development, water conservation, material conservation, and internal air contaminants. The standards took effect in January 1, 2011. The standards did not mandate improvements in energy efficiency above the Title 24 2008 standards.

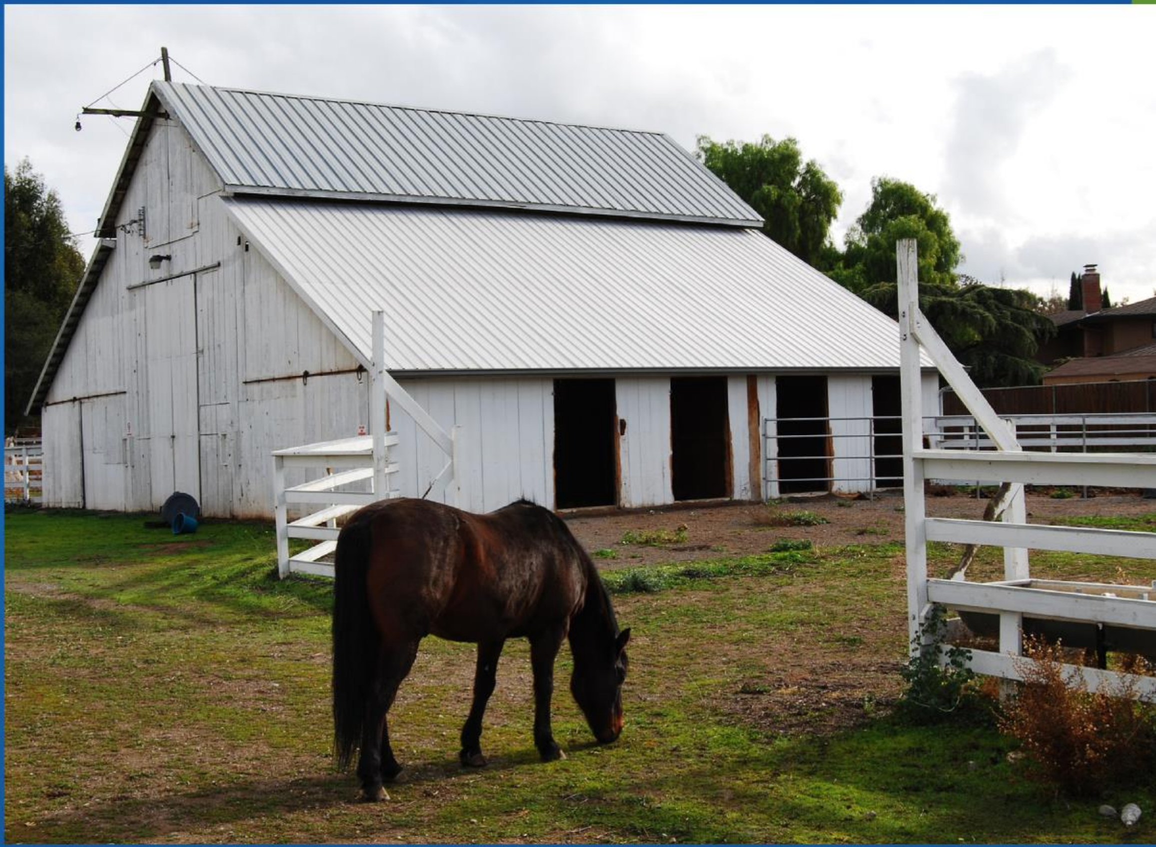
California Air Resources Board Greenhouse Gas Mandatory Reporting Rule Title 17 (2009)

In December of 2007, CARB approved a rule requiring mandatory reporting of GHG emissions from certain sources, pursuant to AB 32. Facilities subject to the mandatory reporting rule must report their emissions from the calendar year 2009 and have those emissions verified by a third party in 2010. In general the rule applies to facilities emitting more than 25,000 MT CO_2e in any given calendar year or electricity generating facilities with a nameplate generating capacity greater than 1 megawatt (MW) and/or emitting more than 2,500 MT CO_2e per year. Additional requirements also apply to cement plants and entities that buy and sell electricity in the state.

1.3.3 Local Governments

The AB 32 Scoping Plan establishes a framework for achieving statewide GHG reductions required by AB 32. Specifically, the Scoping Plan describes a list of measures that the state will undertake, and the anticipated GHG reductions associated by these measures, by 2020. Because the State does not have jurisdictional control over all of the activities that produce GHG emissions in California, the AB 32 Scoping Plan articulates a role for local governments in achieving the state's GHG reduction goals. The AB 32 Scoping Plan recommends that local governments reduce GHG emissions from both their municipal operations and community by 15% below "current" levels. Many jurisdictions across California have completed a CAP. In Alameda County, Dublin, Pleasanton, Fremont, Union City and other jurisdictions have adopted climate action plans to reduce GHG emissions.

CHAPTER 2.
CITY OF LIVERMORE'S GREENHOUSE GAS EMISSIONS INVENTORY AND ESTIMATES



2.1 Overview of Analysis Procedures

To support development of the CAP, the City prepared a community GHG inventory of 2005 emissions and a 2020 emissions estimate in October 2008. An estimate of 2008 emissions was also calculated by ICF in order to establish the emissions reduction goal.

The 2005 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, 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 as a whole.

Consistent with state and federal guidance (e.g., California Air Resources Board [CARB], Intergovernmental Panel on Climate Change [IPCC]), the 2005 inventory includes GHG emissions occurring in association with the land uses within the City's jurisdictional boundary. The inventory also includes emissions that occur outside the City's jurisdictional boundary, but only to the extent that such emissions are due to land uses within the City (e.g., transferring water to within the City produces GHG emissions, yet these emissions do not necessarily occur within city limits). The community GHG inventory represents the *baseline* inventory, or *existing conditions*.

The 2008 estimate is a projection of community emissions in 2008 based on the 2005 inventory calculations. Similar to a BAU scenario, the 2008 estimate does not include the effects of state and local action to reduce GHG emissions. The 2008 estimate was developed based on population, housing, and employment growth between 2005 and 2008. The CAP relies on the 2008 estimate to develop a GHG emissions reduction goal for the City.

The 2020 emissions forecast is a prediction of community emissions that would occur in 2020, absent any federal, state, or local reduction measures designed to reduce GHG emissions. This approach is consistent with CARB's definition of the Statewide 2020 emissions forecast, as outlined in the AB 32 Scoping Plan (California Air Resources Board 2008). The 2020 emissions forecast is therefore an estimate of future emissions based on existing energy and carbon factors. Forecast growth in City population, housing, and employment are used to project baseline emissions to 2020. The analysis is the BAU forecast.

As is the standard practice, the GHG inventories are presented in MT CO_2e in all Livermore CAP figures and tables, unless otherwise noted. Presenting inventories in CO_2e equivalence allows one to characterize the complex mixture of GHG as a single unit taking into account that each gas has a different GWP.

2.1.1 Emission Sectors Included in the Analysis

The baseline inventory and BAU forecast analyzed GHG emissions from the following sectors.

- **Transportation.** Fuel consumption for vehicles on local road and state highways due to the land uses in the City.[11]
- **Building Energy (Residential, Commercial, and Industrial).** Natural gas and electricity consumption for the residential, commercial, and industrial sectors.
- **Solid Waste Generation.** Methane emissions from waste generated by the community and deposited in landfills.
- **High GWP GHGs.** Fugitive emissions of HFCs and CFCs from refrigeration and air conditioning units, as well as SF_6 from the transmission of electricity to the City.
- **Wastewater Treatment.** Process emissions from wastewater treatment, including fugitive emissions, as well as stationary emissions from stationary fuel combustion at the wastewater treatment facility.
- **Water Conveyance.** Electricity consumption associated with water importation.

The 2005 inventory does not include an analysis of GHG emissions from land use change and carbon sequestration. At the time of the original inventory, standard acceptable methodology and emission factors for quantifying these emissions had not been developed by the CARB, BAAQMD, California Climate Action Registry, or other entities. Likewise, a detailed inventory of existing and future vegetation within the City was not available. Emissions from stationary sources (e.g., generators) were also not included, as these are regulated by the CARB and the BAAQMD. In addition, Livermore has no large stationary sources (e.g., cement plants); GHG emissions and potential mitigation would therefore be negligible compared to other inventory sectors.

2.1.2 Quantification Protocols

The City calculated GHG emissions under existing conditions using activity data specific to the City's operations. The primary protocols consulted for the analysis are:

- Local Government Operations Protocol (LGOP) for the quantification and reporting of GHG emissions inventories (California Air Resources Board 2010c);
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006); and
- 2009 General Reporting Protocol (Version 3.1) for reporting entity-wide GHG emissions (California Climate Action Registry 2009).

The complete original inventory report, which includes additional details on quantification methods, is provided in Appendix A, while the inventory update report is provided in Appendix B.

[11] Transportation emissions have been quantified consistent with statewide Regional Targets Advisory Committee (RTAC) recommendations, which exclude pass-by trips and weigh trips that either originate or terminate (but not both) within a jurisdiction by 0.50 (see Appendix B for additional information).

2.2 Summary of Emissions

2.2.1 City of Livermore 2005 Community Emissions Inventory

In 2005, the City produced 411,937 $MTCO_2e$. This is equivalent to the annual GHG emissions generated by approximately 82,000 passenger vehicles (U.S. Environmental Protection Agency 2011).

As shown in Table 2-1, the largest source of emissions within the City is building energy emissions (including electricity and natural gas for both residential and non-residential buildings. Residential building energy use accounted for 30% of emissions while commercial and industrial buildings accounted for 25% of emissions. Onroad transportation emissions represented 36% of total community emissions in 2005. Transportation and energy emissions accounted for 91% of total community emissions. The third largest source is solid waste generation, with a contribution of 8% of the total 2005 emissions. The remaining sources in order of greatest contributions are water importation (1%) and wastewater treatment (0.2%).

Table 2-1. City of Livermore Community 2005 GHG Inventory (MT CO_2e)[a, b]

	2005 Inventory[c]	
Emissions Sector	**$MTCO_2e$**	**% of Total Inventory**
Transportation[d]	147,327	35.8%
Water Conveyance	5,246	1.3%
Wastewater Treatment[e]	826	0.2%
Solid Waste Generation	32,783	8.0%
Residential Energy	121,572	29.5%
Commercial/ Industrial Energy	104,183	25.3%
Total Emissions	**411,937**	**100.0%**

a. For more information, see Appendices A and B.

b. As discussed with all emissions analyses, the calculations presented above contain a certain amount of uncertainty. Quantitative error analyses are complicated, require detailed statistical equations, and are outside the scope of the consultant's work. The EPA estimates an error range of -1% to 6% for the 2009 national inventory. Given that the City's 2005 inventory employed similar methods and analysis factors, a similar level of error can be expected, yielding an emissions range of 407,817 $MTCO_2e$ to 436,653 $MTCO_2e$.

c. Municipal emissions are a subset of the larger community emissions and are included in the total emission values in the Inventory (see below)

d. Take-offs and landings of aircrafts at the Livermore Municipal Airport were not included in the 2005 inventory, as the City does not control airport takeoffs and landings and the protocol for assessing such emissions is contentious. GHG emissions associated with buildings in the airport are included in the inventory.

e. Wastewater emissions include fugitive wastewater treatment emissions associated with incomplete combustion of digester gas and process emissions from effluent discharge. Emissions associated with export through the LAVWMA pipeline are included in the water conveyance sector.

2.2.2 City of Livermore 2005 Municipal Emissions Inventory

As a component of the 2005 Inventory, the Livermore municipal government produced 7,095 $MTCO_2e$ in 2005. This is equivalent to the annual GHG emissions generated by approximately 1,400 passenger vehicles (U.S. Environmental Protection Agency 2011). As shown in Table 2-2, the largest source of emissions resulting from municipal operations was building energy emissions, which accounted for 48% of total municipal emissions, followed by transportation (i.e. the City's vehicle fleet), which represented 16%; and public lighting, with a contribution of 12%. Taken together, transportation and energy emissions accounted for 75% of total municipal emissions. The remaining sources in order of contributions were wastewater treatment (12%), solid waste generation (9%), and water conveyance (4%).

Table 2-2. GHG Emissions from City of Livermore Municipal Operations: 2005 Baseline

	2005 (Municipal)		
Emissions Sector	**$MTCO_2e$**	**% of Total Municipal Emissions**	**% of 2005 Community Inventory**
Transportation	1,111	15.7%	0.3%
Water Conveyance	297	4.2%	0.1%
Wastewater	826	11.6%	0.2%
Solid Waste Generation	642	9.0%	0.2%
Public Buildings	3,378	47.6%	0.8%
Public Lighting	844	11.9%	0.2%
Total Emissions	**7,095**	**100.0%**	**1.8%**

2.2.3 City of Livermore 2008 Emissions Estimate

As noted above, the City's baseline community GHG emission inventory is for 2005. In order to derive a target relative to the 2008 year, the 2005 emissions were forecasted to 2008 using 2008 socioeconomic data. The resultant 2008 estimate is shown in Table 2-3.

Table 2-3. Estimated GHG Emissions in 2008 and Percent Change from the 2005 Inventory[a]

Sector	2008 Emissions Estimate	% of 2008 Emissions Estimate	Percent Change from 2005 Inventory
Transportation	150,881	35.4%	2.4%
Water Conveyance	5,374	1.3%	2.4%
Wastewater Treatment	846	0.2%	2.4%
Solid Waste Generation	33,580	7.9%	2.4%
Residential Energy	129,177	30.3%	6.3%
Commercial/Industrial Energy	106,320	24.9%	2.1%
Total Emissions	**426,177**	**100.0%**	**3.5%**

a. For more information, see Appendices A and B.

2.2.4 City of Livermore 2020 Business as Usual Forecast

By 2020, community-wide emissions within the City are expected to reach 497,302 $MTCO_2e$, which is an increase of approximately 21% more than 2005 levels and 17% more than 2008 levels. The increase will occur primarily because of increases in VMT, building energy use, and solid waste generation. As population and employment in Livermore grow, transportation activity, energy consumption, and solid waste generation will subsequently increase, as well. Based on the baseline GHG inventory, on-road transportation (37%), residential building energy use (28%), and commercial/industrial building energy use (26%) are still expected to be the largest emissions sources within the City in 2020.

The 2020 forecast was estimated using current land use data and projected data based on buildout of all potential development allowed for in the City's General Plan. This data was then compared with annual growth information from the most recent Association of Bay Area Governments projections. The forecast included growth in commercial, residential, and industrial square footage, housing types and units, households, and jobs. Although the forecast for 2020 includes current assumptions about growth that have factored in the economic downturn, it is possible that the 2020 forecast may still be somewhat optimistic. If population, employment and housing growth is less than that estimated at present, then the estimate of 2020 GHG emissions presented below may overestimate likely emissions levels in 2020.

Table 2-4 summarizes GHG emissions for each inventory sector in 2020, as well as the change in emissions between the 2005 inventory and the 2020 BAU forecast. Figures 2-1 and 2-2 provide a graphical representation of the values presented in Table 2-4. Additional detail on inventory assumptions and calculations are presented in Appendices A and B.

Table 2-4. City of Livermore 2020 BAU Forecast and Percent Change from the 2005 Inventory[a]

Sector	2020 BAU Emissions Estimate	% of 2020 BAU Emissions Estimate	Percent Change from 2005 Inventory
Transportation	182,643	36.7%	24.0%
Water Conveyance	6,073	1.2%	15.8%
Wastewater Treatment	956	0.2%	15.8%
Solid Waste Generation	37,948	7.6%	15.8%
Residential Energy	140,726	28.3%	15.8%
Commercial/Industrial Energy	128,956	25.9%	23.8%
Total Emissions	**497,302**	**100.0%**	**20.7%**

[a] For more information, please refer to Appendix B.

2.3 City of Livermore's Emissions in Context

The challenge to reduce GHG emissions is a cumulative and global challenge. The cumulative emissions of the entire world are the cause of rising atmospheric levels of GHGs. As such, the contributions of all sources are important to any effective effort at reducing GHG emissions. The absolute percentage of emissions from any one jurisdiction does not mean its emissions are not cumulatively considerable. Global GHG emissions are the result of the actions of billions of individuals across the planet. Each on their own will not cause climate change, but cumulatively they become meaningful and consequential.

In 2005, the City's community emissions represented approximately 0.09% of the 2005 statewide GHG emissions inventory[12]. Table 2-5 compares baseline emissions in Livermore to statewide GHG emissions inventories for 2005 and available local GHG inventories for years near 2005.

Table 2-5. Livermore 2005 GHG Emissions Relative to State and Other Local GHG Inventories (MT CO_2e)

GHG Emissions	MT CO_2e
City of Livermore (2005)	*411,937*
City of Dublin (2005)	357,211
City of Pleasanton (2005)	770,884
Alameda County (2005)	930,000
City of Tracy (2006)	1,350,321
Bay Area Air Quality Management District [a] (2007)	102,600,000
California (2005)	472,560,000

NOTE: Comparison between inventories for illustrative purposes only. Methodologies for different inventories vary.

[a] The District's jurisdiction encompasses all of seven counties-Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, Napa-and the southern portions of Solano and Sonoma counties.

Sources: California Air Resources Board 2010c; City of Dublin 2010; City of Tracy 2011; City of Pleasanton 2011; Alameda County, 2011

While the information presented in Table 2-5 is useful for analyzing Livermore's emissions within a statewide, regional, and local context, it is only presented for illustrative purposes. Different inventory methods and data availability result in variability between each inventory. Thus, comparing different emissions inventories includes some level of uncertainty. Caution is best applied when comparing one inventory to another; one must examine the actual methods used before asserting any validity in comparing different cities and counties. For example, the regional Bay Area inventory and the state inventory include many sources better estimated at a regional or state level such as refineries, offroad emissions and high global warming potential gases, which are often not included in local inventories.

[12] It should be noted that a direct comparison between inventories may not be possible due to subtle variations in both the protocols used to quantify emissions included in the inventories and sources captured in the inventory. For example, the State inventory includes air travel, while many local inventories (including the City of Livermore GHG inventory) do not; many State and local jurisdictions do not include local traffic data from the respective regional travel demand traffic model, while the City of Livermore's GHG inventory does; and many local jurisdictions do not have sources that are captured in the State inventory, such as landfills (City does not own any landfills).

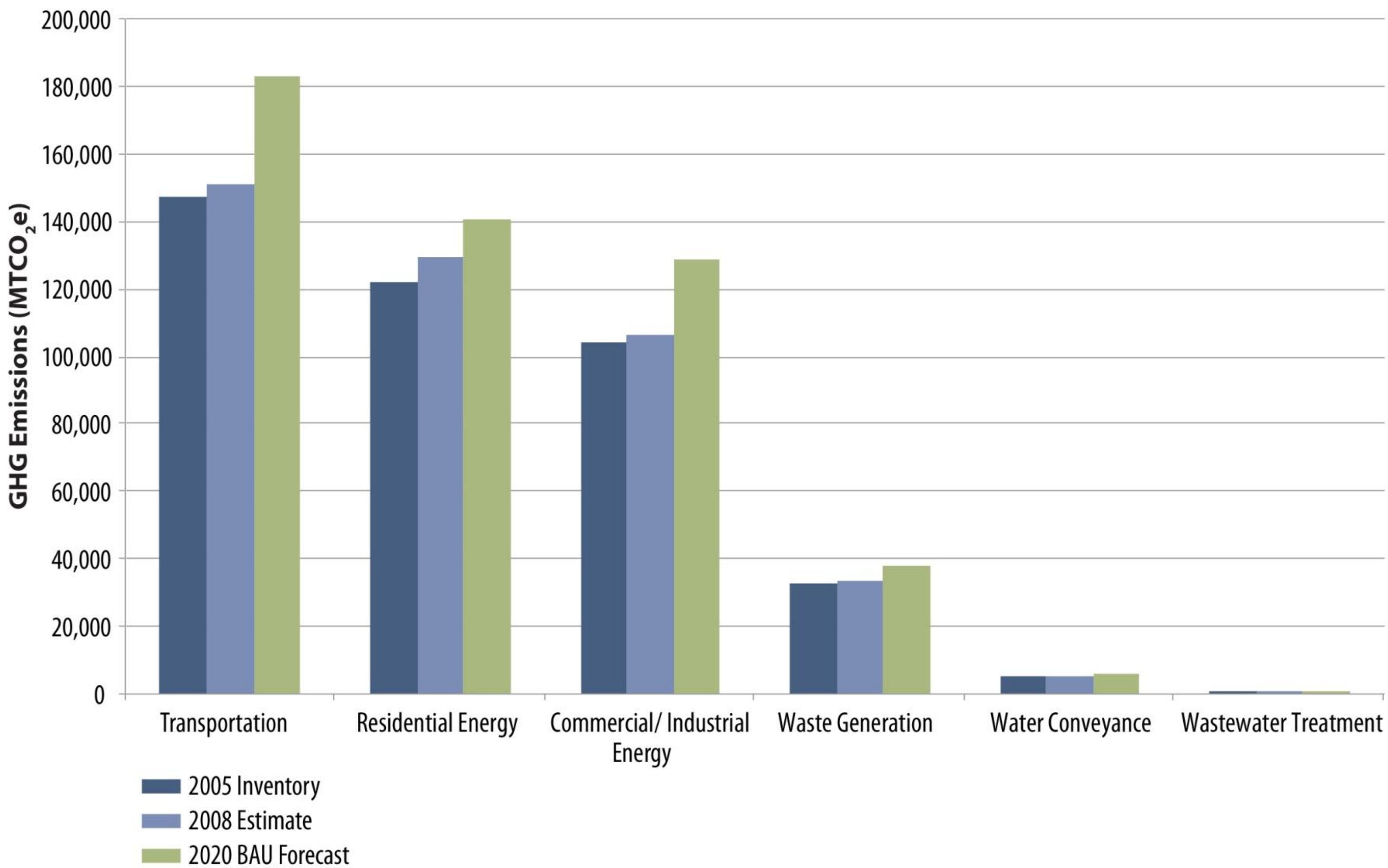


Figure 2-1. City of Livermore Community GHG Emissions: 2005 Baseline, 2008 Estimate, and 2020 BAU Forecast (MT CO_2e)

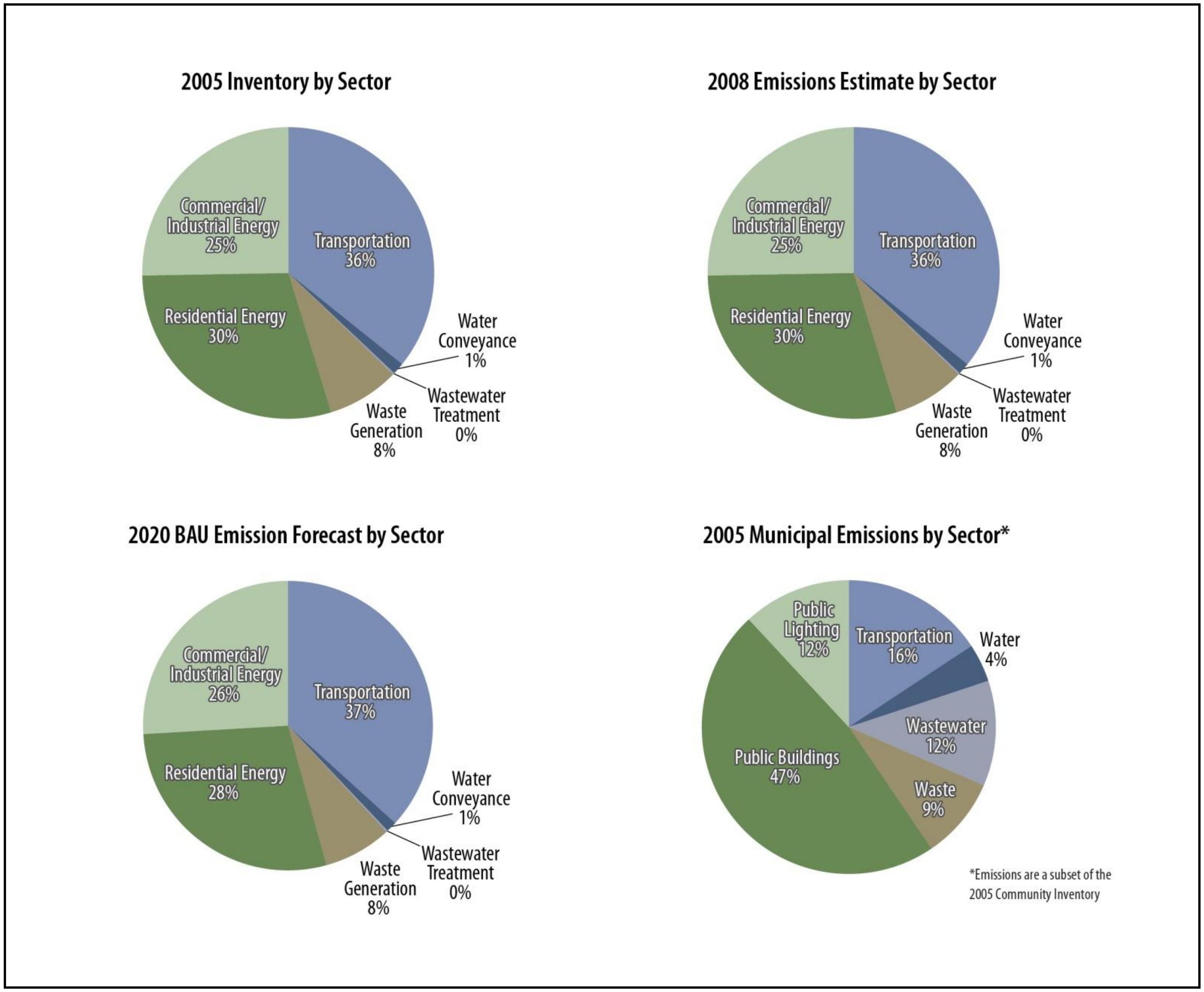


Figure 2-2. Detailed View—City of Livermore GHG Emissions: 2005 Community Baseline, 2020 Community BAU Forecast, and 2005 Municipal Baseline(MT CO_2e)

CHAPTER 3.
CITY OF LIVERMORE'S EMISSIONS REDUCTION PLAN

3.1 Introduction

The City's CAP sets forth a framework for reducing 2020 community emissions that is consistent with AB 32. Successful implementation of the CAP would require commitment and action throughout the community including government, residents, businesses, and employers. Based on the City's GHG emission inventory (see Chapter 2), the CAP targets the following six sectors.

- Building Energy
- Transportation and Land Use
- Water Conveyance
- Wastewater Treatment
- Solid Waste Generation
- Urban Forestry and Conservation

The following sections identify the City's emission reduction targets, describe the CAP framework and measures for meeting this target, summarize emission reductions that will be achieved, and describe limitations and recommendations for further CAP refinement. Appendix C contains detailed information for each individual measure, including the assumptions and methodologies used to quantify emissions reductions.

3.2 Emissions Reduction Goal

California Air Resources Board (CARB), which is the lead agency empowered to implement AB 32, adopted the AB 32 Scoping Plan in December 2008, which is a policy document outlining the State's approach to meeting the AB 32 GHG reduction targets. In the AB 32 Scoping Plan, CARB recommended, but did not require, an emissions reduction goal for local governments of 15% below "current"[13] emissions to be achieved by 2020 (California Air Resources Board 2008). Based on this recommendation, the City identified a GHG emissions reduction goal for the purposes of CAP development of 15% below 2008 levels.

As shown in Table 2-3, the estimated community emission level for the City of Livermore in 2008 is 426,177 $MTCO_2e$. To achieve the identified target of 15% below this level, the Community would need to limit emissions by 2020 to 362,251 $MTCO_2e$ by 2020. Based on the 2020 BAU Community forecast of 497,302 $MTCO_2e$, Livermore will need to reduce community emissions by 135,051 $MTCO_2e$ over the next eight years. As there is some uncertainty in the precise levels of reduction that would be achieved in practice, it is considered wise to plan for slightly more reductions than the target to provide a higher level of confidence that the target can be achieved. The measures described in this Plan would, if fully implemented, result in an emission reduction of 139,654 $MTCO_2e$, which exceeds the target of 15% below 2008 levels.

[13] "Current" as it pertains to the AB 32 Scoping Plan is commonly understood as sometime between 2005 and 2008.

3.3 Developing the CAP Framework

The City's CAP includes a variety of voluntary and mandatory strategies that would affect emissions in both the existing built environment, as well as emissions from new development expected to occur by the year 2020. The CAP builds on current statewide initiatives (such as the California Renewable Portfolio Standard [RPS]) and prior local initiatives. Strategies in the CAP have the potential to both reduce GHG emissions and save local residents and businesses money; for example, measures for existing residential and non-residential buildings to voluntarily improve energy efficiency, if implemented, could reduce energy costs for building owners and occupants and reduce GHG emissions.

3.3.1 Reduction Measure Selection Process

The City's CAP includes a variety of reduction measures that are proposed in addition to State legislation and policy. The reduction measures were selected following a comprehensive review of potential strategies that could be feasibly taken to reduce GHG emissions from the City's community activities and consideration of public and stakeholder input. The list of potential strategies drew from federal and state level resources, recommendations from the Attorney General, as well as existing CAPs throughout California.

3.3.2 Quantification of Emission Reductions

The quantification of GHG reductions was based on guidance provided by the California Air Pollution Control Officers Association (CAPCOA) and ICF's professional experience obtained from preparing CAPs for other jurisdictions in California. The majority of calculations were performed using standard factors and references, rather than performing a specific analysis of individual technologies. To the extent feasible, information specific to the City, such as electricity and natural gas consumption, was used in the calculations. See Appendix C for a detailed discussion of the assumptions and methodologies used to quantify emissions reductions for each individual measure.

3.3.3 Quantification of Costs

The cost analysis estimated the additional costs and savings associated with implementing each measure over the assumed lifetime of the measure. While many measures require upfront investments, they may result in savings over time that helps offset those costs. The cost analysis estimated the following metrics for each measure. Please see Appendix C for more detail about the methods used to estimate costs.

- **Net additional one-time (capital) costs or savings**. These costs represent the costs of purchasing new equipment, retrofitting equipment, planting trees—the "one-time" costs associated with implementing a measure. In many cases, these one-time costs are assumed to occur at the same time; however, there are a few cases where these one-time costs are actually spread over several years as the measure is fully implemented.
- **Net additional annual costs or savings in 2020**. Annual costs generally represent maintenance costs. Annual savings often represent avoided energy costs or avoided maintenance costs. Net annual costs/savings can vary by year, so this document presents the annual net costs anticipated in 2020.

- **Total discounted net costs (or savings).** Total costs or savings were calculated by considering the stream of all costs and savings over the lifetime of the equipment and applying a discount rate for future costs or savings. In some cases, there is no associated lifetime of equipment, and total costs/savings were calculated for the 2012-2020 time period. A discount rate of 5 percent was used.
- **Annualized discounted net costs (or savings) per ton of CO_2e reduction in 2020 (essentially, $/ton).** The total costs/savings were divided by an annuity factor to estimate the annualized costs/savings. This value is from the perspective of annual costs and savings, taking into account the time value of money. Because costs and savings are incurred over a period of several years, it is necessary to calculate the annualized so that it can be evaluated against the GHG reductions that occur in a single year (2020). This value provides an estimate of the cost per ton of implementing the measure.
- **Simple payback period.** The simple payback period is calculated by dividing the one-time costs by the annual savings, or (when annual costs vary) by calculating the break-even point. In some cases, the payback period would exceed the lifetime of the equipment, and this never would actually be "repaid." These instances are noted as "N/A" (for Not Applicable) in the summary tables. Note that the savings and costs are sometimes born by different entities, so the payback period does not necessarily indicate that a given entity would actually be paid back on its investment.

The numbers presented in this document are meant to provide order-of-magnitude estimates and assist in evaluating the relative costs/savings of each measure. There are numerous factors that will affect the actual costs incurred if the measures are implemented. In some cases, assumptions had to be made about the specific actions taken to implement a given measure, although the actual approach to implementing the measure could vary. Second, it is important to understand that in many cases, costs and savings are borne by different entities. For example, a local government may incur costs associated with planting and maintaining urban trees, but the savings from reduced electricity bills due to shading may accrue to local businesses and residents. Where appropriate, the description below distinguishes among the key players incurring the costs and savings.

Where measures are being done pursuant to state regulations and/or prior adopted policy of the City of Livermore, they are no considered to result in additional costs (or savings) due to the adoption of the CAP, as these costs (or savings) would occur regardless of the CAP implementation.

3.4 GHG Emission Reductions and Measures

3.4.1 Summary of Emission Reductions

When combined with federal and state efforts, the GHG reduction measures described in the City's CAP would reduce community GHG emissions by 139,654 $MTCO_2e$. The largest GHG reductions due to local initiatives are achieved by residential and commercial energy (both energy efficiency and renewable energy) programs, water measures, and waste reduction measures with lesser reductions from transportation and land use, wastewater, and urban forestry. Supporting measures detailed in Chapter 4 could also contribute to additional reductions in the future if implemented. Local effects of California's cap-and-trade program, once implemented, could also contribute addition reductions in the City.

Table 3-1 summarizes GHG emissions reductions and cost by candidate measure; Figure 3-1 provides a graphical representation of the GHG reductions presented in Table 3-1. Examples of individual entity GHG emission rreductions and cost for the CAP are shown in Table 3-2. As shown in Table 3-1, approximately 72% and 27% of the GHG reductions achieved by the CAP are attributed to state- and local-level programs, respectively. The City has limited control over the implementation of state programs, as these programs are organized and operated by state agency staff and the City is mandated to comply. Conversely, the state must defer to the City for certain planning decisions that are made at a local level, such as the adoption of local zoning regulations, which remain under the jurisdiction of local governments. The programs described below outline a path for reducing community emissions in conjunction with planned state actions.

A number of measures, such as water conservation and waste diversion, are existing and ongoing initiatives that the City has adopted. These measures would not represent new programs and their costs and savings would not be related to CAP adoption.

There are new measures associated with the CAP with net savings within the building energy and transportation. On a per-ton basis, costs/savings ranged from net savings of $3,500 per ton (Energy-6b, PPA option) to net costs of $3,100 per ton (Energy-6, owner financed option). If solar measures are implemented using power purchase agreement (PPA) approaches, then overall implementation of the CAP by the City and the community is expected to result in net savings to the community overall, ranging from $15 to $84 million over the lifetime of all measures. If the solar measures were entirely owner-financed, which is considered unlikely given the prevalence of PPA approaches (particularly in the residential market) today, then the overall program would result in net costs.

There are some important caveats to note regarding the cost analysis. First, the numbers presented in this document are meant to provide order-of-magnitude estimates and assist in evaluating the relative costs/savings of each measure. There are numerous factors that will affect the actual costs incurred (and who incurs those costs) if the measures are implemented. In some cases, assumptions had to be made about the specific actions taken to implement a given measure, although the actual approach to implementing the measure could vary. Second, it is important to understand that in many cases, costs and savings are born by different entities. For example, a local government may incur costs associated with planting and maintaining urban trees, but the savings from reduced electricity bills accrue to local businesses and residents. Where appropriate, we distinguish among the key players incurring the costs and savings.

3.4.2 Federal and State Programs

Actions undertaken by the federal government and state will contribute to GHG reductions in the City. For example, as discussed in Chapter 1, the state requires electric utility companies to increase their procurement of renewable resources by 2020. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to the City will be cleaner and less GHG intensive than if the state hadn't required the renewable standard. Even though state measures do not always require local government action, emissions reductions achieved by this and other state measures will help lower GHG emissions in the City.

The City has quantified one federal initiative and nine statewide initiatives that will contribute to community reductions within Livermore.[14] The majority of these programs will improve building energy efficiency and renewable energy generation. Specifically, Title 24 standards for new residential and non-residential buildings will require building shells and components be designed to conserve energy and water. Similarly, energy efficiency strategies required by AB 1109 will reduce electricity consumption from lighting. Finally, the state's RPS will increase the amount of electricity generated by renewable resources.

Over the past several decades, California has become a leader in establishing initiatives to reduce fuel consumption and on-road vehicle emissions. The proposed Advanced Clean Car initiative will introduce new standards for model years 2017–2025, and will increase fuel economy up to 62 miles per gallon by 2025. These new fuel economy standards are more stringent than what is currently required under Federal café standards. CARB has also adopted the Low Carbon Fuel Standard, which requires a 10% reduction in the carbon intensity of California's transportation fuels by 2020[15] as well as several other efficiency measures in the AB 32 Scoping Plan. Together, these measures will reduce light- and heavy-duty vehicle emissions.

Regarding near-term fuel economy standards, recent changes to Federal Corporate Average Fuel Economy (CAFE) standards require new passenger cars, light-duty trucks, and medium-duty passenger vehicles to meet a combined 35.5 miles per gallon (mpg) in model year 2016. AB 1493 addresses similar reductions, and the City avoided double counting between related measures. Reductions due to changes in Federal CAFE standards are quantified as part of those reductions due to AB 1493. A complete list of federal and state programs included in the City's CAP, as well as anticipated GHG reductions, is presented in Table 3-3.

[14] State measures to reduce industrial sources were not quantified as industrial source emissions were not included in the City's inventory. Regulation of industrial emissions is primarily done by the Bay Area Air Quality Management District and the California Air Resources Board and thus is not a normal prerogative of local government.

[15] CARB approved the LCFS on April 23, 2009 and the regulation became effective on January 12, 2010 (California Air Resources Board 2011). The U.S. Fresno Federal District court ruled in December 2011 that the LCFS violates the Commerce Clause of the U.S. Constitution and issued an injunction preventing California from implementing the LCFS. CARB appealed this ruling in early January, 2012. While the legal issues are being resolved, given the pending appeal by CARB, it is assumed for the time being that the LCFS will be ultimately implemented by 2020 as proposed. If the LCFS were ultimately to be blocked from implementation due to federal legal constraints, the goal for reduction for the CAP would be adjusted downward accordingly.

Table 3-1. Summary of 2020 GHG Emission Reductions and Cost for the Livermore CAP

Measure Title	Brief Measure Description	2020 GHG Reduction		Additional One-time/Capital Costs			Net Additional Annual Costs or (Savings) in 2020			Total Costs or (Savings)		Annualized Cost or (Savings) per $MTCO_2e$		Simple Payback Period		Measure Lifetime
		$MTCO_2e$	% of Total	Low	High	Incurring Entity	Low	High	Incurring Entity	Low	High	Low	High	Low	High	
Building Energy Use																
Energy-1	Existing Residential Energy Efficiency Voluntary Retrofits	2,999	2.1%	$12,408,032	$21,867,722	Residential building owners	($1,111,338)		Building owners/residents	($583,054)	$8,876,636	($17)	$253	11	20	18
Energy-2	Existing Commercial Energy Efficiency Voluntary Retrofits	3,562	2.6%	$4,144,048	$6,600,806	Building owners	($2,382,428)		Building owners/residents	($23,705,547)	($21,248,789)	($569)	($510)	2	3	18
Energy -3	Exceed Title 24 Requirements	1,425	1.0%	$6,545,591	$10,779,242	Builders and buyers of new buildings	($502,381)		Building owners/residents	284,813	$4,518,464	16	254	13	>lifetime	20
Energy-4	Streetlights	92	0.1%	$647,500	$1,526,250	City [d]	($135,158)	($116,232)	City	($876,275)	$215,842	($842)	$207	5	13	17
Energy-5	Voluntary Rooftop Solar (owner financed)	7,227	5.2%	$160,716,575		Building owners	($2,409,584)		Building owners/residents	$43,674,480		$429		> lifetime		25
	Voluntary Rooftop Solar (PPA financed)			$0 [e]	$0 [e]	PPA issuer	($2,302,028)	($497,073)	PPA issuer, Building owners/residents	($32,445,224)	($7,005,594)	($319)	($69)	NA		15
Energy-6	Voluntary Solar Over Parking Areas (owner financed)	211	0.2%	$25,529,358		Building owners	($487,028)		Building owners/residents	$9,463,592		$3,185		>lifetime		25
	Voluntary Solar Over Parking Areas (PPA financed)			$0 [e]	$0 [e]	PPA issuer	($1,203,353)	($259,833)	PPA issuer, Building owners/residents	($16,959,986)	($3,662,075)	($5,709)	($1,233)	NA		25
Transportation and Land Use																
On Road-1	Idling Restrictions	498	0.4%	$0	$126,190	Vehicle owners	($226,363)		Vehicle Owners	($1,747,914)	($1,621,724)	($454)	($421)	0	1	10
On Road-2	Transit Orientated Development	1,096	0.8%	NE		NE	NE		NE	NE		NE		NE		NE
On Road-3	Transit Enhancements	365	0.3%	NE		NE	NE		NE	NE		NE		NE		NE
On Road-4	Traffic Signal Synchronization	731	0.5%	$284,429	$2,200,000	City [d]	($312,457)		Vehicle Owners	($28,029)	$1,877,543	($38)	$1,272	<1	7	8
On Road-5	Bicycles and Pedestrian Improvements	694	0.5%	$2,464,237	$6,840,382	City [d] and Private Developers	($902,064)	($464,449)	City	($8,777,473)	$1,052,315	($1,015)	$122	2	4	20
On Road-6	Car Sharing Programs	37	0.03%	TBD	TBD	Program Operator	TBD		City, Residents	TBD	TBD	TBD	TBD	TBD	TBD	10
Water Conveyance																
Water-1 [a]	Per Capita Urban Water Use Reduction	Conveyance: 1,089 Hot Water: 5,281	4.0%	State-mandated program; not an additional cost of the CAP.			NA			NA		NA		NA		NA
Wastewater Treatment																
Wastewater-1	Aeration Diffuser	38	0.03%	NE		City [d]	($13,899)		City	NE		NE		NA		NE
Solid Waste Generation																
Waste-1	Waste Diversion	12,307	8.8%	Existing City Program; not an additional cost of the CAP			NA			NA		NA		NA		NA

Measure Title	Brief Measure Description	2020 GHG Reduction		Additional One-time/Capital Costs			Net Additional Annual Costs or (Savings) in 2020			Total Costs or (Savings)		Annualized Cost or (Savings) per $MTCO_2e$		Simple Payback Period		Measure Lifetime
		$MTCO_2e$	% of Total	Low	High	Incurring Entity	Low	High	Incurring Entity	Low	High	Low	High	Low	High	
Urban Forestry and Conservation																
Urban-1	Urban Shade Trees (Note: Cost Analysis does not include other benefits such as air quality and home value –see text)	176	0.1%	$298,200	$413,700	City [d], Private Developers	$66,194	$91,441	City (maintenance); private sector (energy savings)	$806,760	$1,132,988	$266	$374	>life-time	>life-time	40
Municipal Energy-Efficiency Measures (Not included in total below to avoid double-counting)																
Mun-1	Municipal EE Actions	2,340	-	NE	NE	City [d]	$1,009,802		City	NE	NE	NE	NE	NE	NE	NE
State Program GHG Reductions		101,797	73%	-	-	-	-	-	-	-	-	-	-	-	-	-
City of Livermore Local GHG Reductions		37,857	27%	-	-	-	-	-	-	-	-	-	-	-	-	-
Total GHG Reductions (State + Local)		139,654	100%	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes

[a] Water-1 will reduce water consumption, which will likewise contribute to reductions in building energy. For example, efficient faucets that use less water require less electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Emissions reductions achieved by Water-1 through reduced water conveyance are reported in the water sector.

[b] Source for Cost/Ton and Payback term estimates = Capital and O & M costs in Table 4-1 and Table 4-2 and cost source estimates in Appendix C.

[c] Totals do not include potential LAVTA costs for Trans-1, 2, 3, and 6.

[d] City costs would be funded through various local, state, and federal funding sources.

[e] These scenarios assume 100% of new solar installations are financed through Power Purchase Agreements with solar energy providers. In these scenarios, it is assumed that there are no upfront costs to the building owner.

Table 3-2. Examples of Individual Entity GHG Emission Reductions and Cost for the Livermore CAP

Measure	Description	Action	Details	Upfront Cost	Annual Maintenance Cost	Annual Savings	Net Total Cost/(Savings)
Energy- 1	Existing Residential Energy Efficiency Voluntary Retrofits	Single Residence Energy-Efficiency Retrofit	Retrofit: Audit, Indoor light upgrade, thermostat, duct sealing, air sealing, gas furnace, gas dryer, attic insulation, windows (4)	$150 - $900 (audit) $3,000 - $6,800 (retrofit)	N/A	~$1,000	Net lifetime savings of $2,700 to net cost of $1,600
Energy - 2	Existing Commercial Energy Efficiency Voluntary Retrofits	Single Commercial Bldg. Energy-Efficiency Retrofit	Retrofit of 10,000 sf of commercial space	$900 - $5,000 (audit) $9,500 – $15,000 (retrofit)	N/A	~$5,500	Net lifetime savings of $49,000 – $54,000
Energy –5a	Voluntary Rooftop Solar (owner financed)	Single Residence Rooftop Solar	Solar installation of 5 kw, owner-financed	$27,000 (upfront cost paid by owner)	$100/year	~$550	Net lifetime cost of $14,000
	Voluntary Rooftop Solar (PPA financed)	Single Residence Rooftop Solar	Solar installation of 5 kw, PPA-financed	Assume no upfront cost (installation paid by solar provider)	Included in PPA	~$250	Net lifetime savings of $6,300
Energy -6	Voluntary Solar Over Parking Areas (owner financed)	Commercial Solar Installation	Solar installation of 1.7 kw–capacity, owner-financed	$9,700(upfront cost paid by owner)	$34/year	~$200	Net lifetime cost of $2,800
	Voluntary Solar Over Parking Areas (PPA financed)	Commercial Solar Installation	Solar installation of 1.7 kw-capacity, PPA-financed	Assume no cost installation (installation paid by solar provider)	Included in PPA	~$40 to $80	Net lifetime savings of $600 to $1,200
Water -1	Per Capita Urban Water Use Reduction	Water Efficiency Retrofits	Kitchen and bathroom faucets, showerheads, toilets replaced with efficient units (replacement cost included). Dishwashers and clothes washers replaced for ENERGY STAR compliant models when needing replacement (only marginal costs included).	~870 (retrofit paid by building owner)	N/A	~$170	Net lifetime savings of $470
		Water Efficiency Fixtures/Appliances for New Construction	Installing more energy and water-efficient appliances. Install efficient kitchen and bathroom faucets, showerheads and toilets (only marginal costs over less efficient fixtures included). Dishwashers and clothes washers would be ENERGY STAR compliant models (only marginal costs included).	~$160 (paid by building developer)	N/A	~$249	Net lifetime savings of $1,760

Notes: Based on average costs and savings in cost analysis overall and/or project specific assumptions.

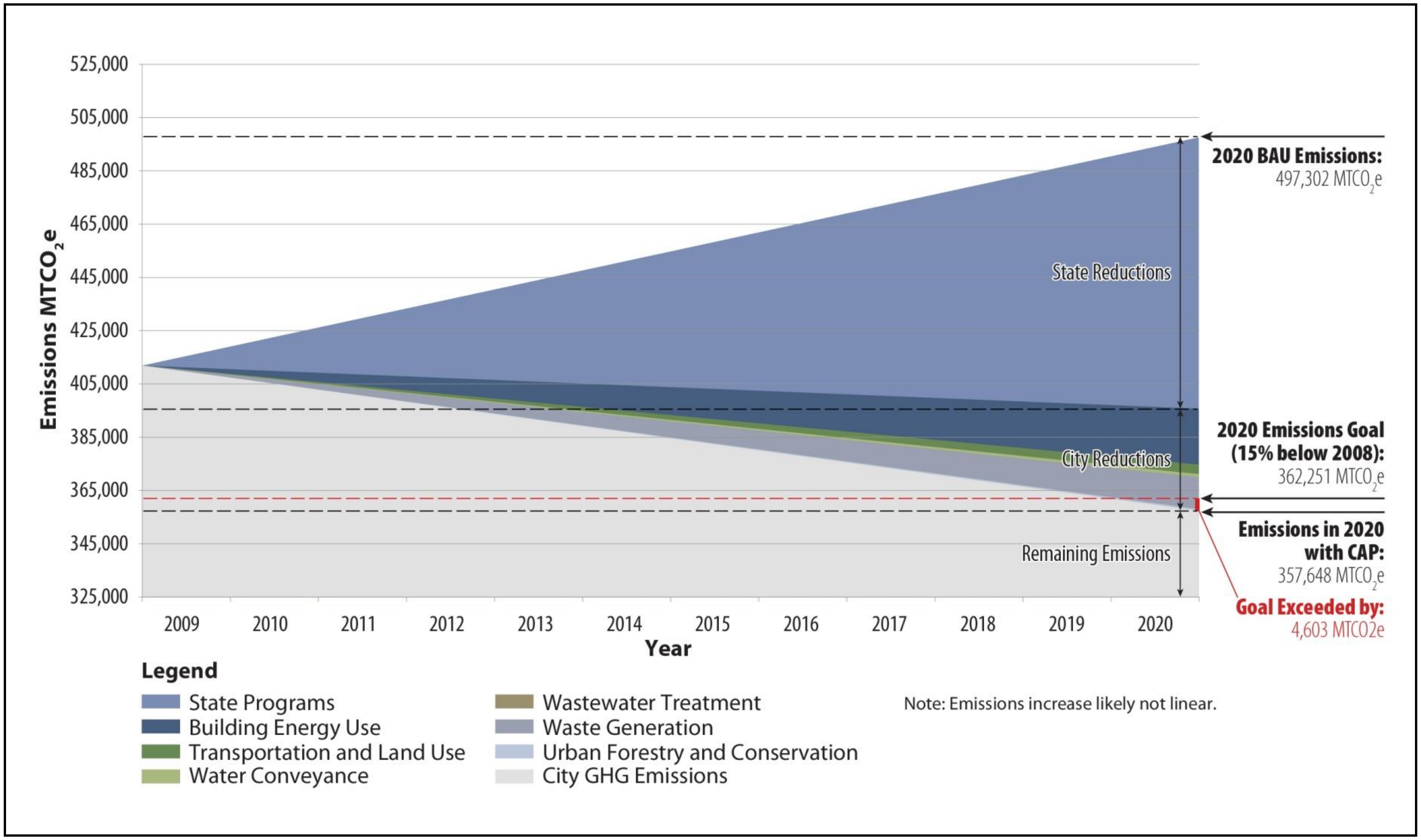


Figure 3-1. Summary of Emissions Reductions by Sector

Table 3-3. GHG Reductions Achieved within Livermore by State Programs (MT CO_2e)[a]

State Actions to Reduce GHG Emissions	MT CO_2e
Federal-1: CAFÉ	Quantified with State-7
State-1: Title 24 Standards for Non-Residential and Residential Buildings	7,234
State-2: Senate Bills 1078/107/X 1-2 (Renewable Portfolio Standard)	37,250
State-3: AB 1109 (Huffman) Lighting Efficiency and Toxics Reduction Act	10,104
State-4: AB 1470 Solar Water Heating and Efficiency	302
State-5: AB 1493 (Pavley I)	26,345
State-6: Advanced Clean Cars[b]	3,836
State-7: Low Carbon Fuel Standard	12,883
State-8: Vehicle Efficiency Strategies[c]	3,548
State-9: AB 32 Landfill Methane Recovery	295
Total Reductions from State Programs	**101,797**

[a] Please refer to Appendix C for quantification details.

[b] Reductions calculated based on the existing Pavley II standard, which applies to model years 2017 to 2020 and will improve fuel economy to 43 miles per gallon. New standards for model years 2017 to 2025 have neither been officially proposed nor quantified. Actual reductions achieved by State-7 will therefore likely be higher than those presented in Table 3-3.

[c] Includes the following initiatives: tire pressure program, low friction oils, and heavy-duty aerodynamic efficiency.

3.4.3 City of Livermore Programs

The section summarizes local efforts that the City proposes to further reduce community-wide GHG emissions. The local measures identified by the City would improve building energy efficiency, increase renewable energy development, reduce vehicle and other transportation emissions, and reduce water conveyance. This section describes the individual reduction measures, both voluntary and mandatory, and their anticipated avoided GHG emissions.

The City has used 2005 as the baseline year for the emission Inventory and to project the 2020 BAU emissions; therefore, the City can receive "credit" for improvements in energy efficiency, use of renewable energy, transportation actions, waste reduction, and water conservation that occurred between 2005 and 2012. Actions that have already been taken will show their effect in future inventories by reducing overall GHG emissions. Thus, where a measure below, such as Energy-1, assumes a certain amount of residential retrofits by 2020, this would include all retrofits occurring between 2005 and 2020. As such, through voluntary actions by residents and businesses in Livermore, as well as through local governmental actions and programs, the City is already implementing some of the necessary actions to achieve its 2020 reduction goal.

Many of the reduction measures described in this section would result in financial, environmental, health, and other co-benefits for the City, its residents and businesses. These co-benefits include cost savings over conventional activities, reductions in criteria air pollutant emissions, increased job growth, increased economic growth, and public health improvements. These co-benefits would be achieved in addition to the co-benefits gained from implementation of state measures, which include, but are not limited to, increases in gross state product, per capita income, and jobs.

The City's CAP includes several actions for which GHG reductions cannot be quantified separately, but would likely result in GHG savings. These strategies directly support implementation of the reduction measures presented below by creating education programs, securing funding, and/or developing policies and guidelines. Chapter 4 identifies supporting actions that the City might undertake to facilitate implementation of the CAP.

The following sections describe the City's GHG reduction measures by sector. A graphical representation of estimated emissions reductions and average total cost (or savings) per $MTCO_2e$ reduced is provided for each measure. For comparative purposes, Figures 3-2 and 3-4 summarize these values across all sectors. Although not summarized in these figures, expected co-benefits are identified in the individual measure descriptions based on the following icons.

Benefits for the City of Livermore's GHG Reduction Measures

Reduced Energy Use	Reduced Energy Price Volatility
Reduced Waste Generation	Economic Growth
Resource Conservation	Public Health Improvements
Energy Diversification and/or Security	Increased Quality of Life
Reduced Air Pollution	Reduced Urban Heat Island Effect
Increased Property Values	Smart Growth

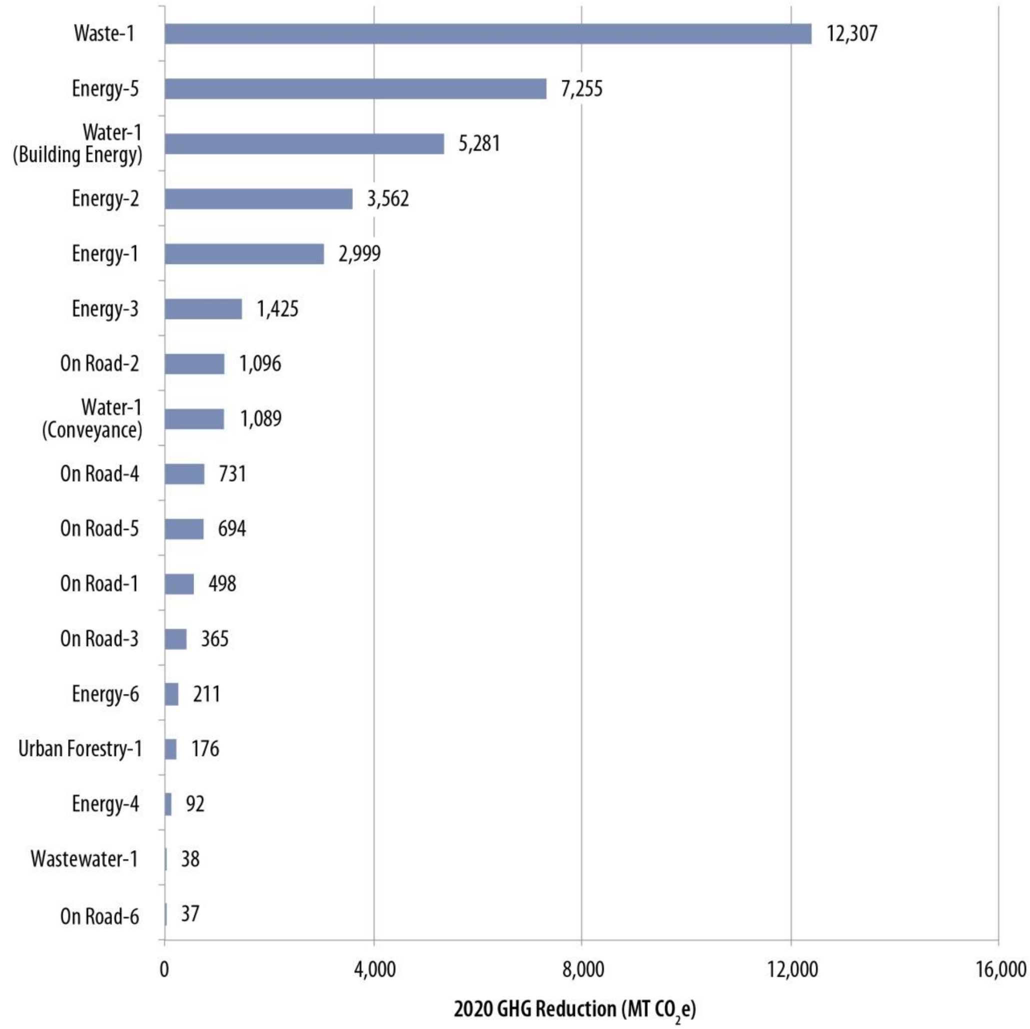


Figure 3-2. 2020 GHG Reductions ($MTCO_2e$) for the City of Livermore GHG Reduction Measures

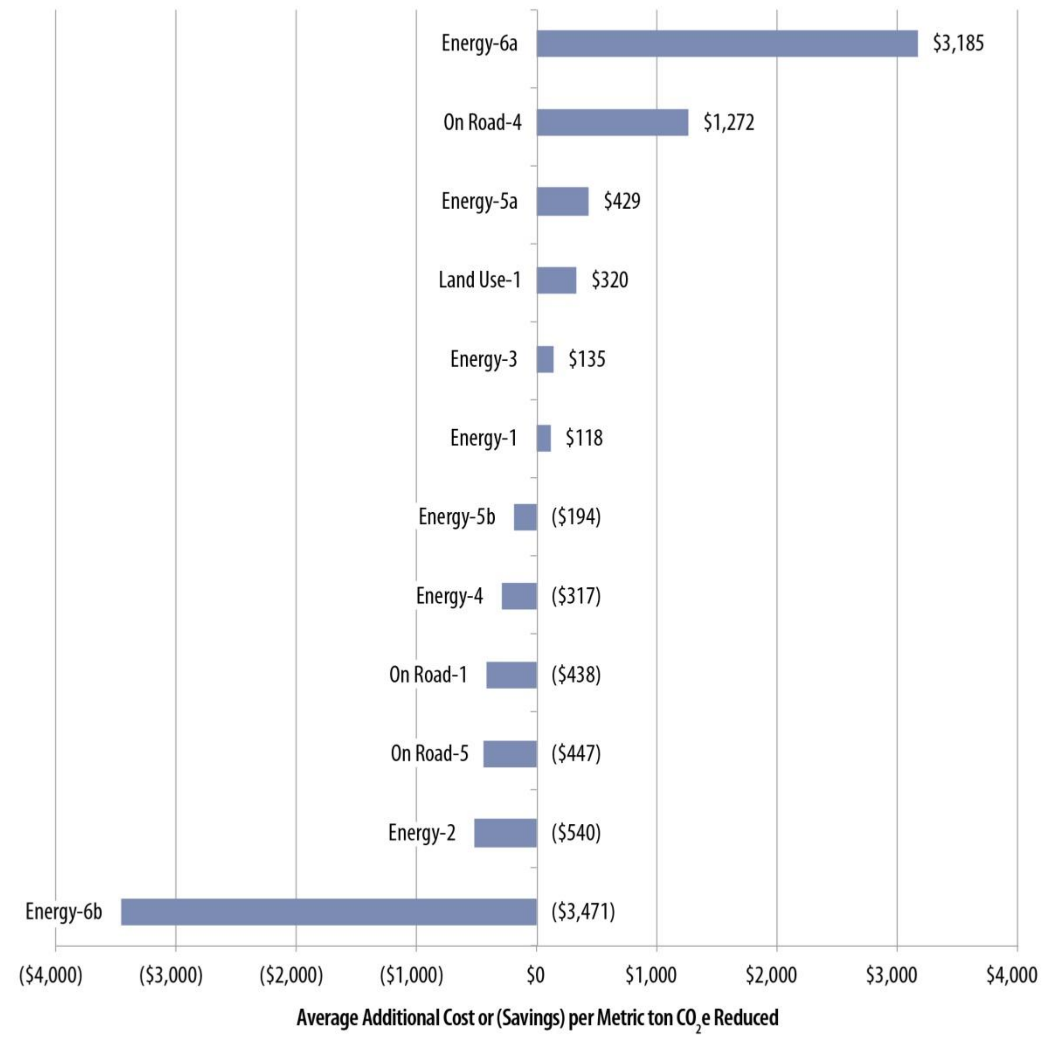


Figure 3-3. Average Total Discounted Cost or Savings per MTCO_2e Reduced for the City of Livermore GHG Reduction Measures

Building Energy Use

Energy – 1 Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings

Energy – 2 Energy Efficiency Voluntary Programs for Existing Commercial Development

Energy – 3 Exceed Title 24 Requirements for New Buildings

Energy – 4 Street lights

Energy – 5 Voluntary Residential and Non-Residential Rooftop Solar

Energy – 6 Voluntary Solar Over Parking Areas Program

Introduction

Reduction measures to address GHG emissions will improve energy efficiency and the percentage of energy generated by renewable resources. Energy efficiency measures (Energy-1 through Energy-4) are intended to promote efficient energy usage, whereas renewable energy measures are intend to reduce the carbon content of electricity (Energy-5 and Energy-6). Energy consumption by the City's built environment will represent over 53% of community emissions in 2020. Reducing electricity usage and improving energy performance are therefore vital to the City's CAP.

The building energy measures would result in co-benefits for both small and large businesses, as well as households in the City. Less combustion of natural gas may produce local air quality and public health benefits. Overall, reductions in energy consumption and expenditures would enhance the ability for homeowners and business to withstand unexpected surges in future energy costs. Energy retrofits would also improve home value and likely contribute to economic growth by providing new jobs within the community.

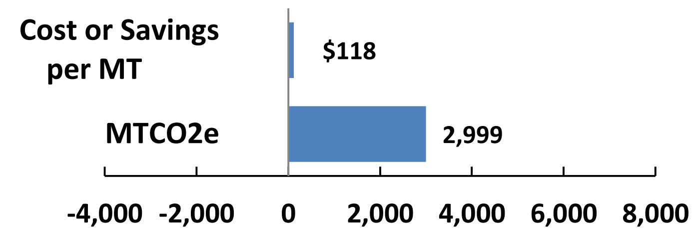
The City has identified six building energy measures. Note that Water-1 will contribute to reductions in building energy through reduced electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Please refer to the water sector (below) for a discussion of Water-1. As shown in Table 3-4, the reduction measures result in a combined reduction of approximately 20,825 $MTCO_2e$ in 2020 emissions.

Table 3-4. Building Energy Use GHG Emissions Reductions by Measure (MT CO_2e)

Energy Measure	2020 GHG Reduction	Percent of Building Energy Reductions	Percent of Total Reductions
Energy-1 Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings	2,999	14%	2.1%
Energy-2 Energy Efficiency Voluntary Programs for Existing Commercial Development	3,562	17%	2.6%
Energy-3 Exceed Title 24 Requirements for New Buildings	1,425	7%	1.0%
Energy-4 Streetlights	92	0.4%	0.1%
Energy-5 Voluntary Residential and Non-Residential Rooftop Solar	7,227	35%	5.2%
Energy-6 Voluntary Solar Over Parking Areas Program	211	1%	0.2%
Water-1 Per Capita Urban Water Use Reduction[a]	5,281	25%	3.8%
Total Reductions	**20,825**	**100%**	**14.9%**

[a] Water-1 will contribute to reductions in building energy through reduced electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Please refer to the water sector (below) for a discussion of Water-1.

Energy-1: Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings



	MTCO2e	Cost or Savings per MT
Energy-1	2,999	$118

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

Under this measure, the City would develop a promotional program that supports voluntary energy efficiency retrofits of existing residential buildings to achieve reductions in natural gas and electricity usage. In order to ensure implementation of this measure in the most cost-effective way, the program will include outreach to stakeholders interested in participating and linking the program to incentives provided by an array of public and private initiatives. This measure would support Climate Change Element Policy CLI-1.1 P5 in the City's General Plan.

One way the City has already supported voluntary energy efficiency retrofits is by providing federal grant funding to Rising Sun Energy Center, a non-profit green workforce development and retrofit services organization. The funding has been used by the Center to run the California Youth Energy Services (CYES) program in Livermore. The program hires and trains local youth to provide free in-home energy education and hardware installation to homeowners and renters. The program not only provides Livermore households of all income levels with energy saving hardware and information, but also provides an opportunity for Livermore youth to receive job training and education in energy conservation. Through the installation of materials and hardware such as compact fluorescent lamps, low-flow showerheads, power strips, and water heater pipe insulation, Rising Sun estimates an average annual reduction over the last three years of the program of 133,535 kWh, 1,481 therms, 203 gallons of water per minute, and 106 $MTCO_2e$.

Existing buildings generate a considerable amount of GHG emissions through energy consumption. Older buildings are typically less energy efficient and therefore consume greater amounts of electricity and natural gas, relative to newly constructed facilities. Conducting home energy audits can help homeowners identify energy retrofits that would improve energy efficiency and save money.

The following retrofits could be promoted through this program.

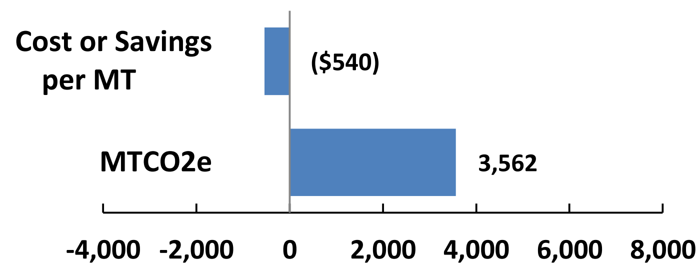
- Replace high use incandescent lamps with compact fluorescent lamps or LEDs.
- Replace electric clothes dryers with natural gas dryers.
- Install a programmable thermostat.
- Replace windows with double-pane solar-control low-E argon gas wood frame windows.

- Seal ducts and air leaks.
- Replace natural gas furnaces with an ENERGY STAR®-labeled model.
- Insulate building attics.

Implementation strategies include the following:

- Partner with community services agencies and other sources to identify funding opportunities for energy efficiency audits and projects, including heating, ventilation, air conditioning, lighting, water heating equipment, insulation and weatherization, for low income residents. Residential energy efficiency projects can be financed through programs such as PACE (Property Assessed Clean Energy) or California First (AB811) financing districts. Financing through PACE is currently only available to multi-family residential and commercial development, but funds may be available for single-family residential development at a later date. The California First program will be available beginning in the summer of 2012. These programs that allow property owners to finance improvements that are repaid through an assessment on their property taxes for up to 20 years. These, and similar programs, are often administered through the local government entity which chooses to participate.
- Launch a climate protection action-awareness campaign targeted at residents. The campaign should provide education on energy efficiency and emissions reduction programs, Smart Grid, and other incentive programs offered by PG&E. To minimize implementation cost to the City, outreach could be done using existing outreach venues, such as the City newsletter or a dedicated web page.

Energy-2: Energy Efficiency Voluntary Programs for Existing Commercial Development



	MTCO2e	Cost or Savings per MT
Energy-2	3,562	($540)

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

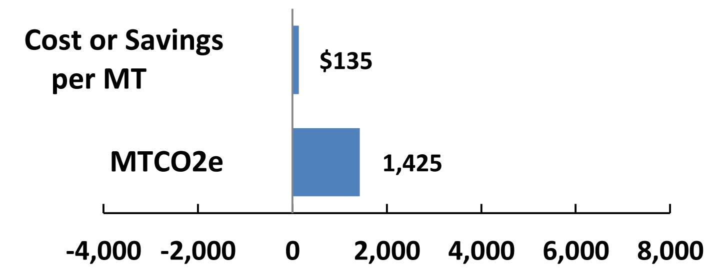
Under this measure, the City would promote voluntary programs for existing commercial facilities to improve building-wide energy efficiency. In addition, the City would adopt a program that encourages existing commercial facilities to improve building-wide energy efficiency by 20% by 2020 (compared to 2005).[16] Increased energy efficiency in commercial facilities would result in decreased energy consumption. Potential goals for this program could overlap with those outlined in Energy-1, and would support Climate Change Element Policies CLI-1.1 P5 and CLI-1.5 P8 in the City's General Plan.

Implementation Strategies include the following:

- Promote energy efficiency "tune-ups" of existing buildings. Energy audit and tune-up programs are typically run by the local utility.
- Promote individualized energy management services for large energy users. The City will work with PG&E to take advantage of energy audit programs for municipal buildings and promote awareness of these programs for private commercial buildings.
- Conduct outreach and provide information about funding sources for energy efficiency improvements. For example, inform residents and businesses about federal tax credits or local rebates, such as those offered by local utilities. Encourage participation in programs (national, state or regional) that provide innovative, low-interest financing (including AB 811 finance districts) for energy efficiency and alternative energy projects.
- Launch energy efficiency campaigns targeted at business. Develop a recognition program to highlight businesses that operate in an environmentally friendly manner.

[16] These goals were developed based on state and federal programs to improve the energy efficiency of existing commercial buildings (U.S. EPA 2010; City of San Francisco 2009; Belzer 2009; U.S. Department of Energy 2008). The Energy Star Challenge is a national campaign to improve the energy efficiency of commercial buildings by 10%. The U.S. Department of Energy's Commercial Building Initiative sets a similar national goal to improve energy performance by 30% by 2025. The City of San Francisco has set a slightly more aggressive goal by committing to a 50% reduction in existing energy use by 2030. The goals selected for the Livermore Area considered these initiatives, as well as economic considerations, such as the Pacific Northwest National Laboratory's (Belzer 2009) finding that a 10-20% reduction in current energy use is economically reasonable.

Energy-3: Exceed Title 24 Requirements for New Buildings



	MTCO2e	Cost or Savings per MT
Energy-3	1,425	$135

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

In 2009, The City of Livermore adopted the Title 24 Voluntary Tier 1 standards in Title 24 which are 15 % better than the mandatory standards. Under this measure, the City would periodically update and strengthen its adopted energy efficiency standards to exceed state mandatory standards to reduce energy consumption.

Title 24 was established in 1978. The mandate includes energy efficiency standards, which are periodically updated to account for new technologies, for residential and non-residential development. Simply meeting the current Title 24 Standards in 2020 would result in significant energy and GHG savings for the City (Table 3-1) because the state has regularly updated the Title 24 requirements since 2005 and plans to continue to update the Title 24 standards periodically in the future. All new development is required to meet Title 24 standards, and these reductions are quantified as part of the state measure.

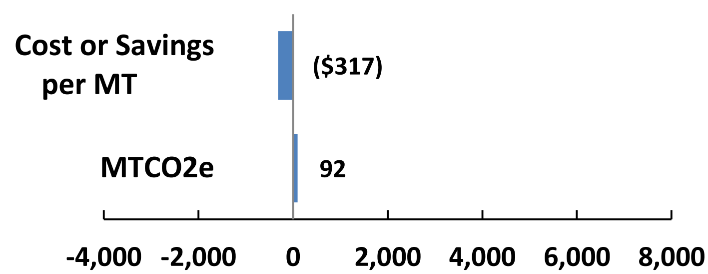
This measure would require the City to continue to "stay ahead" of Title 24 future requirements by periodically updating the Code to exceed Title 24 Standards (or any subsequent standards that replace the current Title 24 Standards) by 15% through 2020.

Methods and options to achieve greater energy efficiency in new development, thereby reducing energy consumption, to meet the existing and future ordinance could include the following.

- Require programmable thermostats in all new residential developments.
- Implement the CALGREEN voluntary measure for third-party heating/venting, air conditioning (HVAC) commissioning and verification for new residential development and CALGREEN's voluntary measure on the use of setback thermostats for commercial building HVAC systems (i.e., all unitary heating and/or cooling systems, including heat pumps) not controlled by a central energy management control system.
- Optimize thermal distribution by separating ventilation and thermal conditioning in structures.
- Paving with a Solar Reflectance Index (SRI) of at least 29.
- Implement or exceed CALGREEN's voluntary Tier 1 and Tier 2 measures for roofing materials and solar reflectance for residential and nonresidential buildings.
- Implement or exceed CALGREEN's voluntary measure for building orientation and shading in nonresidential buildings.

- Light colored/high albedo materials and/or open grid pavement for at least 30% of non-roof surfaces. Implement or exceed CALGREEN's voluntary measures to reduce non-roof and roof heat islands.
- Incorporation of Leadership in Energy and Environmental Design (LEED) elements into building design.
- Implement or exceed CALGREEN's voluntary measures for cool roofs on non-residential buildings.
- Implement or exceed CALGREEN's voluntary measures for material sources for building construction, including use of recycled-content and regional materials.
- Implement or exceed CALGREEN's voluntary measures for reducing cement use in residential and nonresidential buildings.

Energy-4: Streetlights



	MTCO2e	Cost or Savings per MT
Energy-4	92	($317)

Measure Co-Benefits

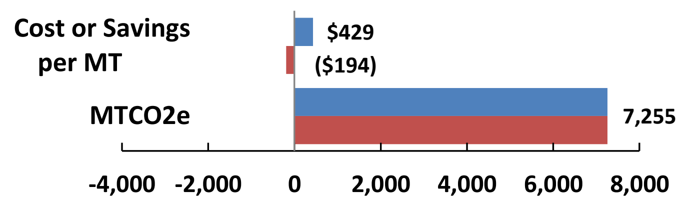
Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

Community infrastructure, including streetlights, consumes a significant amount of electricity. Lighting requires the consumption of electricity to power the lights; this consumption of electricity represents an indirect source of GHG emissions. Different light fixtures have different efficiencies; in other words, certain bulbs can utilize less electricity to obtain the same output. Replacing less-efficient bulbs with energy-efficient ones therefore reduces electricity consumption, and thus GHG emissions. Under this measure, the City would continue upgrading light fixtures with energy efficient bulbs to reduce electricity consumption. The measure would require the following for municipal lighting.

Airport lighting: Consider retrofitting outdoor runway and taxiway lighting fixtures from incandescent to LED.

Street Lighting: Require 15% reduction in electricity use by street lighting by 2020.

Energy-5: Voluntary Residential and Non-Residential Rooftop Solar



	MTCO2e	Cost or Savings per MT
Owner-financed	7,255	$429
PPA-financed	7,255	($194)

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

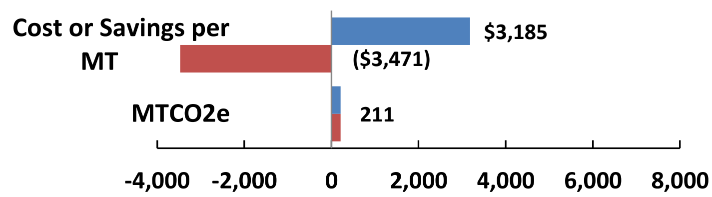
Under this measure, the City would encourage businesses and residents to install rooftop solar on existing buildings. This measure would reduce reliance on sources of energy that emit GHGs, thereby reducing GHG emissions.

When Power Purchase Agreements (PPAs)[17] financing is available on a no upfront cost basis (or minimal cost basis), rooftop solar can be installed in the City with little or no up-front investments, and can reduce costs associated with electricity use for the business owner or homeowner. Given current electricity prices, owner-financed approaches with upfront investment costs are not estimated to be producing discounted net savings, even though they lower energy costs. However, if electricity costs in the future increase notably, owner-financed solar installations would have better financial returns over time. At this time, it is presumed that solar rooftop installations will primarily expand due to low or no-cost upfront PPA arrangements.

This measure assumes 10% of existing commercial electricity use and 5% of existing residential electricity use are provided entirely by solar electricity in 2020. This measure would include any existing residential or non-residential solar retrofits that are installed between 2005 and 2020. This measure would support Climate Change Element Policies CL-1.5 P1, P2, and P5 in the City's General Plan.

[17] PPAs involve a contract between the owner of a building and a private company, which are often arranged as follows: the private company installs and maintains a rooftop solar system on the building owner's property. The building owner then pays the private company an agreed-upon rate for the electricity generated by the solar system. The building owner gets the benefit of solar power, but without the standard up-front costs of installation and regular costs of maintenance. Such arrangements would involve no cost to the City.

Energy-6: Voluntary Solar Over Parking Areas Program



	MTCO2e	Cost or Savings per MT
Owner-financed	211	$3,185
PPA-financed	211	($3,471)

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

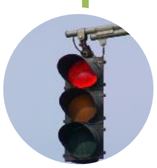
Under this measure, the City could establish a goal for 15% of existing commercial development and multi-family housing complexes to install solar panels over parking areas by 2020 (CA Attorney General's Office 2010a). In addition, the City would continue to fast track permits for the installation of solar technology and investigate other potential low or no cost incentives to encourage solar installation over parking areas. This measure would reduce reliance on sources of energy that emit GHGs, thereby reducing GHG emissions.

Transportation and Land Use

On Road – 1 Idling Restriction

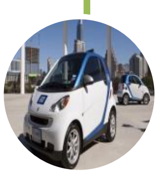
On Road – 2 Transit Oriented Development

On Road – 3 Transit Enhancements



On Road – 4 Traffic Signal Synchronization

On Road – 5 Bicycle and Pedestrian Systems Improvements



On Road – 6 Car Sharing Programs

Introduction

The transportation sector typically represents the largest source of GHG emissions in a City's existing and future community GHG inventories. Within Livermore, transportation represents the second largest source of emissions, representing almost 38% of the City's inventory in 2020. As a result, transportation-related reduction measures have great potential in reducing the City's overall GHG emissions. Implementing transportation measures can be difficult because it involves influencing individuals driving habits. However, it is important to note that the measures outlined below would also contribute to significant reductions in GHG emissions beyond 2020 as they would create a transportation and land use network that supports mixed-use, high density development, and alternative modes of transportation.

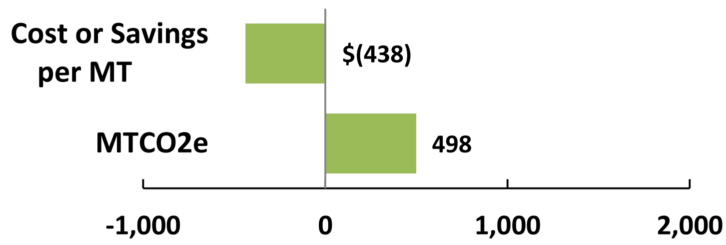
Land use and transportation measures can achieve significant co-benefits for individual residents and the community as a whole. Reductions in VMT and traffic congestion would reduce smog-forming emissions, toxic air contaminants, and diesel particulate matter (California Air Resources Board 2008). Alternative modes of transportation, such as bicycling, walking, and transit, may also help reduce many serious health risks associated with vehicle exhaust. Community well-being and quality of life may also be improved as individuals spend less time commuting, waiting for the bus, and/or sitting in heavy congestion.

The City has identified the following six transportation and land use energy measures. By 2020, these measures would result in a reduction in VMT, compared to 2020 BAU conditions, of over 12 million miles per year. Moreover, as shown in Table 3-5, these measures result in a combined reduction of 3,421 $MTCO_2e$ in 2020 emissions.

Table 3-5. Transportation and Land Use GHG Emissions Reductions by Measure (MT CO_2e)

On Road Measure	2020 GHG Reduction	Percent of On Road Reductions	Percent of Total Reductions
On Road-1 Idling Restrictions	498	15%	0.4%
On Road-2 Transit Oriented Development	1,096	32%	0.8%
On Road-3 Transit Enhancements	365	11%	0.3%
On Road-4 Traffic Signal Synchronization	731	21%	0.5%
On Road-5 Bicycle and Pedestrian System Improvements	694	20%	0.5%
On Road-6 Car Sharing Programs	37	1%	0.03%
Total Reductions	**3,421**	**100%**	**2.4%**

On Road-1: Idling Restrictions



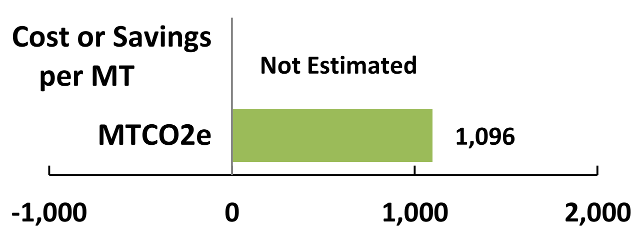
	MTCO2e	Cost or Savings per MT
On Road-1	498	$(438)

Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

Under this measure, the City would adopt an ordinance that limits idling time for heavy-duty trucks beyond CARB regulations, which limits idling to five minutes. The recommended idling limit under this program would be 3 minutes. The reduced idling time would in turn reduce fuel usage and the associated GHG emissions. This measure would support Climate Change Element Policy CLI-1.3 P10. The City will also develop an idling restriction policy for municipal vehicles. There is a long list of cities and counties that have implemented idling policies with a limit of 3 minutes (or less) including: Park City, Utah; Toronto, Canada; Minneapolis, Minnesota; Washington D.C.; St. Louis County, Missouri; New York City, New York; Philadelphia, Pennsylvania; Chicago, Illinois; and Salt Lake City, Utah. States that have adopted 3-minute idling restriction include Connecticut, Delaware, and New Jersey. Implementation measures vary, but can include signage, warning tickets, and fines for repeat offenders. Due to the proliferation of anti-idling ordinances, there is a growing idle reduction industry developing and selling technology to help with truck energy management in idling circumstances.

On Road-2: Transit Oriented Development



	MTCO2e	Cost or Savings per MT
On Road-2	1,096	

Measure Co-Benefits

Under this measure, the City would expand land use planning to support increased transit use and alternatives to vehicle travel. Specifically, this measure includes land use regulations that would encourage Transit Oriented Development (a mixed-use area designed to maximize access to public transport) at the Vasco and Downtown ACE stations. Such development would reduce the amount of vehicle miles traveled by residents, thereby reducing emissions from automobiles and consequently GHG emissions.

At the Vasco Road ACE Station, development would include a total of 510 new housing units and 16 acres of open space north of ACE station/parking. Housing types anticipated include: 110 clustered townhomes, 84 clustered condos, 200 row-homes, and 116 duets. At the Downtown Ace Station, the Downtown Specific Plan would allow mixed uses with development maximums as follows.

- Commercial: 1,000,000 square feet
- Office: 356,000 square feet
- Entertainment: 2,500 performance art seats and up to 15 movie theatre screens
- Lodging: 300 rooms
- Residential: 3,600 units (approximately 3,200 new units)

For the purposes of the CAP, it is expected that by 2020, the following new uses would have been constructed in the Downtown area, including uses constructed between 2005 and 2011.

- 28,905 square feet of office (constructed).
- 318,014 square feet of commercial (288,014 square feet constructed; an additional 30,000 square feet assumed by 2020).
- 500 seat Performing Arts Theater (constructed).
- 13 screen Movie Theater (constructed).
- 959 housing units (250 units constructed, an additional 709 units assumed by 2020).
- 120-room boutique hotel (planned for construction by 2020).

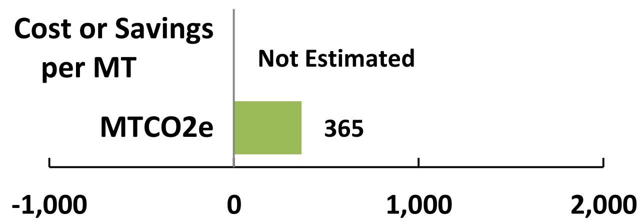
Research has found a link between density and travel behavior; when destinations are close together people are more likely to take modes other than private vehicles. Likewise, positive pedestrian design leads to fewer vehicle trips as mixed use development has the potential to reduce vehicle usage by providing adjacent services that can be accessed by walking. *(Supporting Climate Change Element Policies: CLI-1.3 P4, P12, P13, and P14).*

The research indicates that increases in density can reduce VMT by up to 30%, increasing location efficiency within a region (such as infill development in a downtown area) can reduce VMT by up to 65%, increasing the diversity of land uses can reduce VMT by up to 30%, and increasing destination accessibility can reduce VMT by up to 20%. The reductions typically apply to new development; however, providing increased local shopping opportunities within an established neighborhood can alter the travel behavior of existing residents.

Costs for this measure include the net total of marginal difference of development in infill areas vs. development in outlying areas and the annual savings in reducing vehicle driving due to living close to services and with increased transit opportunities. Costs were not estimated for the marginal different of development as such a calculation depends on both the specifics of the proposed infill development and the alternatives outfill development as well as the infrastructure costs of both locations. Infill development can have less cost than outfill/edge development in part due to the existence of existing infrastructure. However, sometimes infill infrastructure requires replacement or expansion and infill development can incur remediation/rehabilitation/demolition costs that Greenfield sites due not usually incur. Thus without specific proposed infill projects and their comparable outfill development alternative, it is difficult to estimate the costs of this measure.

This measure is expected to result in a net-decrease in daily VMT of approximately 18,322 miles.

On Road-3: Transit Enhancements



	MTCO2e	Cost or Savings per MT
On Road-3	365	

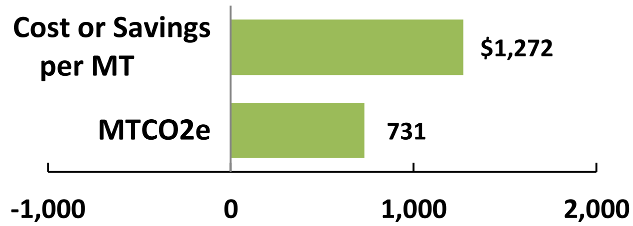
Measure Co-Benefits

Although the City of Livermore is not a transit provider, the City can encourage and require new developments to provide transit amenities within the Project area including the potential for bus stop amenities, and/or transit signal priority at intersections; or encouraging that new residences be located within a half-mile walk of an existing or planned transit route.

The Livermore Amador Valley Transit Authority (LAVTA) is the primary bus transit provider in the City of Livermore. Regular transit service is provided in the Tri-Valley area, serving the Cities of Dublin, Pleasanton and Livermore. Sixteen fixed routes are connecting primary activity centers, including both BART stations, in the Tri-Valley. Additional routes serving various schools are also provided. In 2009, service was cut approximately 25%. One Bus Rapid Transit (BRT) route was implemented in 2011. There are no plans to expand the number of BRT routes or the level of service on the existing route, and the primary goal of LAVTA over the next few years is to restore those service cuts made in 2009. Since LAVTA's primary focus in ensuring years is to restore service cuts made in 2009 to levels prior to that year, this assessment assumes that by 2020, service would be restored to the same per capita level that was provided in 2005 and that the recently implemented BRT route would continue to operate increasing ridership levels per capita above the 2005 levels. This would result in a potential daily VMT reduction of 4,072 miles above the BAU case.

No cost analysis was completed for this measure as this measure assumes actions by LAVTA that are not directly under the control of the City of Livermore. Costs could be incurred where transit amenities are included in new developments. Traffic light synchronization costs are included in On-Road 4. LAVTA service costs are under LAVTA control, not the City's control.

On Road-4: Traffic Signal Synchronization



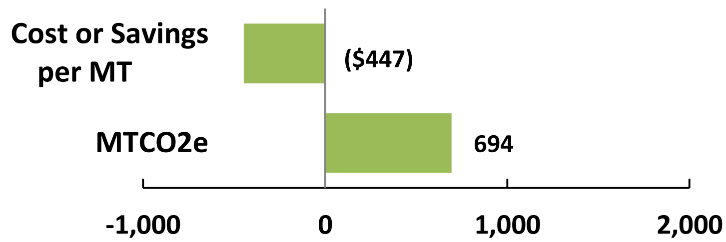
	MTCO2e	Cost or Savings per MT
On Road-4	731	$1,272
Measure Co-Benefits		

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

Under this measure, the City will improve travel speed by enhanced signal synchronization. This measure would reduce idling time for vehicles traveling within and through the city, and the reduced idling time would in turn reduce fuel usage and the associated GHG emissions. This measure would support Climate Change Element Policy CLI-1.3 P9 in the City's General Plan. This measure would not reduce VMT, but rather idling time and resultant emissions. On-Road 4 was calculated using the 2020 City-wide transportation emissions, 182,643 $MTCO_2e$, as a starting point. Reductions from overlapping measures were then subtracted from the City-wide transportation emissions, resulting in a revised transportation emissions total of 156,302 $MTCO_2e$. The following overlapping measures' emissions were subtracted from total transportation emissions: State 6 – AB 1493, State 7 – Advanced Clean Cars, State 9 – AB32 Vehicle Efficiency Strategies, On-road 1 – Idling Restrictions, On-road 2 – Transit Oriented Development, On-road 3 – Transit Enhancements, On-road 5 – Bicycles and Pedestrian System Improvements, and On-road 6 – Car Sharing.

A percent reduction factor of 1% was then applied to the revised transportation emissions total. This reduction factor, 1%, represents the approximate reduction in greenhouse gases due to implementation of traffic signal synchronization. The reduction factor represents an approximation of the potential reductions. A scaling factor of 0.5, derived from ICF's judgment and experience with other CAPs, was applied as well, giving a total reduction of 0.5% of on-road transportation emissions from implementation of On-Road 4.

On Road-5: Bicycle and Pedestrian System Improvements



	MTCO2e	Cost or Savings per MT
On Road-5	694	($447)

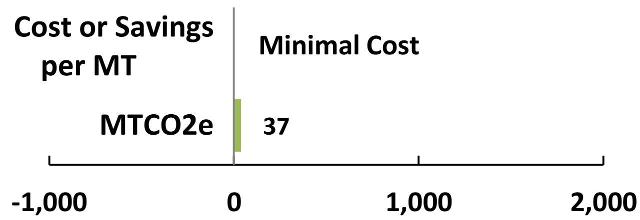
Measure Co-Benefits

Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

Under this measure, the City would continue implementing its bikeway and multi-use trail network identified in the General Plan and encourage employers to provide facilities for bicycle commuters, such as showers and bicycle lockers. These measures would encourage alternative modes of transportation, thereby reducing vehicle miles traveled and consequently GHG emissions. Cycling is a non-emission generating mode of transportation that has a high potential for success in Livermore. Completing existing gaps in the network and providing facilities for bicycle commuters can encourage them to use this mode for short and medium-length trips. (Supporting Climate Change Element Policies: CLI-1.3 P4 and P6).

Livermore had approximately 60 miles of Class I and Class II bicycle path facilities in 2003 and expects to add approximately 18.5 more miles of off-street and on street facilities by 2020, including 3.5 miles of multi-use trail facilities and 2.5 miles of bike lanes which were already constructed between 2005 and 2011. These new bike and pedestrian system improvements will close gaps in the network and connect new development areas to the existing system by 2020. This measure is expected to decrease daily VMT by approximately 7,736 miles.

On Road-6: Car Sharing Programs



	MTCO2e	Cost or Savings per MT
On Road-6	37	MC

Measure Co-Benefits 

This measure would include promotion of a car-sharing program to allow people to have on-demand access to a shared fleet of vehicles on an as-needed basis. This measure assumes that the City will work with private car sharing companies to promote car-sharing in Livermore. It is assumed that the fleet of vehicles would be a privately owned and operated fleet, which is then rented to residents who become members of the car-share program on a per-hour basis. Car Sharing was assumed to be implemented at both ACE stations on a limited basis and is expected to result in a net-decrease of 402 daily VMT.

Costs were not estimated for this measure as it would be primarily implemented by the private car-sharing companies and their members. For members using car-sharing services, they can experience cost savings depending on the vehicle ownership/operating costs that would be displaced over time. For the general public, car sharing is considered a cost-effective alternative to owning a vehicle that is driven less than 6K a year (http://www.vtpi.org/carshare.pdf).

The City would support car-sharing by converting a small amount of on-street parking to permanent spaces for vehicles within this fleet. (Supporting Climate Change Element Policies: CLI-1.3 P7). This would only require limited signage costs and limited decrease in parking fees for the City.

Water Conveyance

Water – 1 Reduce per Capita Urban Water Use 20% below 2008 per Capita Levels

Introduction

Not only is water an important resource with limited supplies, but the treatment, distribution, and conveyance of water requires considerable amounts of electricity. The generation of this electricity consumes fossil fuels and releases GHGs. Reducing water demand and conserving water can therefore save energy and avoid associated emissions.

The City has identified the following strategy to enhance community-wide water and resource conservation. This strategy would reduce water consumption, which would likewise contribute to reductions in building energy use. For example, efficient faucets that use less water require less electricity and natural gas for hot water heating. Additionally, energy required to transport, distribute, and treat water would be reduced. The consumption of less electricity and natural gas would ultimately translate to reductions in regional and local criteria pollutants, which may improve community health and well-being. Water measures that encourage building retrofits also have additional co-benefits of enhancing building value and resale. Table 3-6 summarizes anticipated GHG reductions from Water-1.

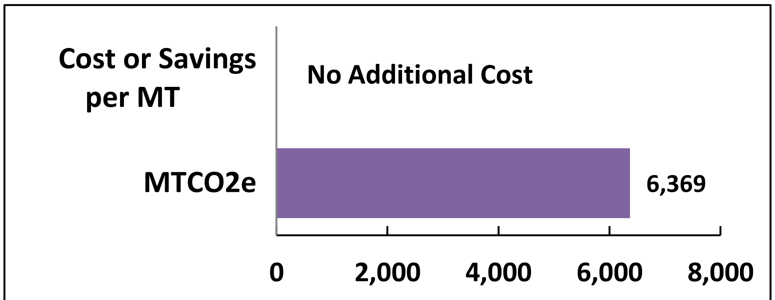
As previously discussed, Water-1 would achieve reductions in the building energy sector because of the energy required to transport and distribute water. Emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector (see Table 3-1). Only emissions reductions associated with reduce water conveyance are reported in the water sector. Table 3-6 summarizes these emissions reductions.

Table 3-6. Water Conveyance GHG Emissions Reductions by Measure (MT CO_2e)

Water Measure	2020 GHG Reduction	Percent of Sector Reductions	Percent of Total Reductions
Water-1 Reduce per Capita Urban Water Use 20% below 2008 per Capita Levels[a]	1,089	100% (water)	0.8%
	5,281	25% (building energy)	3.8%
Total Reductions	**6,369**	**N/A**	**4.6%**

[a] Table includes emissions reductions achieved by Water-1 through reduced water conveyance and through reduction of building energy

Water-1: Reduce Per Capita Urban Water Use 20% below 2008 per Capita levels



	MTCO2e	Cost or Savings per MT
Water - 1	6,369	NA

Measure Co-Benefits

Under this measure, the City would implement a mix of voluntary and mandatory measures to reduce urban water use (including indoor and outdoor use) 20% by 2020 (compared to 2008 per capita levels) per the requirements of state regulation (SBX7 7). Decreased urban water use would decrease the amount of energy needed to transport and deliver this water, thereby reducing GHG emissions.

SB X7 7 was enacted in November 2009 and requires urban water agencies throughout California to increase conservation to achieve a statewide goal of a 20% reduction in urban per capita use by December 31, 2020. This measure would include requirements for new development. CALGREEN voluntary measures recommend use of certain water-efficient appliances and plumbing and irrigation systems, as well as more aggressive water savings targets.

Education and outreach programs can help educate individuals on the importance of water efficiency and how to reduce water use. Rebate and audit programs can help promote installation of water-efficient plumbing fixtures. The focus of Water-1 would be on older (pre-1994) buildings built before the recent focus on water efficiency.

This measure would support Climate Change Element Policies CLI-1.4 P3, P4, and P5 and CLI-1.1 P4 in the City's General Plan**.**

Costs were not estimated for this measure because it is required to be implemented by urban water retailers as a state regulation. As such, costs (and savings) related to reduction in water use are due to prior state regulation, not due to the adoption of the CAP.

Wastewater Treatment

Wastewater – 1 Aeration Diffuser

Introduction

Wastewater generated within the City is currently treated at the Livermore Water Reclamation Plant (LWRP). Collection and treatment of the wastewater would generate fugitive methane emissions from organic decomposition, as well as GHGs from electricity consumption. The wastewater treatment measure addresses the City's ability to utilize the wastewater treatment plant as efficiently as possible so as to minimize energy usage. As shown in Table 3-7, the wastewater treatment measure will result in a reduction of 38 $MTCO_2e$ in 2020 emissions (Chevron 2012).

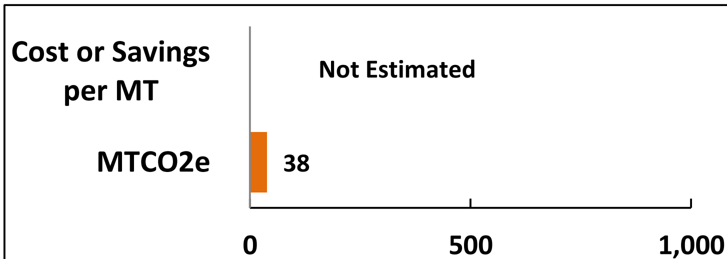
Table 3-7. Wastewater Treatment GHG Emissions Reductions by Measure (MT CO_2e)[a]

Wastewater Measure	2020 GHG Reduction	Percent of Wastewater Reductions	Percent of Total Reductions
Wastewater-1 Aeration Diffuser	38	100%	0.03%
Total Reductions	38	100%	0.03%

[a] Emissions calculations are based on activity data in 2011. Because energy consumption is expected to increase between 2011 and 2020, emissions reductions presented above likely underestimate potential reductions in 2020.

Source: Chevron 2012

Wastewater-1: Aeration Diffuser



	MTCO2e	Cost or Savings per MT
Wastewater-1	38	

Measure Co-Benefits

This measure includes the replacement of inefficient aeration diffusers with high-efficiency blowers. According to a recent analysis prepared by Chevron, old and fouled diffusers might result in inefficiencies requiring as much as 230 kW of energy. Chevron evaluated two alternatives to replace existing diffusers at the LWRP: FlexAir Magnum Tub Diffusers and FlexAir Mini Panel Diffusers. Installation of either high-efficiency design would result in GHG reductions by reducing energy consumption at the LWRP.

Solid Waste Generation

Waste– 1 Waste Diversion

Introduction

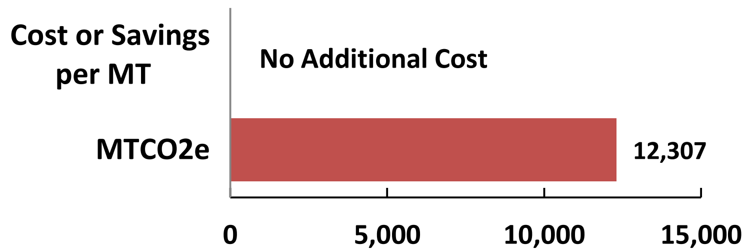
Measures to reduce waste-related emissions are typically separated into two categories: those that are site specific (i.e., at landfills) and those that can be undertaken to reduce the amount of waste generated that will ultimately be transported and disposed/landfilled. Because the City does not own any landfills, and therefore does not have jurisdictional control over landfill activities, the measure proposed in this sector targets the City's annual generation of waste.

In addition to GHG emissions reductions, waste diversion programs (programs that divert waste from landfills by recycling, composting, or otherwise utilizing certain types of waste) may reduce waste-hauling and tipping fees, as well as fuel combustion emissions for transporting waste to landfills. Likewise, reductions in landfilled waste would reduce the need for landfill space, which may contribute to future land conservation. Increased recycling and reuse would reduce the need for raw material and energy manufacturing, thereby contributing fuel savings and criteria pollutant reductions. As shown in Table 3-8, this measure would result in 12,307 $MTCO_2e$ reduction in 2020 emissions.

Table 3-8. Solid Waste Generation GHG Emissions Reductions by Measure (MT CO_2e)

Waste Measure	2020 GHG Reduction	Percent of Waste Reductions	Percent of Total Reductions
Waste-1 Waste Diversion	12,307	100%	8.8%
Total Reductions	**12,307**	**100%**	**8.8%**

Waste-1: Waste Diversion



	MTCO2e	Cost or Savings per MT
Waste - 1	12,307	NA

Measure Co-Benefits

Under this measure, the City would increase the amount of waste diverted from landfills, which would reduce vehicle miles traveled associated with transporting waste to landfills, contribute to land conservation due to the reduced need for landfills, and reduce the use of energy through increased recycling and reuse of waste.

In 2005 (baseline inventory year), the City had a diversion rate of 63%. The City's previously adopted goal is to increase the City's diversion rate to 75% by 2015 and is currently at a rate of 73%, which would support Climate Change Element Policies CLI-1.7 P1-P3, CLI-1.1 P4, and CLI-1.5 P7.

Costs were not estimated for this measure because it is required to be implemented by previously adopted City policy. As such, any costs (and savings) related to reduction in waste emissions would be due to prior City policy adoption, not due to the adoption of the CAP.

Urban Forestry and Conservation

Urban Forestry – 1 Urban Shade Trees

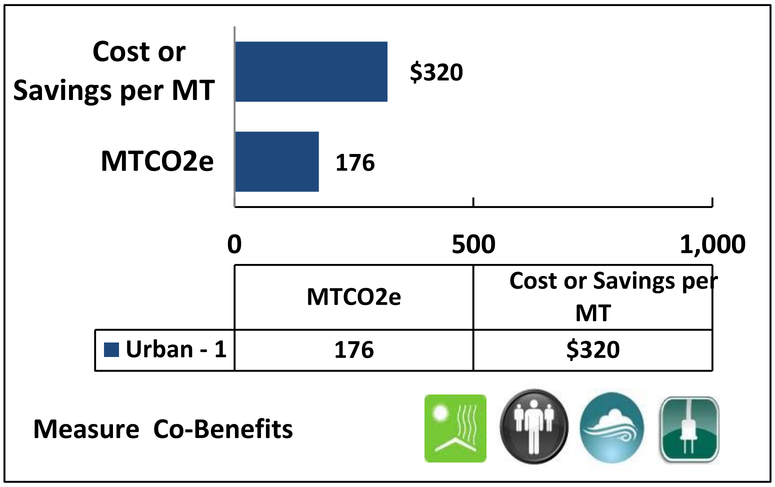
Introduction

Urban forests are dynamic ecosystems within cities that provide environmental and aesthetic benefits. Trees help to clean the air and water, provide shade, enhance aesthetic characteristics, reduce storm water runoff, create walkable communities, and raise property values. The measure in this section seeks to create new areas capable of sequestrating future emissions of carbon dioxide. As shown in Table 3-9, this measure would result in 176 $MTCO_2e$ reduction in 2020 emissions.

Table 3-9. Urban Forestry and Conservation GHG Emissions Reductions by Measure (MT CO_2e)

Urban Forestry Measure	2020 GHG Reduction	Percent of Urban Forestry Reductions	Percent of Total Reductions
Urban Forestry-1 Urban Shade Trees	176	100%	0.1%
Total Reductions	**176**	**100%**	**0.1%**

Urban Forestry-1: Urban Shade Trees



Cost/Savings are based on average net discounted value over the lifetime of the project.
Positive value = net cost
Negative value = net savings

The City has development regulations and engineering standards that require a minimum number of new trees in new development and parking lots, as well as street trees for new private development. The City's Tree Preservation Ordinance also ensures that existing trees in new development are preserved ; if the trees cannot be saved, the ordinance requires they be replaced at a minimum ratio of 3 to 1. Under this measure, the City would continue its existing program , requiring a minimum number of new trees to be planted with new development. A goal of 300 new trees to be planted each year is assumed.

Trees sequester atmospheric CO_2 during respiration. The amount of CO_2 sequestered depends on the type, size, and age of the trees. Planting trees in downtown areas would also help reduce urban heat island effect (the effect of urban development and energy use creating metropolitan areas that are significantly warmer than surrounding rural areas) with increased shade. The GHG benefits associated with shading achieved from specific tree planting would vary based on the distance the tree is planted from the building; trees that are planted adjacent to buildings would achieve the most energy reductions.

The cost analysis only includes the benefits from energy savings and does not include other benefits such as air pollution reduction and improved property values. When including those benefits, then this measure would have a net savings over its lifetime instead of a net cost (see Appendix C).

3.4.4 Municipal Energy Efficiency Actions

The City has identified a number of energy-efficiency measures it can implement to help reduce energy costs and greenhouse gas emissions from municipal operations. These measures would overlap with the community GHG reduction measures included in the CAP. For example, the City is considering installing solar power at several facilities, which would overlap with Energy-5 (Voluntary Residential and Non-Residential Rooftop Solar).To avoid double counting emissions reductions, programs proposed by the City to reduce municipal emissions are provided for informational purposes and are not counted towards the City's GHG reduction goal. However, if all of these energy-efficiency measures were implemented, then the City would contribute approximately 11% of the total local building energy reductions in the community CAP overall (2,340 MT CO_2e out of total sector local reductions of 20,825 $MTCO_2e$). Table 3-10 summarizes these proposed programs and their associated reduction in municipal GHG emissions. This is a preliminary list of energy efficiency measures under consideration by the City. The final list will be determined by Fall 2012.

Table 3-10. Municipal Energy-Efficiency Actions and Associated GHG Reductions (Mun-1) [a]

Measure Name	$MTCO_2e$ Reduction in Municipal Emissions
Solar PV	1,310
Chiller Upgrade	3
Variable Primary Flow	46
HVAC Unit Upgrade	5
Solar Thermal Water Heating	7
EMS Upgrade at Multi Service Center	1
Interior & Exterior Lighting and Lighting Controls	222
Street Lighting	746
Total Reductions (informational purposes only)	2,340

[a] Emissions calculations are based on activity data in 2011. Because energy consumption is expected to increase between 2011 and 2020, emissions reductions presented above likely underestimate potential reductions in 2020.

Source: Chevron 2012

3.5 Limitations and Recommendations for the Climate Action Plan

The CAP is the culmination of dedicated work by the City to identify and reduce community GHG emissions through feasible measures in light of their effectiveness and appropriateness for Livermore. The inventory was designed to capture all major emissions sources, identify data gaps, and make recommendations for future inventory updates (see Chapter 4). The inventory is based on acceptable methods for quantifying GHG emissions. Through future tracking of economic activity and data, future inventories may be able to quantify certain emissions areas at a more disaggregated level, which would allow more precise estimates of reduction potential for different reduction strategies. However, the current inventory is based on standard practice and provides sufficient detail for the City to quantify and monitor effective emission reduction measures.

CHAPTER 4.
IMPLEMENTATION STRATEGIES

4.1 Introduction

The success of Livermore's CAP is dependent on the cooperation, commitment, and participation of the community. This section outlines key steps that the City would follow in order to ensure that the measures in the CAP are implemented effectively and efficiently so that the City achieves maximum GHG benefits and cost savings.

Successful implementation of the CAP would require a framework be developed for the following components.

- Administration, resources, and staffing.
- Timelines for measure implementation.
- Supporting strategies.
- Community outreach and education.
- Monitoring, reporting, and adaptive management.
- Management post-2020.

Implementation guidelines and detailed action steps for individual measures are also required to facilitate the development of policies and regulations. In general, the City would have limited responsibility in implementing state programs, other than tracking the GHG benefits. Establishing a cohesive management approach is necessary to ensure the CAP measures are implemented in a timely manner. The following sections describe the potential strategies City's overall plan to implement the CAP.

4.2 Climate Action Plan Implementation Plan

Table 4-1 summarizes overall costs for implementation of the CAP. The section below describes administration, staffing, financing, budgeting, and timelines.

4.2.1 Administration and Staffing

The City would develop a CAP Implementation Team (CIT), consisting of existing City staff, already working on projects related to energy conservation and GHG emissions reduction projects, to support new programs and streamline existing efforts. The Implementation Team would require a designated Coordinator to oversee the successful implementation of all selected GHG reduction strategies.

Staffing for the CIT would be comprised of individuals from various applicable city departments as needed.

Both the Implementation Coordinator and CAP Implementation Team would be responsible for monitoring and reporting on progress towards implementing the CAP including tasks such as:.

- Research potential opportunities for funding of GHG reduction measures and identifying existing resources that can be used to educate and harness community support for implementation of the CAP.

- Coordinating CIT meetings.
- Outreach to local and regional climate action organizations and the community regarding emission reduction efforts
- Developing a protocol for monitoring the effectiveness of emissions reduction programs.
- Establishing guidelines for reporting and documenting emission reduction progress.
- Submitting progress reports to the City Council.
- Developing a protocol for utilizing the real-time information collected through the verification process to modify and revise existing reduction programs.
- Track state and federal legislation and its applicability to the City.

Local reduction measures will require a variety of implementation activities, including amendments to existing ordinances or the creation of new code/ordinances, the development and administration of promotional programs, project planning, and tracking/monitoring efforts. This will require additional effort by City staff, but in most cases will involve expansion of current efforts. Table 4-2 shows estimated staff hours for implementation efforts.

4.2.2 Financing and Budgeting

Implementation of the local GHG reduction measures will require the City and other public agencies, local businesses, developers/builders, and existing commercial building owners and households to incur increased costs for capital improvements and other investments. Operations and maintenance costs will also increase, although in certain cases, operating costs are anticipated to decrease, offsetting some cost increases. This section presents existing and potential future funding sources that can pay for these costs. Following a summary of costs, this section contains a description of funding and financing options. Because current economic and fiscal conditions limit funding resources and options and the related ability to finance costs associated with local reduction measures, this section also identifies additional funding sources that may become more feasible in the future.

Table 4-1. **Summary of Costs and Benefits for City of Livermore GHG Reduction Measures**

Measure Number	GHG Reduction Measure	GHG Reduction	Additional Cost of CAP?	Entity Incurring Additional Capitol and O& M Costs	Avg. Cost (Savings) /Ton	Avg. Simple Payback Period	Lifetime	Avg. Total Discounted Costs (Savings)	Cobenefits	Notes
State Measures										
State Measures	Energy, transportation, waste measures	101,797	No	Residents, business, City government, and other public agencies will incur additional costs for energy, transportation fuel and other expenses due to state initiatives, but will also incur savings where state requirements result in long-term efficiencies (like from Title 24 requirements). However, these costs and savings will occur with or without adoptions of the CAP. Other cobenefits similar to those articulated by sector below.						
Building Energy										
Energy-1	Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings	2,999	Yes	Building owners/residents	($118)	15	18	(4,146,791)	• Reduced energy use • Energy security and diversity • Reduced price volatility • Reduced air pollution • Resource conservation • Increased property value • Public health improvements • Increased quality of life	New energy efficiency program (Energy-1 and 2)
Energy-2	Energy Efficiency Voluntary Programs for Existing Commercial Development	3,562	Yes	Building owners/residents	($540)	2	18	($22,477,168)		
Energy 3	Exceed Title 24 Requirements for New Buildings	1,425	Yes	Buyers of new buildings/residents	$135	13 to >lifetime	20	$2,401,638		Expansions of current Green Building Ordinance
Energy-4	Streetlights	92	Yes	City	($317)	9	17	($330,216)		
Energy-5a	Voluntary Residential and Non-Residential Rooftop Solar (Owner-Financed)	7,227	Yes	Building owners/residents	$429	NA	25	43,674,480		New solar program (Energy-5 and Energy-6)
Energy-5b	Voluntary Residential and Non-Residential Rooftop Solar (PPA)	7,227	Yes	PPA issuer, building owners/residents	($194)	NA	25	($19,725,470)		
Energy-6a	Voluntary Solar Over Parking Areas Program (Owner Financed)	211	Yes	Building owners/residents	$3,185	NA	25	$9,463,592		
Energy-6b	Voluntary Solar Over Parking Areas Program (PPA)	211	Yes	PPA issuer, building owners/residents	($3,471)	NA	25	($10,311,001)		
Land Use and Transportation										
On Road-1	Idling Restrictions	498	Yes	Vehicle Owners	($438)	1	10	($1,684,819)	• Reduced energy use • Reduced air pollution • Public health improvements • Energy security • Increased quality of life	New program cost for City. Equipment cost for vehicle owners.
On Road-2	Transit-Oriented Development	1,096	Possibly	NE	NE	NE	NE	NE		Net costs depend on cost differential between TOD development and outlying development and may be negative or positive. New program cost for City. LAVTA costs for potential transit service increase included separately.
On Road-3	Transit Enhancements	365	Yes	NE	NE	NE	NE	NE		LAVTA costs for potential transit service increase not included.
On Road-4	Traffic Signal Synchronization	731	Yes	City (Maintenance Costs) Drivers (Fuel Savings)	$1,272	NA	8	$929,757		LAVTA costs for potential transit service increase not included.
On Road-5	Bicycles and Pedestrian Improvements	694	Yes	City and private developers	($447)	3	20	($3,862,579)		Continuation of existing program.
On Road-6	Car Sharing Programs	37	Yes	Measure presumes City partners with Private car share companies who will implement. City costs are limited to coordination and possible incentive parking spaces. Users of service can experience net savings compared to vehicle ownership and maintenance costs.						Minimal cost to City

Measure Number	GHG Reduction Measure	GHG Reduction	Additional Cost of CAP?	Entity Incurring Additional Capitol and O& M Costs	Avg. Cost (Savings) /Ton	Avg. Simple Payback Period	Lifetime	Avg. Total Discounted Costs (Savings)	Cobenefits	Notes
Solid Waste Management										
Waste-1	Increased Waste Diversion	12,307	No	This program is being implemented per prior Livermore adoption of 75% diversion goal for 2015.					• Reduced air pollution • Resource conservation	Existing program.
Water Conveyance										
Water-1[a]	Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels	Conveyance: 1,089 Hot Water: 5,281	No	Expansion of existing program. City already required to do this by SB X7 7 and thus costs and savings are not a consequence of adopting the CAP.					• Reduced energy use • Reduced air pollution	Existing program.
Wastewater Treatment										
Wastewater-1	Aeration Diffuser	38	Yes	City	NA	NA	NA	NA	• Reduced energy use • Reduced air pollution	New program.
Urban Forestry and Conservation										
Urban Forestry-1	Urban Shade Trees	176	Yes	Private developers and builders	$320	NA	40	$969,874	• Reduced energy use • Reduced air pollution • Reduced urban heat island effect • Increased quality of life	Existing program but expanded. Annual savings not constant but expand over time. Annual benefits include electricity reduced, CO2 and air quality emission reductions, as well as property value increases.
Total										
State Reductions		*101,797*	*No*	-	*Not Applicable*				*See above*	Totals assume PPA average values for Energy-5 and Energy-6. Excludes un-quantified costs. Net present value of entire program not fully quantifiable at this time as explained in text and in Appendix C.
Local Reductions		*37,857*	*Varies*	-	*See above*	*Varies*	*Varies*	*($49,943,221)*		
Total Reductions		***139,654***	**-**	**-**	**-**	**-**	**-**	**-**		

Notes*:*

[a] Water-1 will reduce water consumption, which will likewise contribute to reductions in building energy. For example, efficient faucets that use less water require less electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Emissions reductions achieved by Water-1 through reduced water conveyance are reported in the water sector.

[b] Source for Cost/Ton and Payback term estimates = Capital and O & M costs in Table 4-2 and Table 4-3 and cost source estimates in Appendix C.

[c] Totals do not include potential LAVTA costs which are discussed in Table 4-2.

NE-Not estimated

Table 4-2. Estimate Staff Hours for City of Livermore CAP Implementation

Measure No.	Description	GHG Reduction	Program Type	Implementation / Estimated Tasks	Responsible Dept.	Hours / Phase		
STATE PROGRAMS						**Phase I**	**Phase 2**	**Phase 3**
						2012 - 2014	2015 - 2017	2018 - 2020
State Measures	Energy, transportation, waste measures	101,797		No local implementation required, except changes in Title 24 requirements				
LOCAL PROGRAMS - EXISTING OR IN-PROGRESS						**Phase I**	**Phase 2**	**Phase 3**
						2012 - 2014	2015 - 2017	2018 - 2020
Energy-3	Exceed Title 24 Requirements for New Buildings	1,425	Mandatory	City has already adopted the California Building Standard Code, Title 24. Under this measure, staff would periodically update and strengthen standards to "stay ahead" of Title 24 future requirements. Estimated one update per CAP phase.	CDD/Building			
				1. Update Ordinance		40	40	40
				2. City Council review		40	40	40
Energy-4	Streetlights	92	Voluntary	Under this measure staff would continue upgrading light fixtures with energy efficient bulbs. Additional staff time may be required to determine whether lights at airport can be changed.	Engineering/Public Works/Airport			
				1. Assess number of streetlights to be upgraded/schedule and changing lights;		24	24	24
				2. Determine feasibility of installing lights on airport runway		40		
On Road-2	Transit Oriented Development	1,096	Voluntary	City has already implemented land use and zoning changes to facilitate mixed-use and TOD in Downtown Area and designated Mixed Use Centers. Efforts to implement TOD specifically at Isabel and Greenville BART stations are already underway through Priority Development Areas and potential Specific Plans and will continue with or without CAP implementation.	CDD/Planning and Engineering	Existing program underway. No new costs or staff hours associated with this program		
On Road-3	Transit Enhancements	365	Voluntary	City already coordinates with LAVTA during review of new development projects for needed transit improvements. Potential nominal new staff time would be associated with coordination with LAVTA to monitor and track implementation of service levels.	CDD/Planning and Engineering	24	8	8
On Road-4	Traffic Signal Synchronization	731	Mandatory	As part of existing Signal Synchronization program, staff periodically assesses additional corridors where synchronization enhancements could be made.	CDD/Engineering	Existing program underway. No new costs or staff hours associated with this program		
On Road-5	Bicycle and Pedestrian Improvements	694	Mandatory	The City already implements bike and pedestrian improvements for transportation and recreation purposes, consistent with General Plan policy, with existing Specific Plans, and with the existing Bike and Pedestrian Master Plan; City already tracks progress towards implementing improvements. Staff also pursues grant funding for trail and bike improvements and schedules improvements in the City's CIP.	CDD/Engineering and Planning	Existing program underway. No new costs or staff hours associated with this program		
Waste-1	Increased Waste Diversion	12,307	Mandatory	Public works staff is already and will continue implementing waste diversion program to meet goals	Public Works	Existing program underway. No new costs or staff hours associated with this program		
Water-1	Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels	Conveyance: 1,089 Hot Water: 5,281	Voluntary and mandatory	Program involves implementing voluntary and mandatory measures to reduce urban water use per the requirements of SBX7 7. Proposed demand management measures, including education and incentive programs, are contained in the City's 2010 Urban Water Master Plan. Water Resources and CDD staff will implement measures with or without CAP adoption.	Public Works/Water Resources	Existing program underway. No new costs or staff hours associated with this program		

Measure No.	Description	GHG Reduction	Program Type	Implementation / Estimated Tasks	Responsible Dept.	Hours / Phase		
LOCAL PROGRAMS - EXISTING OR IN-PROGRESS						**Phase I**	**Phase 2**	**Phase 3**
Urban Forestry-1	Urban shade trees	176	Mandatory	1. Assess existing requirements and programs for potential to expand;	CDD and Public Works	40		
				2. Establish method for tracking effectiveness/progress		24	40	40
LOCAL PROGRAMS - NEW								
Energy-1	Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings	2,999	Voluntary	Energy Programs 1, 2, 5, and 6 are voluntary new programs that will require additional staff time to establish opportunities for education and outreach to the public and also to coordinate efforts with other agencies and organizations for outreach as well as potential funding opportunities. To maximize staff time, efforts to establish these four new programs would be addressed together.	CDD/Building and Planning			
Energy-2	Energy Efficiency Voluntary Programs for Existing Commercial Development	3,562	Voluntary					
Energy-5	Voluntary Residential and Non-Residential Rooftop Solar	7,227	Voluntary					
Energy-6	Voluntary Solar Over Parking Areas Program	211	Voluntary					
				1. Develop education and promotional outreach programs for Energy measures 1, 2, 5, and 6.		80		
				2. Collaborate with other agencies and organizations to identify and seek funding opportunities.			144	144
				3. Establish method for tracking effectiveness/progress of programs		40	48	48
On Road-1	Idling Restrictions	498	Mandatory	1. Craft Ordinance that limits idling restrictions, conduct CEQA review, and review and approval by City Council	CDD/Public Works	160		
				2. Periodic updates and review of progress/success			24	24
On Road-6	Car Sharing Programs	37	Voluntary	Private program. Staff costs would be associated with research opportunities to attract private developers of program; evaluate success rate of similar programs in other communities; and support program through promotional efforts.	CDD/Planning and Engineering	40	16	16
Wastewater-1	Aeration Diffuser	38	Voluntary	Involves implementing identified aeration diffuser project identified by Chevron. WRP staff and Engineering will program needed improvements at the Waste Treatment Plant in the City's CIP.	Public Works/Water Resources	Existing program underway. No new costs or staff hours associated with this program		
Mun-1	Municipal Energy Efficiency Actions	2,340	Voluntary	Involves implementing identified energy-efficiency projects identified by Chevron. Engineering will program needed improvements in the City's CIP.	Public Works	Existing program underway. No new costs or staff hours associated with this program		
				Total Hours (New and Existing Programs)		**552**	**384**	**384**

Costs and Savings

There will be capital/upfront costs for some of the local GHG reduction measures, as well as operations and maintenance costs for some of the measures. There will also be annual savings for many of the measures in the form of decreased electricity and natural gas energy bills, decreased vehicle/fuel use, and other savings. For measures that are already underway by the City or would be implemented by the City with or without a Climate Action Plan (such as the Water Efficiency measure already required by SB X 7 7 or a number of the On-road measures), the Cap would not represent new costs not already anticipated).

As indicated in Table 4-1, some of the measures' would result in a net savings (discounted savings exceed discounted costs) and some would result in net costs (discounted costs exceed discounted savings) . It is important to note that costs and savings are not borne by the same players. That is, the entity making the upfront investment is not always the entity that experiences the reduction in utility bills or other savings. Therefore, it is important to understand that measures may *overall* be associated with net costs or net savings, but that does not imply that a given entity would experience those same net costs or savings.

As noted previously, some costs cannot be estimated at this time as they depend on further program development to better define costs and savings.

Capital Costs

As shown in Table 3-1 and 4-1, capital costs were estimated for many of the local reduction measures. Altogether, assuming PPA financing approaches are used for voluntary solar measures, total capital costs are estimated to range between $68 and $204 million , with those costs spread across local governments and the private sector. It is important to note that many of the local reduction measures offer improvements in service, efficiency, and quality of life that provide co-benefits beyond the targeted reductions in greenhouse gas emissions.

The capital costs can be characterized as follows:

- **Building Energy Measures** fall predominantly to the private sector to undertake and fund. These measures envision several types of energy efficiency and renewable energy upgrades to new and existing development citywide. Capital costs for solar measures vary substantially depending on financing approaches.
- **Transportation Measures** have capital costs associated with changes to existing transportation infrastructure to reduce vehicle miles traveled (VMT) or for increasing operational efficiency of vehicles. Public agencies will be responsible for undertaking and funding many of these measures but private development will have a role in certain measures, such as On Road-1 (Idling Restrictions) and On Road-6 (Car Sharing Programs)
- **Land Use Measures** have capital costs associated with planting new trees in urban areas, which are assumed to be borne by the local government.
- **Waste Measures** comprise those actions necessary to increase the waste diversion rate citywide. No capital costs are foreseen for this measure at this time . Capital and operating costs likely incurred by waste providers would be passed on in terms of potential increased waste disposal fees.

- **Water Measures** aim to reduce water consumption and conveyance; capital costs are associated with installing new water-efficient fixtures and retrofits of existing plumbing fixtures in private and public buildings.

Private Costs and Savings

Local reduction measures will include capital costs, operational costs, and operational savings that would be incurred by the private sector. Many of the measures in the CAP are voluntary (such as energy-efficiency and solar retrofits for existing buildings) such that the private sector will only incur associated costs and savings is they choose to take part. Some of the measures, such as Green Building Standards under Energy-3 would be mandatory. Table 4-3 shows identified costs and savings by private entities.

Funding Opportunities and Financing Options

Private Funding

Some measures (e.g., Energy-3) will require new development to include energy saving and/or other improvements that will increase construction costs but at the same time are expected to generate annual cost savings equivalent to the value of the improvements over a certain number of years. Under normal economic conditions these improvements should increase the price of the building to account for buyer preferences and the discounted value of long-term annual savings. However, given current economic conditions, it may not be the case that highly energy-efficient homes/buildings can garner a higher price compared to other, conventional-energy homes/ buildings.

Builders who own and operate buildings (i.e., commercial buildings or apartment complexes) can use private equity to finance these improvements, with returns realized as future cost savings (energy expenditures, etc.). As market conditions improve over time, rents can be increased to defray the investment costs.

Similarly, other Measures, such as Energy-1 and Energy-2, encourage existing building owners/homeowners to install significant energy-efficiency upgrades. The cost of these "retrofit" improvements could be funded by increasing rents (commercial buildings) and/or realizing the net energy cost savings back toward costs (households). However, long payback periods for some measures may inhibit wide-scale, private-sector participation, thus requiring public subsidies or incentives such as rebates or incentives offered by public utilities.

The City could also promote Power Purchase Agreements (PPAs) to promote energy savings. In a PPA, a private company or third party purchases and installs a renewable energy technology, often solar panels. The third party maintains ownership of the installed panels and also monitors and maintains the systems to ensure functionality. The contract period for a PPA is typically 15 years, at which point the third party will either uninstall the panels or sign a new agreement with the building owner. The power produced is sold to customers on a per kilowatt-hour basis at a contractually-established rate.[18]

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[18] The rate is lower than what customers pay their utility today, and increases annually at a fixed percentage (usually 2.5 to 4.0%) that is typically lower than the rate escalation by the utilities.

Table 4-3. Summary of Costs and Savings by Entity for the City of Livermore GHG Reduction Measures

Measure Number	GHG Reduction Measure	GHG Reduction	Additional Cost of CAP to Private Sector?	Avg. Additional Capital Costs	Avg. Additional Annual Cost/(Savings)	Private Entity Incurring Costs/Savings	Avg. Cost (Savings)/Ton	Lifetime	Avg. Total Discounted Costs (Savings)	Notes
State Measures										
State Measures	Energy, transportation, waste measures	101,797	No	Residents, business, City government, and other public agencies will incur additional costs for energy, transportation fuel and other expenses due to state initiatives, but will also incur savings where state requirements result in long-term efficiencies (like from Title 24 requirements). However, these costs and savings will occur with or without adoptions of the CAP. Other cobenefits similar to those articulated by sector below.						
Building Energy										
Energy-1	Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings	2,999	Yes	$17,137,877	($1,111,338)	Residents and owners	$118	18	$4,146,791	Voluntary program to increase energy efficiency
Energy-2	Energy Efficiency Voluntary Programs for Existing Commercial Development	3,562	Yes	$5,372,427	($2,382,428)	Building occupants	($540)	18	($22,477,168)	
Energy 3	Exceed Title 24 Requirements for New Buildings	1,425	Yes	$8,662,417	($502,381)	Buyers of new buildings	$135	20	$2,401,638	Mandatory ordinance for new development
Energy-4	Streetlights	92	No	Municipal program						
Energy-5a	Voluntary Residential and Non-Residential Rooftop Solar (Owner-Financed)	7,227	Yes	$160,717,247	($2,409,584)	Building owner/resident	$429	25	$43,674,480	Voluntary program to increase solar deployment.
Energy-5b	Voluntary Residential and Non-Residential Rooftop Solar (PPA)	7,227	Yes	$0	($1,399,571)	PPA issuer, building owner/resident	($194)	25	($19,725,470)	
Energy-6a	Voluntary Solar Over Parking Areas Program (Owner Financed)	211	Yes	$25,529,358	($487,028)	Building owner/resident	$3,185	25	$9,463,592	
Energy-6b	Voluntary Solar Over Parking Areas Program (PPA)	211	Yes	$0	($731,593)	PPA issuer, building owner/resident	($3,471)	25	($10,311,030)	
Land Use and Transportation										
On Road-1	Idling Restrictions	498	Yes	$63,095	($226,363)	Vehicle Owners	($438)	10	($1,684,819)	
On Road-2	Transit-Oriented Development	1,096	No	NE	NE	Building owners/developers	NE	NE	NE	Private developers will incur costs of infill development which may be higher or lower relative to cost for development on the edge of the City. City has already begun and will continue implementing TOD policy consistent with General Plan goals.
On Road-3	Transit Enhancements	365	Yes	NE	NE	NE	NE	NE	NE	Improvements and costs borne by LAVTA. Possible that costs to restore service levels could be passed on to rider
On Road-4	Traffic Signal Synchronization	731	No	Municipal program						Municipal program.
On Road-5	Bicycles and Pedestrian Improvements	694	No	Private new development/builders						Private developers will incur costs to extend infrastructure in new developments. However, this would be a requirement with or without CAP
On Road-6	Car Sharing Programs	37	Yes	This program would be implemented by the City working with private car-sharing firms. The City would incur minimal costs for dedication of a limited number parking spaces. Individual use of car-sharing can result in personal savings depending on the level of personal vehicle use avoided.						
Solid Waste Generation										

Measure Number	GHG Reduction Measure	GHG Reduction	Additional Cost of CAP to Private Sector?	Avg. Additional Capital Costs	Avg. Additional Annual Cost/(Savings)	Private Entity Incurring Costs/Savings	Avg. Cost (Savings)/Ton	Lifetime	Avg. Total Discounted Costs (Savings)	Notes
Waste-1	Waste Diversion	12,307	No	Waste diversion goal of 75% by 2015 is an existing City adopted policy and thus is not an additional cost of the CAP.						
Water Conveyance										
Water-1[a]	Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels	Conveyance: 1,089 Hot Water: 5,281	No	Reduction of urban per capita water use is already required by state regulation (SB X7 7) and thus, this is not an additional cost of CAP.						
Wastewater Treatment										
Wastewater-1	Aeration Diffuser	38	No	Municipal Program						
Urban Forestry and Conservation										
Urban Forestry-1	Urban Shade Trees	176	No	Cost of new trees will be incurred by private developers, however, this is already an existing requirement. Program will produce tangible benefits for residents and business in terms of reduced energy costs, air pollution reduction, home prices, and quality of life improvements.						
Total										
State Reductions		*101,797*	*No*	*Not Applicable*						
Local Reductions		*37,857*	*Varies*	*$31,235,815*	*($6,353,673)*	*Varies*	*See above*	*Varies*	($49,943,221)	*Totals assume PPA average values for Energy-5 and Energy-6. Excludes unquantified costs. Net present value of entire program not fully quantifiable at this time as explained in text and in Appendix C.*
Total Reductions		***139,654***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	

Notes:

[a] Water-1 will reduce water consumption, which will likewise contribute to reductions in building energy. For example, efficient faucets that use less water require less electricity and natural gas for hot water heating. For reporting purposes, emissions reductions achieved by Water-1 through reduced hot water heating have been added to the building energy sector. Emissions reductions achieved by Water-1 through reduced water conveyance are reported in the water sector.

[b] Source for Cost/Ton and Payback term estimates = Capital and O & M costs in Table 4-2 and Table 4-3 and cost source estimates in Appendix C.

[c] Totals do not include potential LAVTA costs which are discussed in Table 4-2.

NE-Not estimated

In addition, the City could promote on-bill financing (OBF) to fund energy improvements to City businesses. OBF provides no-interest financing for businesses and government agencies to make energy efficiency retrofit improvements. Funding is provided in the form of a no-interest loan that is paid back through a monthly utility bill. Financing is available to fund many technologies, including lighting, refrigeration, HVAC and LED street light projects. Government agencies may qualify for loans between $5,000 and $250,000 per PG&E meter, with loan periods up to 120 months. Business customers may qualify for loans between $5,000 and $100,000, with loan periods up to 60 months.

Utility Rebates

The following rebates will help create incentives for building energy investments.

- **California Solar Initiative.** Pacific Gas & Electric (PG&E) is one of three utilities participating in the state's Go Solar Initiative. This program provides a variety of rebates, incentives, and other types of support for both existing and new homes. Program rebates apply to photovoltaics, thermal technologies, and solar hot water; the program is designed to accommodate single-family homes, commercial development, and affordable housing. These programs have a total budget of $2.2 billion between 2007 and 2016 for solar generation and $250 million between 2010 and 2017 for thermal systems (i.e., new solar hot water systems).
- **Energy Upgrade California.** The City could help promote this program to City residents to facilitate home energy upgrades. Energy Upgrade California is funded by the American Recovery and Reinvestment Act, California utility ratepayers, and private contributions. It is administered by participating utilities. Under this program, a homeowner selects one of two energy upgrade packages, basic or advanced, with each offering different enhanced options. The program connects homeowners with home energy professionals, including participating contractors and Whole-House Home Energy Raters. In addition, rebates, incentives, and financing are offered. For instance, homeowners can get up to $4,000 back on an upgrade through a local utility.

State and Federal Funds

The following federal and state funding mechanisms will help to incentivize various GHG reduction measures.

Federal Tax Credits for Energy Efficiency

The City could promote the federal government's tax credits for energy efficiency to City residents. Tax credits available through 2016 provide a discount of 30% of cost with no upper limit for Geothermal Heat Pumps, Small Wind Turbines (Residential), and Solar Energy Systems. The 2016 tax credits also include 30% of the cost up to $500 per 0.5 kW of power capacity for fuel cells in a principal residence.

Energy Efficiency Mortgages

The City could promote Energy Efficiency Mortgages (EEM) to City residents. An EEM is a mortgage that credits a home's energy efficiency in the mortgage itself. EEMs give borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage. To get an EEM a borrower typically has to have a home energy rater conduct a home energy assessment before financing is approved. This rating verifies for the lender that the home is energy-efficient. EEMs are typically used to purchase a new home that is already energy efficient such as an ENERGY STAR qualified home.

California Department of Resources Recycling and Recovery (CalRecycle)

The City could apply for CalRecycle grant programs, which are authorized by state legislation to assist public and private entities in the safe and effective management of the waste stream. Funds are intended to further reduce, reuse, and recycle all waste, encourage development of recycled-content products and markets, and protect public health and safety and foster environmental sustainability. Incorporated cities and counties in California, as identified by the California Department of Finance, are eligible to receive funding.

California Air Resources Board

CARB has several air pollution incentives, grants, and credit programs that could be utilized to help fund local measures. The following programs will offer grant opportunities over the next several years with the goal of reducing emissions from on- and off-road vehicles and equipment.

- Air Quality Improvement Program (AB 118).
- Enhanced Fleet Modernization Program (AB 118).
- Carl Moyer Program – Voucher Incentive Program.
- Goods Movement Emission Reduction Program.
- Loan Incentives Program.
- Lower-Emission School Bus Program/School Bus Retrofit and Replacement Account.

State Funding for Infrastructure

Similarly, the State's Infill Infrastructure Grant Program may be able to provide funding toward Measure On Road-2 (Transit Oriented Development). This program seeks to promote infill housing development. Grants are available as gap funding for infrastructure improvements necessary for specific residential or mixed-use infill development projects.

Planning Grants from the Strategic Growth Council

The City could pursue grants for planning from the Strategic Growth Council (SGC) of the State Department of Conservation (DOC). The SGC manages competitive grants to cities, counties, and designated regional agencies that promote sustainable community planning and natural resource conservation. The DOC has allocated approximately $18 million of Proposition 84 as competitive grant funding to support development, adoption, and implementation of Sustainable Community planning elements, including, but not limited to, Climate Action Plans and General Plan amendments. The grants awarded from this solicitation will cover up to a three-year project period. Grant requests for amounts from $100,000 to $1,000,000 will be considered.

Transportation-Related Federal and State Funding

Transportation programs will require a variety of federal and state funding sources suitable for transit, bicycle, and pedestrian improvements. A list of some of the state and federal transportation funding sources are noted in Table 4-4.

Local/Regional Funding

The City has a CIP that provides funding for needed City infrastructure improvements. In many cases, the measures can be integrated into the City's CIP (or the enterprise utility CIPs). For example, the replacement of street lights and traffic signals under Local Measure Energy-4 could be integrated into the City's CIP.

Public Utility Enterprises

The City operates water and sewer public utilities supported by rates that cover the cost of their infrastructure and operations. An increase in these rates to fund capital improvements associated with local reduction measures Water-1 and Wastewater-1 could be considered.

Table 4-4. State and Federal Transportation Funding Sources

Safe, Accountable, Flexible, Efficient Transportation Equity Act – Legacy for Users (SAFETEA-LU).	FTA Small Starts
Surface Transportation Program Fund, Section 1108 (STP)	FTA Section 5311(f)
Congestion Mitigation and Air Quality Improvement Program, Section 1110 (CMAQ)	California's Bicycle Transportation Account (BTA)
Transportation Enhancement Activities (TEA)	Environmental Enhancement and Mitigation (EEM) Program
National Recreational Trails Program	Safe Routes to School (SR2S)
National Highway System Fund (NHS)	Office of Traffic Safety (OTS)
National Highway Safety Act, Section 402	Transportation Development Act (TDA) Article III
Transit Enhancement Activity, Section 3003	Transportation Funds for Clean Air (TFCA, formerly AB 434)
Section 3 Mass Transit Capital Grants	Flexible Congestion Relief (FCR) Program
Bridge Repair & Replacement Program (BRRP)	State Highway Operations and Protection Program (SHOPP)
Federal Transit Administration (FTA) 5309	

Bay Area Air Quality Management District

BAAQMD has several grant programs related to the improvement of air quality, some of which may apply to different CAP measures.

Livermore Amador Valley Transit Authority

While the City does not have control over how LAVTA chooses to expend its resources, it's possible that the following measures could be taken by LAVTA to generate revenue that would lead to reductions in GHG emissions.

- **Bus Stop Sponsorships**. Advertisement sponsorship of bus stops has been utilized as a revenue source.
- **Transit Fare Increases.** ACTA or LAVTA could increase fares to help to fund capital improvements, though increases also have the potential to decrease ridership in the short term.

Implementation Funding

City implementation costs will be integrated into the City's existing operating Budget and CIP as the City and other public agencies will be responsible for implementing local reduction measures. Given fiscal constraints, it may be necessary to support increased operating costs with charges applied to capital programs, grants, fees, and other new revenue sources. As an example of a grant that could be utilized, the City could pursue grants for planning from the SGC of the DOC, which is described above under “State and Federal Funds”.

Local Fees

The City is not proposing any local fees or taxes at this time. While current economic conditions and fiscal realities limit funding options for the local reduction measures, as the economy recovers, additional funding sources that are currently infeasible may become realistic. One potential future funding sources is described below.

AB 811 Districts (PACE)

AB 811 is a California environmental law passed in 2008 to help California municipalities accomplish the goals outlined by the Global Warming Solutions Act of 2006. AB 811 authorized all California cities and counties to designate areas where property owners could enter into contractual assessments to receive long-term, low-interest loans for energy and water efficiency improvements and renewable energy installations on their property. The financing is repaid through property tax bills. AB 811 only allows for financing of the purchase and installation of appliances that are permanently attached to real property.

The Property-Assessed Clean Energy (PACE) finance program is the state of California’s AB 811 program; the program is designed to finance the installation of energy and water improvements within their home or business via a land-secured loan, repaying the amount through property assessments. Eligible projects under the CaliforniaFIRST Program[19] may include, but are not limited to: air sealing, wall and roof insulation, energy-efficient windows, tankless water heaters, solar photovoltaics, and low-flow toilets.

The City of Livermore is not part of the pilot program. However, the California Statewide Communities Development Authority (California Communities), sponsor of the PACE program, intends to extend CaliforniaFIRST to include all interested counties and cities that are members of California Communities.

For residential properties, AB 811—including the PACE program—is currently on hold owing to a July 2010 decision by the Federal Housing Finance Agency (FHFA) to halt all lending through these programs, after it was determined that the senior AB 811 District loans are in violation of standard mortgage contracts. However, early in 2012, a bipartisan panel introduced legislation for capital improvements for a variety of local measures that require private-sector participation.

There is no constraint for PACE-style financing districts for commercial properties because FHFA is not involved in commercial property loans.

Implementing Actions

The City will need to undertake a series of steps in order to move local reduction measures into action. The nature of these tasks ranges widely and includes both regulatory and discretionary actions on the part of the City.

[19] CaliforniaFIRST (AB 811) is a commercial and multifamily energy funding tool that uses PACE to support low cost project financing.

- Refine cost estimates. As described above, the estimated costs for local reduction measures are based on a variety of participation, per-unit, and other assumptions. As programs are developed, cost estimates should be refined with more precise implementation level data.
- Adopt or update ordinances and/or codes[20]. Some local reduction measures represent a continuation of recently enacted ordinances (e.g., Energy-3's association with the City's existing Building Standards Code), while others would require new ordinances (e.g., Trans-1: Idling ordinance). Staff will need to coordinate these efforts in conjunction with the City Council.
- Pursue outside funding sources. A range of funding from state and federal agencies has been identified. The City may pursue these (and other emerging) funding sources as a part of implementation efforts.
- Create monitoring/tracking processes. Several local reduction measures will require program development, tracking, and/or monitoring. For example, Energy-1 (Promotion of Retrofits for Energy-Efficiency in Existing Development) will necessitate staff time to promote replacement of water fixtures; the City may also desire to track the number of households that participate in the program as well as the amount of water saved over time.
- Identify economic indicators to consider future funding options. Economic recovery may occur rapidly or slowly. Whatever the timeframe, the City will need to determine the point at which certain additional funding sources will become feasible and/or desirable. Identification and monitoring of economic indicators, such as home prices, unemployment rates, or real wage increases, can help the City in deciding when to further explore the potential for local reduction measures to be funded through additional taxes, surcharges, and/or fees on existing and new development.

4.2.3 Timelines for Measure Implementation

It is anticipated that the CAP would be implemented in phases. The following is an outline of key priorities for three potential implementation phases.

- **Phase 1 (2012–2014).** During this phase, the City would develop key ordinances, programs, policies, and procedures required to support and enforce the local mandatory GHG reduction measures. Likewise, the City would create a planning framework, which would guide implementation of the voluntary measures. Measure funding and a finance plan would be developed. The City would encourage implementation of cost-effective measures identified in the CAP.
- **Phase 2 (2015–2017).** During Phase 2, the City would continue to implement measures that were begun in Phase 1. The City would evaluate the effectiveness of these measures and adapt management procedures accordingly. Likewise, the City would conduct an updated community GHG inventory to monitor emissions trends. The City would also select and encourage implementation of Phase 2 measures (as shown in Table 4-5).
- **Phase 3 (2018–2020).** The City would continue to implement and support measures begun in Phases 1 and 2, and encourage implementation of all remaining CAP measures (Phase 3 measures as shown in Table 4-5). An analysis of the effectiveness of Phase 1 and 2 measures

[20] Many measures identified in the CAP, such as Energy-3, codify represent a continuation of programs already underway or programmed to be implemented by the City. It is not anticipated that these measures would present substantial additional capital costs to the City.

would be conducted, as well as an updated community GHG inventory. The City would begin developing plan for post-2020 actions.

To encourage implementation of all reduction measures, the Implementation Coordinator would develop a CAP Implementation Timeline. Measure prioritization would be based on the following factors.

- Cost/Funding—How much does the measure cost? Is funding already in place for the measure?
- Greenhouse Gas Reductions—How effective is the measure at reducing greenhouse gases?
- Other Benefits—Does the measure improve water quality or conserve resources? Would it create jobs or enhance community wellbeing?
- Consistency with Existing Programs—Does the measure compliment or extend existing programs?
- Impact on the Community—What are the advantages and disadvantages of the measure to the community as a whole?
- Speed of Implementation—How quickly can the measure be implemented and when would the City begin to see benefits?
- Implementation Effort—How difficult would it be to develop and implement the program?

Table 4-5 presents potential preliminary timeline and phasing schedule for the GHG reduction measures. A qualitative appraisal of implementation effort for the City is also provided. Measures are categorized based on the following conventions:

- Low—Measure would require limited staff resources to develop. In some cases, existing programs may be utilized to facilitate program implementation. Policy or code revisions may be necessary, although internal and external coordination efforts would likely be limited.
- Medium—Measure would require staff resources beyond typical daily levels. Policy or code revisions may be necessary. Public outreach and coordination with stakeholders would be necessary to ensure program success.
- High—Measure would require extensive staff resources to develop and implement. A robust outreach campaign would be necessary to properly communicate program requirements and address public questions and issues.

4.3 Supporting Strategies

Successful implementation of individual GHG reduction measures requires the identification of key action items, known obstacles, and resources. The goals of several reduction measures can often be achieved through a variety of means, especially those related to building energy efficiency, renewable energy development, and improvements to the transportation network. Comprehensive implementation strategies for each measure would develop over time. However, supporting actions to achieve further GHG emission reductions in the future can be identified now (Tables 4-6 through 4-12). This section presents a series of supporting actions for each emissions sector.

These supporting measures have not been quantified, since they would only be implemented in the event any of the state or local measures are not successful or achieve fewer emissions reductions than expected. If it is necessary to utilize any of these support measures in the future, they would be re-evaluated and quantified at that time to determine which ones would be most appropriate and feasible for implementation.

Table 4-5. Potential Phasing and Ease of Implementation for GHG Reduction Measures

Title	Measure	Phase	Implementation Effort
Building Energy			
Energy-1	Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings	1,2,3	Low
Energy-2	Energy Efficiency Voluntary Programs for Existing Commercial Development	1,2,3	Low
Energy-3	Exceed Title 24 Requirements for New Buildings	2	Low
Energy-4	Streetlights	1,2,3	Medium
Energy-5	Voluntary Residential and Non-Residential Rooftop Solar	1,2,3	Medium
Energy-6	Voluntary Solar Over Parking Areas Program	1,2,3	Medium
Land Use and Transportation			
On Road-1	Idling Restrictions	2	Low
On Road-2	Transit Oriented Development	1,2,3	High
On Road-3	Transit Enhancements	1,2,3	Low
On Road-4	Traffic Signal Synchronization	2,3	Medium
On Road-5	Bicycles and Pedestrian Improvements	1,2,3	Low
On Road-6	Car Sharing Programs	1,2,3	Low
Water Conveyance			
Water-1	Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels	1,2,3	Low
Wastewater Treatment			
Wastewater-1	Aeration Diffuser	2,3	Medium
Solid Waste Generation			
Waste-1	Waste Diversion	1,2,3	Low
Urban Forestry and Conservation			
Urban Forestry-1	Urban Shade Trees	1,2,3	Low
Municipal Programs[a]			
Muni-1	Municipal Energy-Efficiency Actions	1,2,3	Medium

[a] Measure applies to municipal emissions and is included for informational purposes only. Emissions reductions achieved by Mun-1 are not included in the emissions reduction goal due to potential overlap with other community reduction measures.

Table 4-6. Supporting Actions for Building Energy Measures—Energy Efficiency

Supporting Actions	
Energy-7: Municipal Computers Power Management	The City already requires that municipal computers be turned off every night before City employees go home and before weekends, thus reducing municipal electricity consumption.
Energy-8: Municipal Building Energy Use Management	The city already manages municipal building heating and cooling at a goal of 70 to 71 degrees in winter and 74 to 75 degrees in summer.
Energy-9: Consider Community Choice Aggregation.	An alternative means to achieve increased renewable energy use would be for the City to consider becoming a Community Choice Aggregator by itself or in combination with other municipalities in Alameda County. Formation of a CCA would allow the participating parties to purchase power with a higher renewable content than that provided by PG&E. *(Supporting Climate Change Element Policies: CL-1.5 P1, P2, and P5).*
Energy -10: Promote Rooftop Gardens	This measure could also reduce energy consumption and associated GHG emissions in the building energy sector (CAPCOA 2010).

Table 4-7. Supporting Actions for Building Energy Measures—Renewable Energy

Supporting Action	
Energy-11: Regulatory Barrier Reduction	Identify and remove regulatory or procedural barriers to implementing green building practices in the City, such as updating codes, guidelines, and zoning.
Energy-12: Community Education and Outreach	Expand community education materials to promote energy efficiency and renewable energy.
Energy-13: Renewable Energy Protocol	Establish a protocol for reviewing a proposed alternative energy project against existing City policies and ordinances. The protocol shall identify optimal locations and best means to avoid noise, aesthetic, and other potential land use compatibility conflicts.
Energy-14: Renewable Energy Storage	Develop standards for alternative energy storage such as biodiesel, hydrogen, and/or compressed air in order to incentivize renewable energy use.
Energy15: Financial Assistance for Renewable Energy Projects	Consider provision of financial assistance for alternative energy projects and retrofits. Collaborate with PG&E to support and expand their renewable energy incentive programs. Consider establishing a clearinghouse of information on available funding alternatives for renewable energy projects, rates of return, and other information to support developers and community members interested in pursuing renewable energy projects.
Energy-16: Co-Generation Facilities for New Commercial/Industrial Development	Co-generation facilities simultaneously generate electricity and useful heat. They are typically used in district heating systems. As feasible, encourage co-generation facilities to supply 15% of building energy in new commercial and industrial facilities greater than 100,000 square feet.

Table 4-8. Supporting Actions for Land Use and Transportation Measures

Supporting Action	
On Road-6: Transit Funding	Collaborate with a broad range of agencies and organizations to improve and expand funding for public transit infrastructure and operations. *(Supporting Climate Change Element Policies: CLI-1.3 P16)*
On Road-7: Municipal Vehicle Fleets	When purchasing vehicles and/or equipment the City of Livermore will research vehicles that increase the fleet's overall fuel efficiency, lower emissions, and control costs. As part of this, the City will look at ways to limit the use of large sedans, sport utility vehicles and trucks to work assignments where they are essential and encourage the purchase of alternative fuel vehicles, such as hybrid-electric, all electric, and propane powered when applicable. The City will evaluate fuel consumption, emissions, and cost effectiveness for every vehicle purchase. All vehicles purchased will have the following items considered: In the top 10% of fuel economy and lowest emissions within the vehicle class/type 2- Alternative fueled when available and applicable 3- Commercially available (no prototype vehicles) 4- Necessity 5- Reasonably cost-competitive for the class/type of vehicles needed for specific assignments. 6- Trucks, Vans, and Sport Utility Vehicles (SUVs) to be based on a verified work assignment. Justifiable work assignments will include rough terrain/off-road travel, passenger/cargo requirements, and/or trailer towing requirements on a routine basis.
On Road-8: Freeway Improvements (operated by Caltrans)	- Support provision of ramp metering onto all freeways through Livermore and eliminate major freeway bottlenecks to smooth traffic flows.
On Road-9: Alternative Fuel Infrastructure	- Promote the necessary facilities and infrastructure, such as electric vehicle charging facilities and conveniently locate alternative fueling stations, to encourage the use of publicly and privately owned low or zero-emission vehicles. The following implementation strategies can be used to help achieve this goal: *(Supporting Climate Change Element Policies: CLI-1.3 P1-P3 and CLI-1.1 P4)* - Coordinate with local and regional governments to leverage the purchasing power of multiple jurisdictions/businesses
On Road-10: Employee Benefits	- Encourage use of fringe benefits for employees related to trip reduction. Benefits may include telecommuting, alternative work schedules, guaranteed ride home programs, and free or low-cost monthly transit passes. *(Supporting Climate Change Element Policies: CLI-1.3 P5)*

Supporting Action	
On Road-11: Trip Reduction Plans	- Consider a trip reduction ordinance that promotes the preparation and implementation of a trip reduction plan (TRP) for large employers (100 employees or more). Possible performance targets for the TRPs could be a reduction of the vehicle trips per employee by 15% in five years and 25% in ten years *(Supporting Climate Change Element Policies: CLI-1.3 P15 and CLI-1.1 P4).* The TRP could also consider the following: - Limiting the hours when deliveries can be made to off-peak hours in high traffic areas. - Conducting annual employee commute surveys to help inform trip reduction goals and focus implementation strategies.
On Road-12: Transportation Demand Management	- Modifications to travel behavior that the average citizen can undertake could result in large VMT reductions, and consequent reductions in GHG emissions. Changes to daily commute routines, such as, working from home one day a month, working a compressed schedule, and/or using an alternative mode of transportation, such as biking, transit or carpooling, to work one day at month could result in significant reductions should a large enough proportion of the population alter their travel behavior. The City will consider promoting voluntary programs for local businesses (of all sizes) to encourage their employees to modify their travel behavior.
On Road-13: Parking Policies	- Over time, consider development of parking polices to help encourage alternatives to single-occupancy vehicle travel: - Consider expanding percentage of downtown parking spaces for ride-sharing vehicles, while reducing the available downtown parking spaces for private vehicles. - Use parking pricing to discourage private vehicle use, especially at peak times. - Create parking benefit districts, which invest meter revenues in pedestrian infrastructure and other public amenities. Parking districts should be encouraged throughout the City, but they should be concentrated in high traffic areas including downtowns. - Provide convenient pathways through parking for pedestrians; provide shade trees for parking. - Encourage adequate parking and passenger loading and waiting areas to accommodate vans used for ride sharing. *(Supporting Climate Change Element Policies: CLI-1.3 P8*).
On Road-14: Other Transportation Policies	- Consider support of transit and alternatives to vehicle travel through the following strategies: - Support development and implementation of congestion road pricing for the I-580 High Occupancy Toll Lanes. - Require a public transportation impact fee for new development.
On Road-15: Safe Routes to School	- Both the State and Federal Government provide funding for Sate Routes to Schools. Individual projects can include the enhancement of pedestrian crossings, encouragement activities such as a walking school bus, and educational programs including teaching students bicycle safety. The City will consider pursuing Safe Routes to School funding.

Table 4-9. Supporting Actions for Water, Waste and Wastewater Measures

Supporting Action	
Water-2: Drought Resistant Landscaping	Encourage use of mulch in landscape areas to improve the water-holding capacity of the soil by reducing evaporation and soil compaction. Require drought-tolerate landscape plantings for all municipal buildings.
Water-3: Municipal Water Meters	Install individual water meters on all municipal facilities for both indoor and outdoor use to allow municipal facilities to track water consumption more accurately, and target specific locations for water conservation measures (required by the 2010 California Green Building Standards Code).
Water-4: Water Efficiency Upgrades	Require water efficiency upgrades as a condition of issuing permits for renovations or additions of existing buildings.
Water-5: Water Audit Programs	Promote water audit programs that offer free water audits to single family, multi-family and commercial customers
Water-6: Water Meters	Require separate water meters for nonresidential buildings' indoor and outdoor water use.
Water-7: Regional Water Conservation Efforts	Participate in and support regional programs and projects in cooperation with the Zone 7 Water Agency that target the improvement and conservation of the region's groundwater and surface water supply. Also consider programs to collect storm water for landscape watering.
Water-8: Municipal Rainwater Collection Systems for New Buildings	Consider requiring rainwater collection systems at new municipal facilities and parks to collect rainwater for appropriate non-potable water uses. Develop and distribute educational materials to City employees on the use of rainwater collection systems and locations for purchase for private development.
Water-9: Municipal Water Monitoring System	The city already has a highly computerized irrigation system (approximately 30%). With this measure, the City could continue expansion of the monitoring system to further reduce the municipal water consumption.
Waste-2: Packaging Materials	Encourage local businesses to expand their recycling and composting efforts and to reduce packaging of products manufactured in the City. Mandatory recycling per state regulations (AB 341 and county StopWaste requirements) will force more aggressive commercial recycling efforts.
Waste-3: Regional Waste Collaboration	Enhance regional coordination on waste management, to take advantage of economies of scale of recycling, composting, and other diversion programs. Collaboration already occurs via StopWaste.org. Efforts to date on a county composting facility have not advanced.
Waste-4: Waste Education and Outreach	Expand educational programs to inform residents about reuse, recycling, composting, and waste reduction programs. Encourage local recycling and composting initiatives at the neighborhood level. City of Livermore's Strategic Plan will detail outreach activities.
Waste-5: Municipal Procurement Policy	Extend current procurement policies for municipal operations to purchase environmentally preferable (or "green)" and energy efficient products and services. Purchase office supplies with at least 50% recycled content by 2020. A draft procurement policy has already been prepared but has not yet been approved by the City Council.

Supporting Action	
Waste-6: Reuse/Recycling Center	Establish a reuse/recycling center where furniture, appliances, building materials, and other useful, nonhazardous items may be dropped off or purchased for a nominal fee. Livermore Sanitations provides a "free ebay" type program and will pick up and delivery bulky items for free within city limits.
Waste-7: Waste-to-Energy	Consider proposals and identify appropriate siting for efficient, low pollution generating waste-to-energy projects for private sector subject to environmental assessment of impacts (*Supporting Climate Change Element Policy: CLI-1.7, P4).*
Wastewater-2: Low Impact Development	Consider implementation of low-impact development practices that maintain the existing hydrologic character of the site to manage storm water and protect the environment. (Retaining storm water runoff on-site can drastically reduce the need for energy-intensive imported water at the site.)
Wastewater-3: Waste-to-energy	Consider implementation of waste-to-energy projects at the Livermore Water Reclamation Plant.

Table 4-10. Supporting Actions for High Global Warming Potential Gases Measures

Supporting Action	
HGWP GHG-1: Equipment Disposal	Consider an ordinance requiring residences practice responsible appliance disposal (RAD) for all decommissioned refrigerators and freezers (U.S. Environmental Protection Agency 2010b).
HGWP GHG-2: Municipal Equipment Replacement	Consider replacement of existing refrigeration and air conditioning units in municipal buildings with ENERGY-STAR certified appliances by 2020,, where feasible (CAPCOA 2009). It should be noted that this measure will result in GHG emission reductions through energy efficiency as opposed to control of fugitive emissions of HCFCs.
HGWP GHG-3: Municipal Equipment Inspections	Consider requiring inspections of municipal refrigeration and air conditioning units to ensure that all are working at their maximum capacity according to their design efficiencies. Require annual inspection of equipment with the goal of reducing all leaks by 95%. This measure will lead to faster servicing of equipment with refrigerant leaks.
HGWP GHG-4: Municipal Procurement Policy	Consider a requirement that when replacing old equipment for municipal facilities, that the City only purchase refrigeration/air-conditioning equipment that does not contain HFCs, to the extent available on the market.

Table 4-11. Supporting Actions for Off-Road Activity Measures

Supporting Action	
Off-Road-1: Idling Ordinance	Adopt an ordinance that limits idling time for heavy-duty off-road vehicles and equipment beyond ARB regulations. Recommended idling limit is 3 minutes (CAPCOA 2010).
Off-Road-2: Construction Vehicle Inventory Tracking Systems	Encourage construction contractors hired by the City to develop a construction vehicle inventory tracking system. The system should include strategies such as requiring hour meters on equipment and documenting the serial number, horsepower, age, and fuel of all onsite equipment.
Off-Road-3: Municipal Off-Road Equipment	All municipal construction equipment and gasoline power landscape equipment purchased by the City will have the following items considered: 1- In the top 10% of the lowest emissions for construction vehicles 2- Alternative fueled when available and applicable 3- Commercially available (no prototype vehicles) 4- Necessity (rent vs. own)
Off-Road-4: Electrical Outlets	Encourage the necessary facilities and infrastructure for low or zero-emission equipment, such as electric charging facilities and conveniently locate alternative fueling stations on or near all new building developments.
Off-Road-5: Construction Equipment	Consider offering financial incentives to municipal construction contractors that utilize alternative fueled or electric equipment in at least 75% of their fleet (CAPCOA 2010).
Off-Road-6: Lawnmower Exchange Program	Consider sponsoring a lawnmower exchange program that allows residents to trade in their gasoline powered mower for an electric mower at a low or discounted price.
Off-Road-7: Landscaping Equipment Ordinance	Consider adopting an ordinance that reduces gasoline-powered landscaping equipment use and/or reduces the number and operating time of such equipment.

Table 4-12. General Supporting Actions for CAP Implementation

Supporting Action	
Other-S1: Establish community outreach campaign to support local purchasing of goods and food.	Focus the outreach campaign on the financial, health, and society benefits achieved by purchasing local products. Consider using the campaign to highlight local businesses.
Other-S2: Consider purchasing offsets to reduce GHG emissions.	Offset providers should be considered in the following geographical priority for maximizing potential co-benefits of offsets: local, regional, and then state.

4.4 Community Outreach and Education

The citizens and businesses in Livermore are integral to the success of the CAP. Their involvement is essential, considering that several measures depend on the voluntary commitment, creativity, and participation of the community.

The City would collaborate with other local and regional agencies, businesses, and organizations to educate and inform stakeholders, such as businesses, business groups, residents, developers, and property owners about the CAP and encourage participation in efforts to reduce GHG emissions.

To create efficiency and reduce costs as much as possible, the City will collaborate with existing organizations and businesses that may already have resources such as database lists for notification, websites to help disseminate information, or data on energy use, retrofits, etc. These organizations could include the East Bay Association of Realtors, the Chamber of Commerce, and PG&E, etc.

The CIT would schedule periodic meetings to facilitate formal community involvement in CAP implementation and adaptation over time. These meetings would be targeted to stakeholder groups and provide information on CAP implementation progress. Stakeholders would be provided an opportunity to comment on potential improvements or changes to the CAP. The CIT would also sponsor periodic outreach events to directly inform and solicit the input, suggestions, and participation of the community at large.

4.5 Regional Involvement

There are substantial opportunities to enhance the effectiveness of the CAP through regional collaboration.

There are several regional partners and collaboration opportunities in addition to Valley CAN that would be essential to the CAP. The City would explore the potential to leverage resources provided by these opportunities to support implementation of the CAP. Potential opportunities and partners include:

- **BAAQMD.** BAAQMMD is the local agency responsible for developing and implementing air quality plans. The agency also sponsors various air quality programs that may support implementation of several energy efficiency, transportation, and renewable energy measures.
- **Pacific Gas and Electric Company.** PG&E offers numerous incentives and rebate programs to encourage energy efficiency. Resources offered by PG&E may reduce program implementation and administration costs. There may also be opportunities for cooperation on community-scale alternative energy installations (e.g., wind, solar).
- **Transportation Agencies (ACTA, MTC)**. In order to fully implement the transportation reduction measures that promote mixed use development, continued coordination with regional transportation agencies would be necessary. With SB 375 and its linkage to transportation funding, it would also be crucial for the City and transportation agencies to develop a shared vision of how transportation and land use can be consistent with the next Regional Transportation Plan and the required Sustainable Communities Strategy.

- **Alameda County Waste Management Authority.** Waste-1 includes the adoption of a 75% waste diversion goal. Coordination with the County to provide the facilities, programs, and incentives would help ensure this goal can be achieved by 2020.
- **Livermore-Amador Valley Cities.** Neighboring cities of Dublin, Pleasanton and Tracy (In San Joaquin County) all have adopted or will be adopting greenhouse gas reduction plans, with many similar local strategies as the City. Cooperation with others in Alameda County and elsewhere could help to find collective efficiencies in implementing GHG reduction strategies.
- **Zone 7 Water Agency and California Water Service Company.** The City can work with the both the water wholesaler (Zone 7) and the other water retailer (California Water Service Company) in order to promote reductions in indoor and outdoor water use from existing developments and achieve the goals set forth by SB X7-7.

4.6 Monitoring, Reporting, and Adaptive Management

Regular monitoring is important to ensure programs are functioning as they were originally intended. Early identification of effective strategies and potential issues would enable the City to make informed decisions on future priorities, funding, and scheduling. Moreover, monitoring provides concrete data to document the City's progress in reducing GHG emissions. The Implementation Coordinator would be responsible for developing a protocol for monitoring the effectiveness of emissions reduction programs as well as for undertaking emissions inventory updates.

Effective monitoring would require regular data collection in each of the primary emissions sectors. For example, reports detailing annual building electricity usage and fuel consumption at the RWCF would be necessary. The Implementation Coordinator would coordinate with internal City departments, PG&E, and other stakeholders to obtain and consolidate information into repository that can be used to evaluate the effectiveness of individual reduction measures.

The Implementation Coordinator would also be responsible for tracking the State's progress on implementing the state level programs. The CAP relies heavily on state level measures. Close monitoring of the real gains being achieved by state programs would allow the City to adjust its CAP, if needed.

The City would re-inventory, at a minimum, community GHG emissions for 2017 and 2020 in order to measure progress. If feasible at a reasonable cost/effort, annual GHG inventory monitoring may be conducted started in 2014, but at this time funding and staff resources are not available, and it is not a commitment of the City until funding mechanisms and resource availabilities are better understood. This effort may be funded by a CAP fee or other supplemental funding.

The Implementation Coordinator would report annually to the City council on CAP implementation progress. Where annual reporting, periodic inventorying, or other information indicates that the GHG reduction measures are not as effective as originally anticipated, the CAP may need to be adjusted, amended, or supplemented. At a minimum, the City would conduct a 4-year review of CAP effectiveness as part of annual reporting in 2016 which would allow the potential to make mid-course adjustment in the CAP to effect change prior to 2020.

4.7 Managing the City's Greenhouse Gas Emissions after 2020

While GHG management in the state of California is currently focused on a 2020 target, Executive Order S-03-05 articulates a GHG reduction goal for California in 2050. Executive Order S-03-05 states that by 2050 California shall reduce their GHG emissions to a level that is 80% below the level in 1990. It is reasonably foreseeable that as California approaches its first milestone in 2020, focus will shift to the 2050 target. A detailed plan for how the state would meet this target is expected. The City will monitor developments at the national and state levels.

Beginning in Phase 3 (2018), the City would commence planning for the post-2020 period. At this point, the City would have implemented the first two phases of the CAP and would have a better understanding of the effectiveness and efficiency of different reduction strategies and approaches. The new post-2020 reduction plan would include a specific target for GHG reductions for 2030, 2040, and 2050. The targets would be consistent with broader state and federal reduction targets and with the scientific understanding of the needed reductions by 2050. The City would adopt the post-2020 reduction plan by January 1, 2020.

4.8 CEQA Considerations and Tiering

This CAP is consistent with the Climate Change Element Adopted by the City of Livermore in 2009. At that time, the City of Livermore prepared a Supplemental Environmental Impact Report that disclosed the potential environmental effects of the Climate Change Element. As a discretionary action, prior to adoption of the CAP by City of Livermore, CEQA review will be required. The CAP does not change the level of development activity in the City compared to that disclosed in the EIR for the General Plan or the Supplemental EIR for the Climate Change Element. The community measures in the CAP, in most cases, mirror adopted Climate Change Element measures calling for energy efficiency, water conservation, waste minimizations and diversion, and reduction of vehicle-miles travelled. As such, the potential effects of implementation of this Plan were covered by the EIR analysis for the Climate Change Element. As a result, the City expects to use the previously prepared EIR for the General Plan and the Supplemental EIR for the Climate Change Element as the basis for CEQA compliance for this project.

Amendments to the CEQA guidelines in March 2010 describe that CEQA project evaluation of GHG emissions can tier off a programmatic analysis of GHG emissions provided that the GHG analysis (or CAP) includes the following (CEQA Guidelines Section 15183.5):

- *Quantify greenhouse gas emissions*, both existing and projected over a specified time period, resulting from activities within a defined geographic area. The CAP has quantified all primary sectors of GHG emissions within the City for 2005, 2008, and 2020.
- *Establish a level*, based on substantial evidence, below which the contribution to GHG emissions from activities covered by the plan would not be cumulatively considerable. The CAP includes a reduction target of 15% below 2008 levels, which is consistent with the recommendations in the AB 32 Scoping Plan for municipalities to support the overall AB 32 reduction targets

- *Identify and analyze the GHG emissions* resulting from specific actions or categories of actions anticipated within the geographic area. The CAP analyzes community emissions for the City as a whole and includes predicted growth expected by 2020.
- *Specify measures* or a group of measures, including performance standards that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level. The CAP includes both specific measures and project-level reduction standards to achieve the overall reduction target.
- *Monitor the plan's progress.* The CAP includes periodic monitoring of plan progress.
- *Adopt the GHG Reduction Strategy* in a public process following environmental review. The CAP will be adopted in a public process following compliance with CEQA.

Once adopted, subsequent project-level CEQA evaluation of greenhouse gas emissions can tier off of this CAP provided it is being fully implemented by the City and the specific project is consistent with all applicable requirements from this CAP.

The BAAQMD adopted new CEQA Guidelines in June 2010, including recommended significance thresholds for project and plan evaluation.[21] BAAQMD encourages local governments to adopt a qualified GHG reduction strategy consistent with AB 32 goals and the new statewide CEQA guidelines described above. BAAMQD recommends that projects consistent with an adopted qualified GHG reduction strategy that meets the standards described in the CEQA guidelines can be presumed to not have significant GHG emissions and do not need to be evaluated against the BAAMQD's recommended mass emissions or efficiency thresholds. BAAMQD provides specific criteria for interpreting the broader language of the CEQA guidelines concerning what defines a qualified GHG reduction strategy.

BAAMQD recommends that a GHG reduction strategy must meet one of three targets, that of reduction of emissions 15% below 2008 or earlier (e.g. 2005) levels by 2020. Thus, the CAP would meet this applicable targets recommended by BAAQMD. The BAAQMD includes another target which is meeting a "Service Population" (= residents + jobs) metric of 6.6 MT CO2e/person in 2020. With implementation of the CAP, Livermore's community emissions would be approximately 2.7 MT CO2e/service population, which is well below the plan target. However, the City's inventory does not include several sources of emissions included in the calculation of the Service Population metric using the state inventory (such as offroad emissions, industrial point sources, high global warming potential gases, agriculture, etc.), so this metric is not utilized for demonstration of meeting one of the required targets.

Accordingly, emissions associated with projects that are consistent with this CAP can be considered less than significant and their contributions to cumulative emissions are not considered cumulatively considerable. Projects that are consistent with this CAP will still create emissions, but they can be approved knowing that overall emissions projected to occur in 2020 will be less than the baseline emissions in 2005 and less than the emissions that would occur in 2020 if we continued "business as usual" and did not implement the CAP.

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[21] In early 2012, an Alameda County Superior Court ruling found that the BAAQMD needed to complete CEQA review and compliance before adopting the guidelines. Thus, the guidelines are technically only draft at this time. However, the factual findings in the June 2010 guidelines regarding GHG thresholds for qualified GHG reduction plans remain and constitute an appropriate basis for significance thresholds in the judgment of the City.

Appendix A
Original Greenhouse Gas Emissions Inventory/Forecast

City of Livermore

Greenhouse Gas Emissions Analysis

2005 Community Emissions Inventory
&
2005 Municipal Operations Emissions Inventory

LIVERMORE
CALIFORNIA

October 2008

Credits and Acknowledgements

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With generous support from the Stopwaste.org

Table of Contents

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*

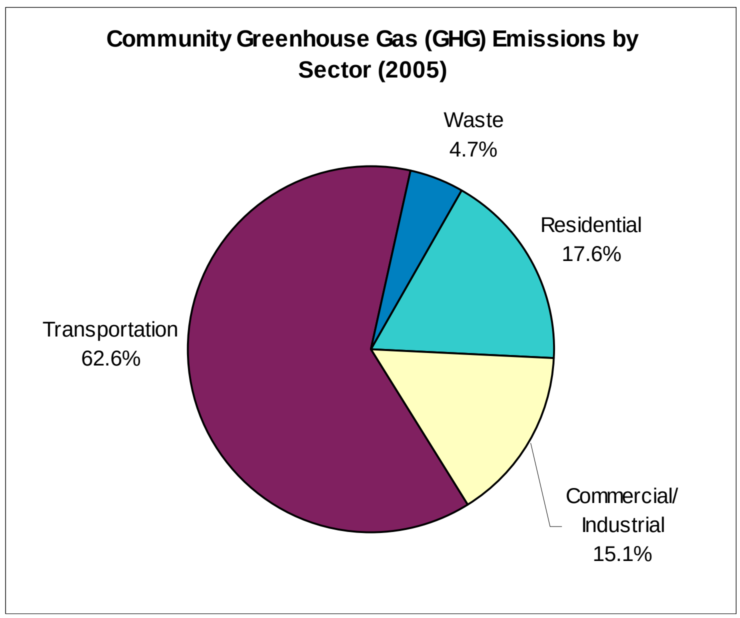


Table 1 – *Community GHG Emissions by Sector (metric tons CO_2e)*

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.

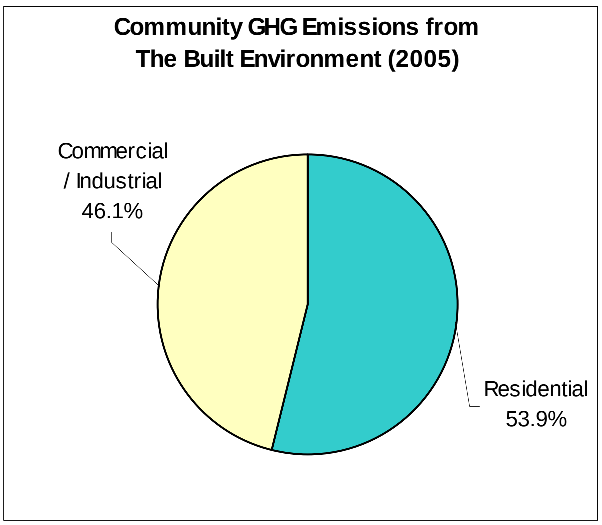
power sources that make up a utility's electricity generation mix have a significant impact on a city's greenhouse gas emissions. A coal fired power plant, for example, releases 1.3 tons of CO_2e per megawatt-hour of electricity generated versus 0.7 tons for gas turbines and 0 tons for renewable sources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

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[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%.

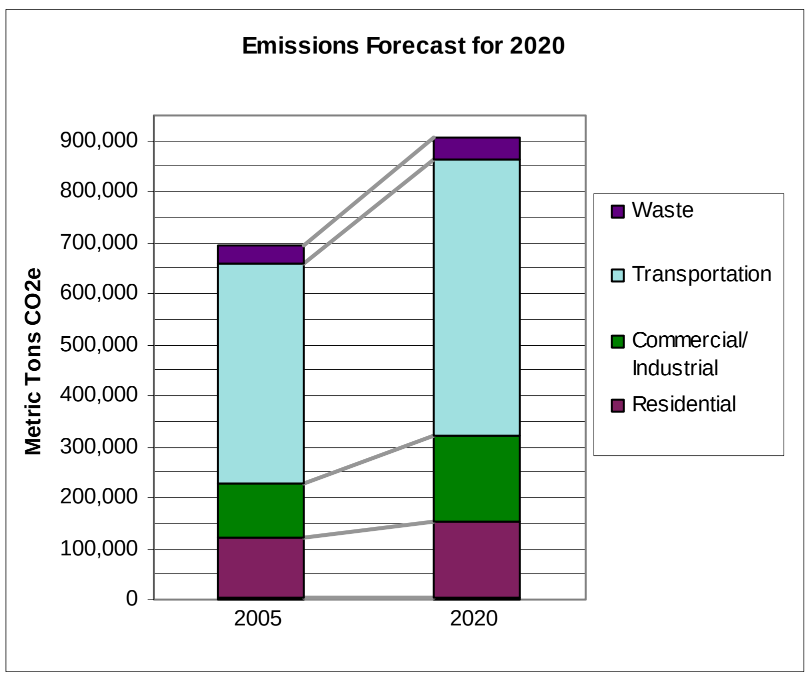
Transportation Forecast Methodology

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*



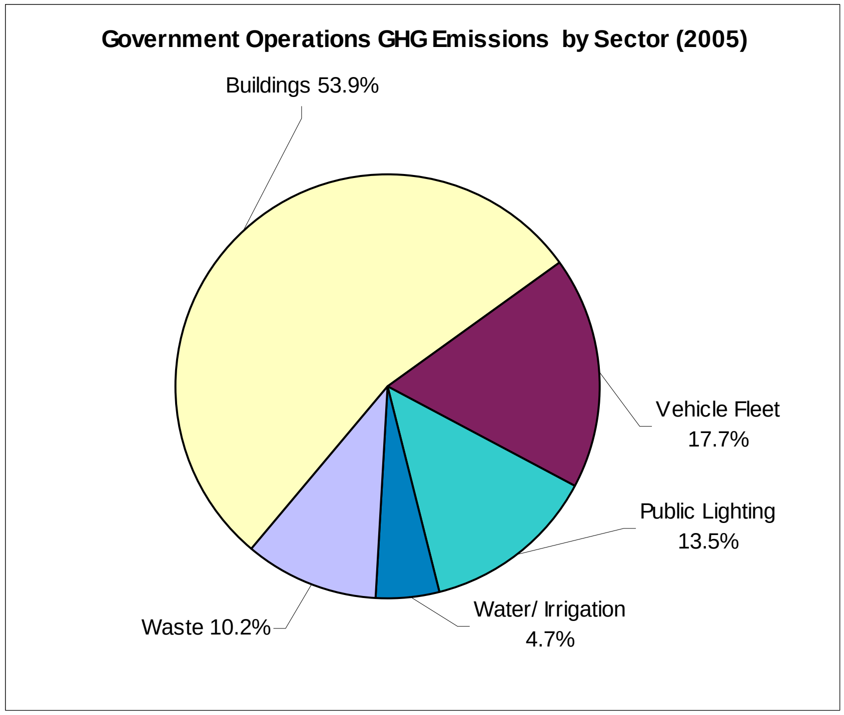
[11] Compounded annual growth rate= ((2020 population/2005 population)^(1/15))-1
[12] http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF
[13] Report available at: http://www.energy.ca.gov/2007publications/CEC-600-2007-009/CEC-600-2007-009-SF.PDF. Compounded Annual growth 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.

<u>Facilities / Municipal Buildings</u>

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**

<u>City Vehicle Fleet and Mobile Equipment</u>

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:

$CO_2e = W_t * (1\text{-}R)A$

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'.

Appendix B
Updated Greenhouse Gas Emissions Inventory/Forecast

Introduction

This appendix summarizes the revised City of Livermore greenhouse gas (GHG) baseline inventory (Revised 2005 Inventory) and 2020 business as usual GHG inventory forecast (Revised 2020 Community Forecast), and compares the results of the Revised 2005 Inventory and Revised 2020 Community Forecast to the original inventory and forecast prepared by ICLEI- Local Governments for Sustainability U.S.A., *City of Livermore Greenhouse Gas Emissions Analysis: 2005 Community Emissions Inventory & 2005 Municipal Operations Emissions Inventory* (ICLEI Inventory) (2010). The Revised 2005 Inventory is based on revised vehicle miles traveled (VMT) estimates provided by Fehr & Peers (2010), the addition of GHG emissions associated with transfer of water purchased from the Zone 7 Water Agency (Zone 7) to the City, the addition of fugitive GHG emissions from wastewater treatment (WWT) at the Livermore Water Reclamation Plant, the addition of GHG emissions from pumping of wastewater over the Dublin Grade into the San Francisco Bay through the Livermore Amador Valley Water Management Agency (LAVWMA), and revised growth factors for the 2020 Forecast.

Methodology

Transportation

Fehr & Peers provided revised VMT estimates for the Community Inventory and Forecast. To estimate VMT, Fehr & Peers modified the Alameda County CMA Travel Demand Model (ACCMA Model) to reflect the City Staff's land use projections and network characteristics. Once the ACCMA Model had been modified, a select link analysis was used to calculate VMT associated with three types of vehicle trips.

1. Vehicle trips that remained internal to Livermore (I-I trips)
2. Vehicle trips with one end in Livermore and one end outside of Livermore (I-X/X-I trips)
3. Vehicle trips with neither end in Livermore (X-X trips)

In accordance with the Regional Transportation Advisory Committee's (RTAC) guidance for VMT accounting under SB 375, VMT from trip types 1, 2, and 3 were counted as 100 percent, 50 percent, and zero percent, respectively, towards Livermore-generated VMT (Fehr & Peers 2010). The method used to inventory VMT in the original ICLEI Community Inventory differs from the revised methodology used by Fehr & Peers in the following ways:

1. The ICLEI VMT inventory included trips which neither start nor end in Livermore (X-X trips), whereas the ACCMA Model VMT estimate prepared by Fehr & Peers does not include these trips.
2. The ICLEI VMT inventory includes only the portion of I-X/X-I trips which occur on roadways in Livermore, whereas the ACCMA Model VMT estimate prepared by Fehr & Peers includes 50 percent of the *entire* trip lengths from those trips (Fehr & Peers 2010).

To calculate GHG emissions, the revised VMT data was modeled using the California Air Resources Board's EMFAC2007 model to obtain an estimate of 2005 gallons of fuel used by fuel type. Emission factors from the California Climate Action Registry General Reporting Protocol, Version 3.1 (CCAR Protocol) were then used to estimate CO_2e emissions from the fuel consumption calculated with EMFAC2007(California Climate Action Registry 2009).

Import of Water Purchased from Zone 7

GHG emissions associated with purchase and transfer of water from Zone 7 to the City were not included in the ICLEI Community Inventory. The City's water is provided by the City's Water Resources Division and the California Water Services Company (CWS). The amount of water imported to each of these water suppliers in 2005 was obtained from their Urban Water Management Plans (UWMPs) (California Water Service Company 2007; City of Livermore 2005). To calculate emissions associated with water imported into the City, an energy intensity factor providing the amount of energy required to move an acre-foot of water was obtained from the California Department of Water Resources' (DWR) *Bulletin132-06: Management of the California State Water Project* (Bulletin 132-06) (2007). DWR's Bulletin 132-06 provides cumulative energy use for 2005, including losses, by pumping station along State Water Project (SWP) aqueducts. The cumulative kWh per acre-foot for the South Bay Pumping Plant (including Del Valle) (1,165 kWh/acre-foot) was multiplied by the amount of water imported to the City obtained from the City's and CWS's UWMPs to estimate energy use associated with importing water to the City. Then, the 2005 energy use was multiplied by GHG emission factors for electricity generation, which were obtained from the ICLEI Inventory to obtain 2005 GHG estimates.

Fugitive Wastewater Treatment Emissions

Fugitive GHG emissions associated with WWT were not included in the ICLEI Municipal or Community Inventory. The Livermore Water Reclamation Plant treats the City's wastewater. For the Revised 2005 Municipal Inventory, fugitive WWT emissions were calculated according to the California Air Resources Board's (CARB) *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.1 (LGOP Protocol) (2010). The LGOP Protocol was developed and adopted in partnership by the CARB, CCAR, ICLEI - Local Governments for Sustainability, and The Climate Registry, to provide a standardized set of guidelines to assist local governments in quantifying and reporting GHG emissions (California Air Resources Board 2010). WWT data used to calculate GHG emissions was obtained from the City (Stoops pers. comm.). The following equations from the LGOP Protocol were used to calculate fugitive WWT emissions:

- Equation 10.1: Stationary CH_4 from Incomplete Combustion of Digester Gas:

  Annual CH_4 emissions (metric tons CO_2 equivalents [CO_2e]) = (Digester Gas x F_{CH4} x ρ(CH4) x (1-DE) x 0.0283 x 365.25 x 10^{-6}) x GWP

  Where, Digester Gas = measured standard cubic feet of digester gas produced per day [ft3/day], F_{CH4} = measured fraction of CH_4 in biogas, ρ(CH_4) = density of methane at standard conditions [g/m3] (662.00), DE = CH_4 Destruction Efficiency (0.99), 0.0283 = conversion from cubic feet (ft^3) to cubic meters (m^3) (m^3/ft^3), 365.25 = conversion factor (days/year), 10^{-6} = conversion from grams (g) to metric tons (metric ton/g), and GWP = Global Warming Potential of CH_4 (21).

- Equation 10.9: Process N_2O Emissions from Effluent Discharge:

  Annual N_2O emissions (metric tons CO_2e) = (N Load x EF effluent x 365.25 x 10^{-3} x 44/28) x GWP

  Where, N Load = measured average total nitrogen discharged (kilograms [kg] N/day), EF effluent = emission factor (kg N_2O-N/kg sewage-N produced) (0.005), 365.25 = conversion factor (days/year), 10^{-3} = conversion from kg to metric tons (metric ton/kg), 44/28 = molecular weight ratio of N_2O to N_2, and GWP = Global Warming Potential of N_2O (310).

Secondary Effluent Wastewater Pumping Emissions

GHG emissions associated with pumping secondary wastewater effluent over the Dublin Grade into the San Francisco Bay (SF Bay) through the LAVWMA export pipeline were not included in the ICLEI Community Inventory. In order to account for these emissions in the Revised 2005 Community Inventory, an energy intensity factor was obtained from the LAVWMA (Cummings pers. comm.). The energy intensity factor provides the amount of energy necessary to pump one-million gallons of wastewater effluent over the Dublin Grade into the SF Bay. This energy intensity factor was then multiplied by the amount of 2005 secondary effluent exported to the SF Bay, which was obtained from the City (Stoops pers. comm.) to estimate energy (kilowatt hours [kWh]) for 2005 exports of wastewater through the LAVWMA pipeline. Then, the 2005 energy use was multiplied by GHG emission factors obtained from the ICLEI Inventory to obtain 2005 GHG estimates.

Revised Growth Factors for the 2020 Community Forecast

Revised growth factors for the Revised 2020 Community Forecast were calculated according to the revised VMT estimates provided by Fehr & Peers (2010) and the latest population and job projections from the Association of Bay Area Governments (ABAG) (Moran pers. comm.). Revisions to the growth factors were necessary because the 2005 ABAG projection factors used for the ICLEI forecast were outdated and overestimate future growth through 2020; they did not account for the effect of the recession on population and economic growth.

Comparison of ICLEI 2005 Inventory to Revised 2005 Inventory

This section describes the differences in CO_2e emissions and percent CO_2e emissions by sector between the ICLEI Community and Municipal Inventories and the Revised 2005 Community Inventory and Revised 2005 Municipal Inventory, respectively.

Revised Community Inventory

As shown in Table 1 below, the Revised 2005 Community Inventory is lower than the original inventory by 279,652 metric tons CO_2e, or 40.44 percent. This substantial change is due to the revised VMT estimates provided by Fehr & Peers (2010). The revised VMT estimates led to a reduction in transportation-related CO_2e emissions by 285,724 metric tons. The revised methods used to estimate VMT are explained in the *Transportation* methodology section above. Although imported water emissions and emissions from wastewater exported through LAVWMA pipeline have been added to the ICLEI 2005 Community Inventory, the reduction in CO_2e emissions from the transportation sector more than offsets the addition of these emissions.

Table 1. Revised 2005 Community Inventory

Emissions Type	Metric Tons CO_2e
Total ICLEI 2005 Community Inventory	691,589
Difference in Transportation	-285,724
Additional of Water	5,246
Additional of Wastewater Treatment	826
Total Revised 2005 Community Inventory	411,937
Decrease in CO_2e compared to ICLEI Inventory	-279,652
Percent Decrease in CO_2e from ICLEI Inventory	-40.44%

Figure 1 below shows the contribution of CO_2e by sector for the Revised 2005 Community Inventory. As shown in Figure 1, transportation accounts for 36 percent of the total Revised 2005 Community Inventory, whereas the transportation sector in the original ICLEI Community Inventory accounted for 63 percent of the total inventory. While the transportation sector is still the largest contributor to total CO_2e in the revised inventory, transportation emissions are considerably lower in the updated analysis. The percent contribution of waste from the ICLEI Community Inventory was 5 percent, and for the Revised 2005 Community Inventory, the percent contribution of waste is 8 percent. Residential CO_2e emissions accounted for 18 percent of total CO_2e emissions for the ICLEI Community Inventory, and they account for 30 percent of total CO_2e emissions for the Revised 2005 Community Inventory. Commercial/Industrial emissions accounted for 15 percent of total CO_2e emissions for the ICLEI Community Inventory, and they account for 25 percent of total CO_2e emissions for the Revised 2005 Community Inventory. As previously mentioned, emissions associated with water imports from Zone 7 and wastewater export through the LAVWMA pipeline were not included in the ICLEI Community Inventory, so there is no comparison to be made between the ICLEI and Revised inventories.

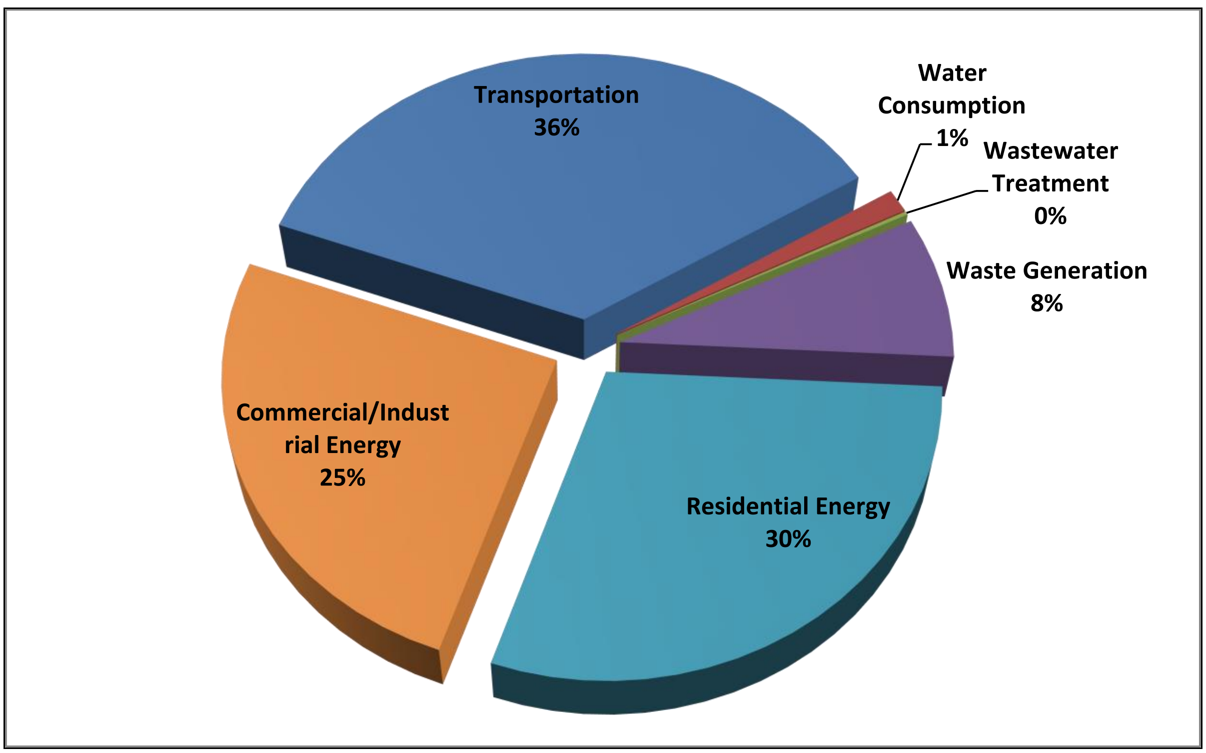


Figure 1. 2005 Community CO_2e Emissions by Sector

Revised Municipal Inventory

As shown in Table 2 below, the Revised 2005 Municipal Inventory is higher than the original inventory by 826 metric tons CO_2e, or 12 percent. This increase in CO_2e emissions is due to the addition of fugitive emissions from WWT at the Livermore Water Reclamation Plant. The revised methods used to estimate fugitive emissions are explained in the *Fugitive Wastewater Treatment Emissions* methodology section above.

Table 2. Revised 2005 Municipal Inventory

	Metric Tons CO2e
Total ICLEI 2005 Municipal Inventory	6,269
Addition of Fugitive Emissions from Wastewater Treatment at the Livermore Water Reclamation Plant	+826
Total Revised 2005 Municipal Inventory	7,095
Increase in CO2e from ICLEI Inventory	+826
Percent Increase in CO2e from ICLEI Inventory	11.64%

Figure 2 below shows the contribution of CO_2e by sector for the Revised 2005 Municipal Inventory. As shown in Figure 2, buildings account for 48 percent of the total Revised 2005 Municipal Inventory, whereas the buildings sector in the ICLEI Municipal Inventory accounted for 54 percent of the total inventory. The percent contribution of vehicle fleet from the ICLEI Municipal Inventory was 18 percent, and for the Revised 2005 Municipal Inventory, the percent contribution of the City's vehicle fleet is 16 percent. CO_2e emissions associated with public lighting accounted for 14 percent of total CO_2e emissions for the ICLEI Municipal Inventory, and they account for 12 percent of total CO_2e emissions for the Revised 2005 Municipal Inventory. Emissions associated with waste accounted for 10 percent of total CO_2e emissions for the ICLEI Municipal Inventory, and they account for 9 percent of total CO_2e emissions for the Revised 2005 Municipal Inventory. Water/irrigation emissions accounted for 5 percent of total CO_2e emissions for the ICLEI Municipal Inventory, and they account for 4 percent of the Revised 2005 Municipal Inventory. As previously mentioned, fugitive emissions from WWT treatment at the Livermore Water Reclamation Plant were not included in the ICLEI Municipal Inventory, so there is no comparison to be made.

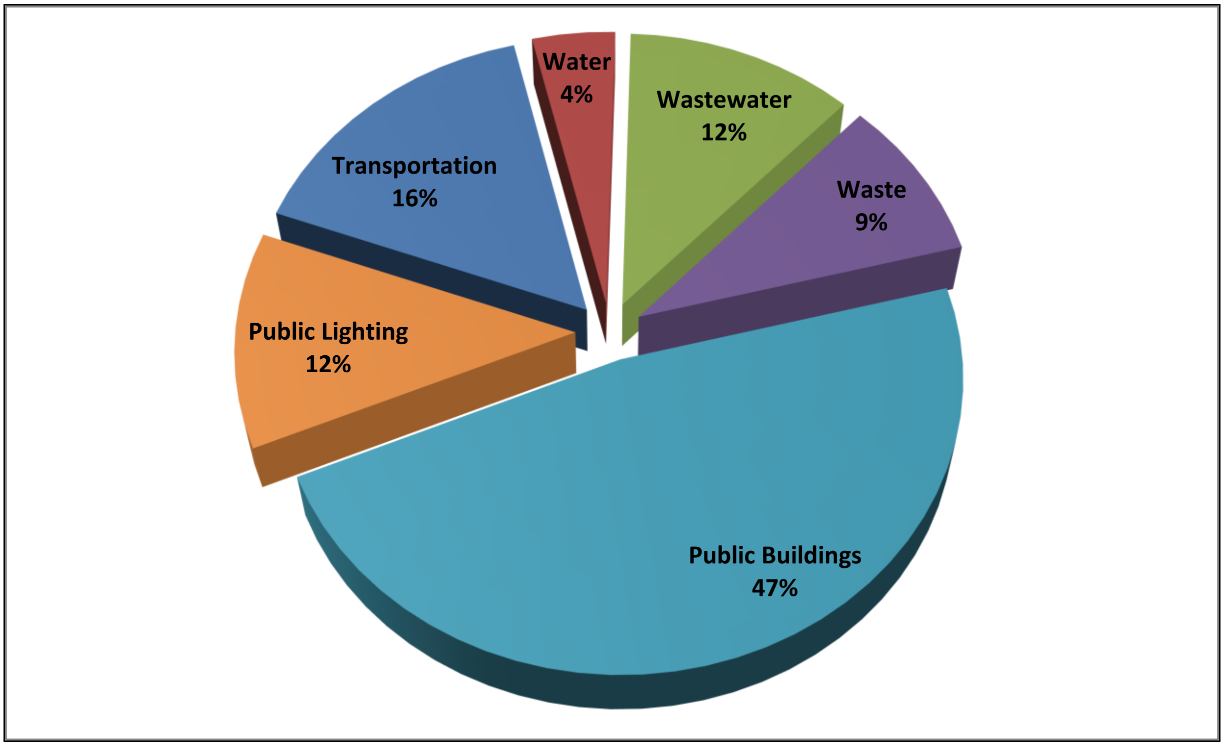


Figure 2. 2005 Municipal CO_2e Emissions by Sector

Comparison of ICLEI 2020 Community Forecast to Revised 2020 Community Forecast

Table 3 below provides the Revised 2020 Community Forecast. A revised 2020 Municipal Forecast is not provided, as municipal emissions of CO_2e were not forecasted for the ICLEI Inventory. As shown in Table 3, the percent increase in total emissions from 2005 to 2020 is estimated to be 21 percent. The original ICLEI 2020 community forecast showed an increase in total emissions of 30.6 percent which is 9.6 percent higher than the revised estimate. This decrease in percent change in total emissions from 2005 to 2020 is due to updated lower annual growth rates based on the most recent ABAG projections (Moran pers. comm.) to account for the effect of the recession on population and economic growth.

Table 3. Revised 2020 Community Forecast

	2005 Inventory		2020 BAU Forecast		% Change from 2005 Inventory
	$MTCO_2e$	% of Total	MT CO_2e	% of Total	
Transportation	147,327	36%	182,643	37%	24%
Water Consumption	5,246	1%	6,073	1%	16%
Wastewater Treatment[a]	826	0.2%	956	0.2%	16%
Waste Generation	32,783	8%	37,948	8%	16%
Residential Energy	121,572	30%	140,726	28%	16%
Commercial/Industrial	104,183	25%	128,956	26%	24%
Total Emissions	411,937	100%	497,302	100%	21%

[a] Wastewater emissions include both fugitive wastewater treatment emissions (4,172 $MTCO_2$ in 2005, 4,829

	2005 Inventory		2020 BAU Forecast		% Change from 2005 Inventory
	$MTCO_2e$	% of Total	MT CO_2e	% of Total	
$MTCO_2$ projected in 2020) and emissions associated with wastewater export through the LAVWMA pipeline (1,075 $MTCO_2$ in 2005, 1,244 $MTCO_2$ projected in 2020).					

Table 4 provides a comparison of the Revised 2020 Community Forecast to the ICLEI 2020 Community Forecast. Figure 3 shows the contribution of CO_2e by sector for the Revised 2020 Community Forecast. As shown in the figure, transportation contributes the largest amount of CO_2e with 37 percent of total CO_2e emissions, then residential (28 percent) commercial/industrial (26 percent), waste (8 percent), and small contributions from other sources.

Table 4. Comparison of Community Emissions Growth Projections by Sector

Source	Comparison	2005	2020	Percent Change from 2005 to 2020
Transportation	Revised Inventory and Forecast	147,327	182,643	24%
	ICLEI 2020 Community Forecast	433,051	542,095	25%
	Difference	-285,724	-359,452	—
Water Emissions	Revised Inventory and Forecast	5,246	6,073	16%
	ICLEI 2020 Community Forecast	—	—	—
	Difference	—	—	—
WWT Emissions	Revised Inventory and Forecast	826	956	16%
	ICLEI 2020 Community Forecast	—	—	—
	Difference	—	—	—
Waste	Revised Inventory and Forecast	32,783	37,948	16%
	ICLEI 2020 Community Forecast	32,783	40,474	23%
	Difference	0	-2,526	—
Residential	Revised Inventory and Forecast	121,572	140,726	16%
	ICLEI 2020 Community Forecast	121,572	150,095	23%
	Difference	0	-9,369	—
Commercial/ Industrial	Revised Inventory and Forecast	104,183	128,956	24%
	ICLEI 2020 Community Forecast	104,183	170,450	64%
	Difference	0	-41,494	—

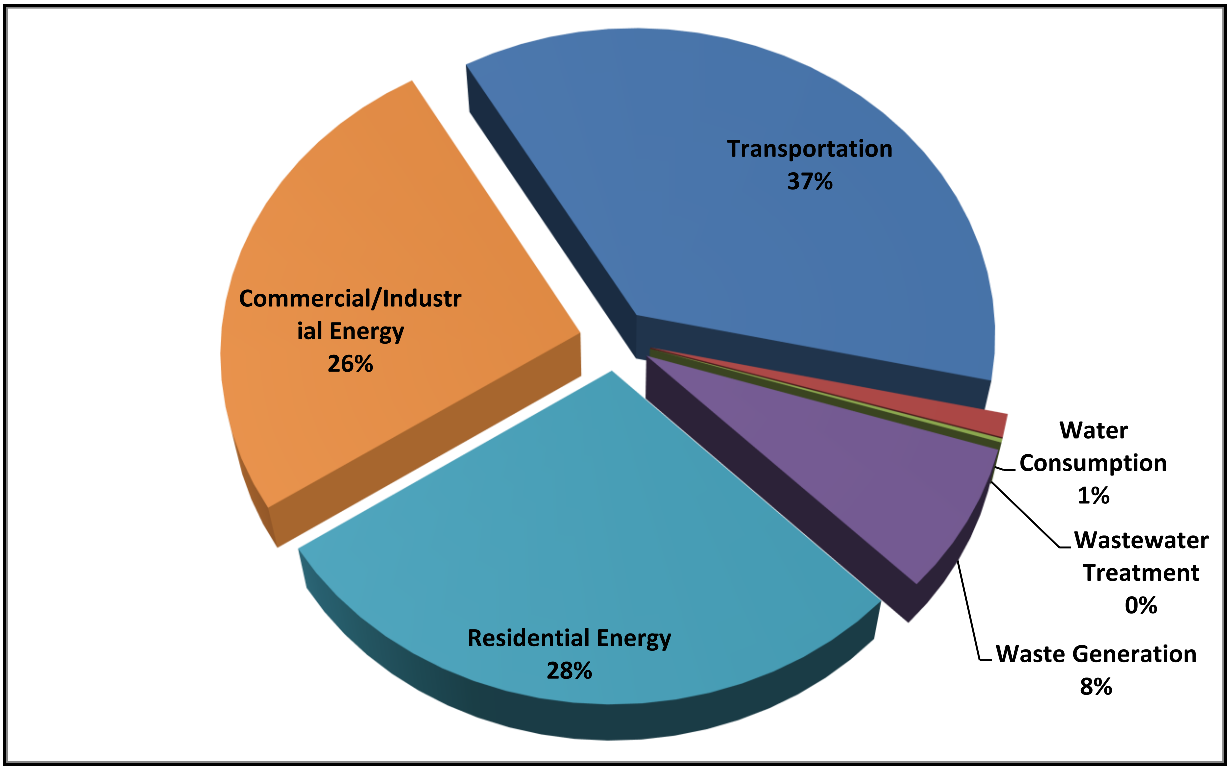


Figure 3. 2020 Community CO_2e Emissions by Sector

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Appendix C
Greenhouse Gas Reduction Measure Methodology

Appendix C
Greenhouse Gas Reduction Measure Methodology

C.1 Introduction

This Appendix provides a detailed overview of the calculations and assumptions used to quantify greenhouse gas (GHG) reductions and the monetary costs and savings for each of the City of Livermore's (City) GHG reduction measures. A qualitative discussion of benefits is also presented. The following information is provided for each measure.

- **Measure Description**. Details the implementation requirement(s) and reduction goal.
- **Assumptions**. Includes all assumptions used in calculating emissions reductions and costs. Because the majority of measures utilize the same assumptions, Table C-1 includes a master list of assumptions for reference.
- **Analysis Details**. Presents the methods for calculating business-as-usual (BAU)[1] and baseline[2] emissions, as well as a more detailed discussion of calculations performed to quantify emissions reductions. A qualitative summary of benefits is also provided. Note that a reasonable amount of information is provided so that the reader can understand the basic methods and equations used to quantify emissions reductions and costs. However, this section *does not* include an exhaustive list of all calculations and steps performed; doing so would result in hundreds of pages of documentation. For additional information, please refer to the citations provided for each measure.

As an introduction to the measure details, this Appendix begins with an overview of the general GHG quantification methods by emissions sector, followed by a brief description of the approach for the cost analysis.

C.2 Overview of GHG Methods

The quantification of GHG reductions was based primarily on guidance provided by the California Air Pollution Control Officers Association (CAPCOA), other reference sources (such as the U.S. Environmental Protection Agency), and professional experience obtained from preparing climate action plans (CAP) for other jurisdictions in California. The majority of calculations were performed using standard factors and references, rather than performing a specific analysis of individual technologies. The following sections provide an overview of general calculation methods by emissions sector.

[1] BAU emissions are defined as those that would occur without the implementation of state or local action.

[2] Baseline emissions are defined as those that would occur with the implementation of state action, but no local action.

To avoid double counting emissions savings achieved by state programs, emissions reductions attributed to the candidate measures first subtract reductions achieved through the relevant state measures. Likewise, emissions reductions attributed to certain candidate measures subtract reductions achieved by overlapping local measures. By removing overlapping reductions, one can combine GHG reduction strategies to determine the cumulative effect of several measures without double counting measure effectiveness.

C.2.1 State Measures

The City's CAP includes emissions benefits from nine statewide initiatives. These State measures span multiple emission sectors, but are primarily targeted at the building energy and transportation sectors. Emissions reductions achieved by these measures were apportioned to the City-level using statewide estimates of measure effectiveness and sector-specific information. For example, the California Air Resources Board (CARB) estimates that implementation of Pavley I will reduce statewide emissions from passenger vehicles by 27.7 million metric tons (MT) of CO_2 equivalent (CO_2e), or by approximately 17% (California Air Resources Board 2011). GHG reductions achieved by Pavley I within Livermore were therefore quantified by multiplying City-level 2020 BAU emissions from passenger vehicles by 17%. It is important to note that while Livermore will achieve emissions reductions as a result of State programs, implementation of State measures does not require local action.

C.2.3 Local Measures

The section summarizes local efforts that the City proposes to further reduce community-wide GHG emissions.

Building Energy Use

Reduction measures to address GHG emissions from building energy are designed to improve energy efficiency and to transition consumption towards renewable sources of energy. Consumption data of electricity (kWh) and natural gas (therms) consumed by residential, and commercial and industrial buildings were provided for the existing inventory year (2005) and scaled to 2020 under BAU conditions using the socioeconomic data. (City of Livermore 2005a and ICF International 2010).

Emissions reductions achieved by energy measures were quantified using a general standard and factors. Specifically, percent reductions in energy consumption for various actions, such as exceeding the Title 24 Standard, were obtained from CAPCOA and other literature sources. These reductions were applied to the calculated 2020 energy usage to quantify total reductions in energy consumption. GHG emissions that would have been emitted had the energy been consumed were then calculated using utility-specific emission factors.

Transportation

Measures within the transportation sector seek to both reduce the number of vehicle trips, as well as encourage mode shifts from single occupancy vehicles to alternative transportation. Fehr & Peers calculated the potential reduction in vehicle miles of travel (VMT)[3] that are expected to occur by 2020 with implementation of each GHG reduction measure (Fehr & Peers 2011) (Attachment C-1).

ICF estimated GHG emissions reductions from transportation measures using VMT data provided by Fehr & Peers. GHG emissions reductions were quantified by multiplying the reduction in VMT (Fehr & Peers 2011) by an emission per VMT factor, which is simply the quotient of 2020 BAU transportation emissions and 2020 BAU VMT. 2020 BAU transportation emissions and VMT are summarized in the Livermore 2005 GHG Inventory (City of Livermore 2005a).

Waste Generation

The City's waste reduction strategy aims to reduce the amount of waste produced by the community and sent to landfills by increasing the waste diversion rate. Waste generation volumes from 2005 were obtained from the City's existing inventory, and the City's baseline diversion rate was obtained from CalRecycle (n.d.). Future year waste generation volumes were determined by scaling to 2020 using the City's socioeconomic data. GHG emissions that would have been generated from the decomposition of waste in a landfill if it had not been diverted were quantified using the City's 2020 BAU waste emissions, 2020 BAU waste sent to landfills, and the goal diversion rate specified in the reduction measure description.

Water Consumption (Conveyance and Building Energy Reductions)

The CAP seeks to reduce energy and GHG emissions associated with water consumption through compliance with Senate Bill (SB) X7-7. Pursuant to SB X7-7, the City's urban water retailers will reduce per capita water consumption by 20% by 2020. Total community-wide forecasted water consumption in 2020 was provided by the water providers' Urban Water Management Plans. The difference in 2020 water usage between the SB X7-7 and the BAU scenarios was assumed to the represent the water reductions associated with the measure. Indirect GHG emissions from electricity required to pump, treat, distribute and/or heat the consumed water were calculated using state-specific emission factors.

Wastewater Treatment

The CAP targets emissions from the City's wastewater treatment plant by seeking to implement high-efficiency aeration diffusers at the Livermore Water Reclamation Plant (LWRP). A recent report prepared by Chevron was used to calculate expected GHG reductions associated with this measure (Chevron 2012). .

[3] VMT is the number of miles traveled by vehicles on the City's roads.

Urban Forestry

The City's CAP includes a measure to expand urban forestry programs to plant 100 new trees per year. Emissions benefits from increased shade and sequestration were quantified based on information provided by ICLEI and CAPCOA. The City's tree planting lists were consulted to determine the types of tree species appropriate for planting along City streets and in open spaces. It was assumed that tree planting would begin in 2013 and occur on an annual basis.

Municipal Energy-Efficiency Measures

The City is considering a suite of energy-efficiency measures for municipal operations based on an evaluation conducted by Chevron (Chevron 2012). The identified annual savings from the Chevron report are presented below. The report did not provide initial capital cost estimate or total discounted estimates of cost or savings.

C.3 Overview of Cost Analysis Methods

The cost analysis estimated the following metrics for each measure:

- **Net additional one-time (capital) costs or savings**. These costs represent the costs of purchasing new equipment, retrofitting equipment, planting trees—the "one-time" costs associated with implementing a measure. In many cases, these one-time costs are assumed to occur at the same time; however, there are a few cases where these one-time costs are actually spread over several years as the measure is fully implemented.

- **Net additional annual costs or savings in 2020**. Annual costs generally represent maintenance costs. Annual savings often represent avoided energy costs or avoided maintenance costs. Net annual costs/savings can vary by year, so this document presents the annual net costs anticipated in 2020.

- **Total Costs/Savings**. Total costs or savings were calculated by considering the stream of all costs and savings over the lifetime of the equipment and applying a discount rate for future costs or savings. In some cases, there is no associated lifetime of equipment, and total costs/savings were calculated for the 2012-2020 time period. A discount rate of 5 percent was used.

- **Annualized net costs /savings per ton of CO_2e reduction in 2020 (essentially, $/ton).** The total costs/savings were divided by an annuity factor to estimate the annualized costs/savings. This value is from the perspective of annual costs and savings, taking into account the time value of money. Because costs and savings are incurred over a period of several years, it is necessary to calculate the annualized so that it can be evaluated against the GHG reductions that occur in a single year (2020). This value provides an estimate of the cost per ton of implementing the measure.

- **Simple payback period.** The simple payback period is calculated by dividing the one-time costs by the annual savings, or (when annual costs vary) by calculating the break-even point. In some cases, the payback period would exceed the lifetime of the equipment, and this never would actually be "repaid." These instances are noted as "N/A" (for Not Applicable) in the summary tables. Note that the savings and costs are sometimes born by different entities, so the payback period does not necessarily indicate that a given entity would actually be paid back on its investment.

There are some important caveats to note regarding the cost analysis. First, the numbers presented in this document are meant to provide order-of-magnitude estimates and assist in evaluating the relative costs/savings of each measure. There are numerous factors that will affect the actual costs incurred if the measures are implemented. In some cases, assumptions had to be made about the specific actions taken to implement a given measure, although the actual approach to implementing the measure could vary. Second, it is important to understand that in many cases, costs and savings are born by different entities. For example, a local government may incur costs associated with planting and maintaining urban trees, but the savings from reduced electricity bills accrue to local businesses and residents. Where appropriate, we distinguish among the key players incurring the costs and savings.

C.4 Overview of Measure Benefits

Many of the GHG reduction measures would result in financial, environmental, and public benefits for the City and community that are additional to the expected GHG emission reductions. These benefits include cost savings over conventional activities, reductions in criteria pollutants, job growth, economic growth, and public health improvements. Studies have shown that some climate actions in California can produce net gains for the statewide economy, increasing growth and creating jobs while others will result in net costs. Climate policies can produce positive economic growth through monetary savings from improvements in energy efficiency and reduced energy bills, as well as investing in technologies for innovation, which can provide new stimulus for employment (Roland-Holst 2008). Another study demonstrated that addressing and mitigating GHG emissions on a national level can yield a large savings potential, benefit the global economy, and can be mostly achieved through implementation of existing technology (Vattenfall 2007). Based on literature reviews, a qualitative discussion of anticipated benefits is provided for each of the City's GHG reduction measures. Benefits are identified using the following icons.

Benefits for the City of Livermore's GHG Reduction Measures

Reduced Energy Use	Reduced Energy Price Volatility
Reduced Waste Generation	Economic Growth
Resource Conservation	Public Health Improvements
Energy Diversification and/or Security	Increased Quality of Life

Reduced Air Pollution

Reduced Urban Heat Island Effect

Increased Property Values

Smart Growth

C.5 Common Assumptions

As discussed in Section C.1, the measure write-ups include all assumptions used in calculating emissions reductions and costs. Because the majority of measures utilize the same assumptions, Table C-1 provides a master list of assumptions. Each assumption is numbered for reference.

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
Business-as-Usual Emissions Data (MT CO_2e)			
1	2020 Emissions from Transportation	182,643	City of Livermore Inventory Update
2	2020 Emissions from Transportation: Heavy-Duty Trucks Only	23,067	City of Livermore Inventory Update
3	2020 Emissions from Building Energy	269,682	City of Livermore Inventory Update
4	2020 Emissions from Residential Building Energy	140,726	City of Livermore Inventory Update
5	2020 Emissions from Commercial/Industrial Building Energy	128,956	City of Livermore Inventory Update
6	2020 Emissions from Waste	37,948	City of Livermore Inventory Update
7	2020 Emissions from Water	6,073	City of Livermore Inventory Update
8	2020 Emissions from Wastewater	956	City of Livermore Inventory Update
9	2020 City Wide Emissions	497,302	City of Livermore Inventory Update
Socioeconomic Data and Growth Factors			
10	2005 Housing	28,646	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
11	2005 Existing Single Family Homes (units)	22,583	Email from Ingrid Rademaker on 1/24/12
12	2005 Existing Multi Family Homes (units)	6,063	Email from Ingrid Rademaker on 1/24/12
13	2005 Existing Other Homes (units)	0	Email from Ingrid Rademaker on 1/24/12
14	2011 Housing	30,661	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
15	2011 Existing Single Family Homes (units)	22,382	Email from Ingrid Rademaker on 1/24/12.
16	2011 Existing Multi Family Homes (units)	8,279	Email from Ingrid Rademaker on 1/24/12
17	2011 Existing Other Homes (units)	0	Email from Ingrid Rademaker on 1/24/12
18	2020 Housing	34,742	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
19	2020 Single Family Homes (units)	23,947	Email from Ingrid Rademaker on 1/24/12
20	2020 Multi Family Homes (units)	10,795	Email from Ingrid Rademaker on 1/24/12
21	2020 Other Homes (units)	0	Email from Ingrid Rademaker on 1/24/12
22	“New” Housing in 2020 (2020-2012)	4,081	2020 minus 2011 values
23	“New” Single Family Homes in 2020 (units)	1,565	2020 minus 2011 values
24	“New” Multi Family Homes (units) in 2020	2,516	2020 minus 2011 values

Table C-1. Master List of Quantification Assumptions			
Number	**Parameter**	**Assumption**	**Source (if applicable)**
25	"New" Other Homes (units) in 2020	0	2020 minus 2011 values
26	2005 Population	79,046	Livermore 2005 GHG Inventory
27	2011 Population	80,968	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
28	2020 Population	91,500	Livermore 2005 GHG Inventory
29	"New" Population in 2020 (persons) (2020–2012)	10,532	2020 minus 2011 values
30	2005 Employment	32,340	Livermore 2005 GHG Inventory
31	2011 Employment	42,204	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
32	2020 Employment	40,030	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
33	"New" Employment in 2020 (jobs) (2020–2012)	-2,174	2020 minus 2011 values
34	2005 Commercial Floor space (square feet)	5,532,840	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
35	2011 Commercial Floor space (square feet)	5,954,638	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
36	2020 Commercial Floor space (square feet)	6,588,299	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
37	"New" Commercial Floor space 2020 (2020–2012)	633,661	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
38	2005 Industrial Floor space (square feet)	8,603,079	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
39	2011 Industrial Floor space (square feet)	15,902,334	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
40	2020 Industrial Floor space (square feet)	16,449,286	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
41	"New" Industrial Floor space 2020 (2020–2012)	546,952	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
42	Growth in housing between 2005 and 2020	1.21	ICF International 2010
43	Growth in employment between 2005 and 2020	1.24	ICF International 2010
44	Growth in population between 2005 and 2020	1.16	ICF International 2010

Table C-1. Master List of Quantification Assumptions			
Number	**Parameter**	**Assumption**	**Source (if applicable)**
Global Warming Potentials			
45	Carbon Dioxide	1	IPCC 1996 and 2001
46	Methane	21	IPCC 1996 and 2001
47	Nitrous Oxide	310	IPCC 1996 and 2001
48	CFC-11	4,750	California Climate Action Registry 2010
49	HCFC-141b	725	California Climate Action Registry 2010
Emission Factors			
50	2005 PG&E Electricity Emissions Factor (lbs CO_2/MWh)	493	Livermore 2005 GHG Inventory
51	2005 Default Electricity Emissions Factor (lbs CH4/MWh)	0.072000	Livermore 2005 GHG Inventory
52	2005 Default Electricity Emissions Factor (lbs N2O/MWh)	0.0540000	Livermore 2005 GHG Inventory
53	2020 PG&E Electricity Emissions Factor (lbs CO_2/MWh)	375	Calculated based on California Energy Commission 2007
54	2020 Statewide Electricity Emissions Factor (lbs CH_4/MWh)	0.0536000	Calculated based on California Energy Commission 2007
55	2020 Statewide Electricity Emissions Factor (lbs N_2O/MWh)	0.0402000	Calculated based on California Energy Commission 2007
56	2005 and 2020 Natural Gas Emissions Factor (kg CO_2/MMBtu)	53.05	Livermore 2005 GHG Inventory
57	2005 and 2020 Natural Gas Emissions Factor (g CH_4/M^3)	0.214398873	Livermore 2005 GHG Inventory
58	2005 and 2020 Natural Gas Emissions Factor (g N_2O/M^3)	0.036338792	Livermore 2005 GHG Inventory
59	Ratio—Single: Multi Family Housing—Electricity	1.39	Energy Information Administration 2009
60	Ratio—Single: Multi Family Housing—Natural Gas	1.23	Energy Information Administration 2009
61	Groundwater Importation Energy Proxy (kWh/MG)	896	California Air Pollution Control Officers Association 2010
62	Surface water Importation Energy Proxy (kWh/MG)	1,510	California Air Pollution Control Officers Association 2010
63	State Water Project Importation Energy Proxy (kWh/MG)	896	California Air Pollution Control Officers Association 2010
64	Water Treatment Energy Proxy (kWh/MG)	111	California Air Pollution Control Officers Association 2010
65	Water Distribution Energy Proxy (kWh/MG)	1,272	California Air Pollution Control Officers Association 2010
66	Wastewater Distribution Energy Proxy (kWh/MG)	2,028	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
67	Gasoline (MT CO_2/GJ)	0.0658	GHGID Model Tool
68	Gasoline (MT CH_4/GJ)	0.0000	GHGID Model Tool
69	Gasoline (MT N_2O/GJ)	0.0000	GHGID Model Tool

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
70	Diesel (MT CO_2/GJ)	0.0704	GHGID Model Tool
71	Diesel (MT CH_4/GJ)	0.00001	GHGID Model Tool
72	Diesel (MT N_2O/GJ)	0.0000006	GHGID Model Tool
73	LGP (MT CO_2/GJ)	0.0599	GHGID Model Tool
74	LGP (MT CH_4/GJ)	0.0000	GHGID Model Tool
75	LGP (MT N_2O/GJ)	0.0000	GHGID Model Tool
76	Kg CO_2/gallon diesel	10.15	Climate Registry 2011
Detailed Building Energy Data			
77	CEC Forecast Climate Zone	4	California Air Pollution Control Officers Association 2010
78	2005 Residential Electricity Usage (kWh)	223,300,000	Livermore 2005 GHG Inventory
79	2005 Commercial and Industrial Electricity Usage (kWh)	331,800,000	Livermore 2005 GHG Inventory
80	2011 Residential Electricity Usage (kWh)	236,755,960	ICF International 2010
81	2011 Commercial and Industrial Electricity Usage (kWh)	361,305,801	ICF International 2010
82	2020 Residential Electricity Usage (kWh)	258,475,401	ICF International 2010
83	2020 Commercial and Industrial Electricity Usage (kWh)	410,556,341	ICF International 2010
84	"New" Residential Energy Usage (kWh) (2020–2011)	21,719,441	2020 minus 2011 values
85	"New" Commercial and Industrial Energy Usage (kWh) (2020–2012)	49,250,540	2020 minus 2011 values
86	2005 Residential Natural Gas Usage (therms)	13,400,000	Livermore 2005 GHG Inventory
87	2005 Commercial and Industrial Natural Gas Usage (therms)	5,600,000	Livermore 2005 GHG Inventory
88	2011 Residential Natural Gas Usage (therms)	14,207,478	ICF International 2010
89	2011 Commercial and Industrial Natural Gas Usage (therms)	6,097,988	ICF International 2010
90	2020 Residential Natural Gas Usage (therms)	15,510,839	ICF International 2010
91	2020 Commercial and Industrial Natural Gas Usage (therms)	6,929,221	ICF International 2010
92	"New" Residential Natural Gas Usage (therms) (2020-2011)	1,303,361	2020 minus 2011 value
93	"New" Commercial and Industrial Natural Gas Usage (therms) (2020-2011)	831,233	2020 minus 2011 value

Table C-1. Master List of Quantification Assumptions			
Number	**Parameter**	**Assumption**	**Source (if applicable)**
94	New Residential Natural Gas Usage (therms) (2020-2005) (For state measures only)	2,110,839	2020 minus 2005 value
95	New Commercial + Industrial Natural Gas Usage (therms) (2020-2005) (For state measures only)	1,329,221	2020 minus 2005 value
Reduction for 1% Improvement in T24 (Residential)			
	Electricity (%)		
96	Single Family	0.09%	CAPCOA 2010
97	Multi Family	0.12%	CAPCOA 2010
98	Townhome	0.09%	CAPCOA 2010
	Natural Gas (%)		
99	Single Family	0.91%	CAPCOA 2010
100	Multi Family	0.88%	CAPCOA 2010
101	Townhome	0.90%	CAPCOA 2010
Reduction for 1% Improvement in T24 (Commercial)			
102	Electricity (%)	0.27%	CAPCOA 2010
103	Natural Gas (%)	0.71%	CAPCOA 2010
104	Percent of Commercial Electricity from Outdoor Lighting (Commercial)	5.20%	CEC 2006
105	Percent of Commercial Electricity from Interior Lighting (Commercial)	28.90%	CEC 2006
106	Percent of Commercial Electricity from Outdoor Lighting (Lodging-Used for Residential)	4.74%	CEC 2006
107	Percent of residential electricity used for other appliances and lighting (%)	39.13%	EIA 2005
108	Percent of "other appliances and lighting" that is lighting (%)	50.00%	EIA 2005
109	Percent heating associated with commercial boilers (%)	12.00%	CAPCOA 2010
110	Percent reduction in natural gas emissions associated with a fan-assisted non condensing boiler or condensing (%)	8.30%	CAPCOA 2010
111	Percent of commercial natural gas used for heating equipment (%)	73.50%	CEC 2006

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
Detailed Streetlight and Traffic Signal Data			
112	Number of existing traffic signals (2005)	92	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
113	Number of existing street lights (2005)	6,800	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
114	Number of 2020 BAU traffic signals	110	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
115	Number of 2020 BAU street lights	7,400	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
116	Percent electricity savings per outdoor LED light	75%	U.S. Environmental Protection Agency 2011
117	Percent electricity savings per traffic light LED light	90%	CAPCOA 2010
118	Incandescent Wattage of a Traffic Signal	150	CAPCOA 2010
119	Traffic Signal Daily Hours of Operation	24	ICF Assumption
120	Streetlight Daily Hours of Operation	11	ICLEI 2010
BAU Streetlight Profile			
121	Mercury Vapor (%)	0%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
122	Metal Halide (%)	0%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
123	High Pressure Sodium Cutoff (%)	100%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
124	Low Pressure Sodium Cutoff (%)	0%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
125	LED (%)	0%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
Lighting Wattage (kW)			
126	Wattage of Mercury Vapor Lamps	0.18	ICLEI 2010
127	Wattage of Metal Halide Lamps	0.20	ICLEI 2010
128	Wattage of High Pressure Sodium Lamps	0.19	ICLEI 2010
129	Wattage of Low Pressure Sodium Lamps	0.18	ICLEI 2010
130	Wattage of LED streetlight	0.12	ICLEI 2010

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
Detailed Cool Roof Data			
131	Annual Electricity Savings per Roof Square Foot (kWh)	0.84	ICLEI 2010
132	Annual Natural Gas Savings per Roof Square Foot (therm)	0.00	ICLEI 2010
Detailed Co-Generation Data			
133	CO_2 reductions from a 100 kW Reciprocating Engine in the PG&E Service District	2%	CAPCOA 2010 Table AE-4.1
Detailed Transportation Data			
134	Percent Emissions Light-Duty	75	ICF International 2010, EPA 2010, and EMFAC 2007
135	Percent Emissions heavy, medium-duty, and busses	23	ICF International 2010, EPA 2010, and EMFAC 2007
136	Percent emissions heavy-duty only	13	ICF International 2010, EPA 2010, and EMFAC 2007
137	Number of parking spaces per multifamily home - Studio/1 Bedroom	1	Email from Ingrid Rademaker on 1/24/12
138	Number of parking spaces per multifamily home - 2+ bedrooms	2	Email from Ingrid Rademaker on 1/24/12
139	Number of parking spaces per multifamily home - guest spaces	0.25	Email from Ingrid Rademaker on 1/24/12
140	Number of parking spaces per multifamily home – average	1.75	Average of assumptions 95 and 96, added to assumption 97
141	2005 Daily VMT	1,642,169	Livermore Existing Inventory
142	2005 Annual VMT	569,832,643	Livermore Existing Inventory
143	2020 Daily VMT	2,035,818	Livermore Existing Inventory
144	2020 Annual VMT	706,428,846	Livermore Existing Inventory
145	2020 Annual HDT VMT	17,620,819	Livermore Existing Inventory
146	2020 HDT average speed (mph)	45.1	EMFAC 2007 and ICF International 2010
147	Daily VMT Reduction from On-Road 2	12,215	Fehr & Peers 2012
148	Daily VMT Reduction from On-Road 3	4,072	Fehr & Peers 2012
149	Daily VMT Reduction from On-Road 5	7,736	Fehr & Peers 2012
150	Daily VMT Reduction from On-Road 6	407	Fehr & Peers 2012
151	Number of parking spaces per commercial building - General Retail (spaces per sq ft)	0.004	Email from Ingrid Rademaker on 1/24/12
152	Number of parking spaces per commercial building - Office (spaces per sq ft)	0.003	Email from Ingrid Rademaker on 1/24/12

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
153	Number of parking spaces per commercial building - Service (spaces per sq ft)	0.003	Email from Ingrid Rademaker on 1/24/12
154	Number of parking spaces per office building less than 50,000 square feet (space per 200 square feet)	1.0	ICF Assumption
155	Number of parking spaces per office building greater than 50,000 square feet (space per 500 square feet)	1.0	ICF Assumption
156	Number of covered commercial parking spaces	550	Email from Ingrid Rademaker on 1/24/12
157	Size of a parking space (square feet)	171.0	ICF Assumption
158	Percent of commercial parking space that is covered (%)	1%	ICF Assumption
159	Percent of commercial parking space that is stacked (%)	25%	ICF Assumption
160	Percent of multifamily parking space that is covered (%)	5%	ICF Assumption
ailed Water Data			
161	2005 Water Consumption from the State Water Project (gallons)	4,060,890,849	Livermore Municipal Water 2005 Urban Water Management Plan (UWMP), California Water Service Company 2007 UWMP, and ICF International 2010
162	2005 Water Consumption from Surface Water (gallons)	1,015,222,712	Livermore Municipal Water 2005 Urban Water Management Plan (UWMP), California Water Service Company 2007 UWMP, and ICF International 2010
163	2005 Water Consumption from Ground Water (gallons)	1,000,038,036	Livermore Municipal Water 2005 Urban Water Management Plan (UWMP), California Water Service Company 2007 UWMP, and ICF International 2010
164	2020 BAU Water Consumption by source (percentage)	GW - 12% SW –18% Delta -70%	Livermore Municipal Water 2005 Urban Water Management Plan (UWMP), California Water Service Company 2007 UWMP, and ICF International 2010
165	2020 BAU Water Consumption per capita per day (gallons)	194.6	Livermore Municipal Water 2010 Urban Water Management Plan (UWMP).
166	2020 BAU Water Consumption (gallons)	6,499,153,500	Calculated by ICF International from per capita per day factor and 2020 forecasted population
167	2005 Water Delivered by the City of Livermore - Residential (MGD per year)	1,210.0	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
168	2005 Water Delivered by the City of Livermore - Commercial (MGD per year)	412.5	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire

Table C-1. Master List of Quantification Assumptions			
Number	**Parameter**	**Assumption**	**Source (if applicable)**
169	2005 Water Delivered by the City of Livermore - Industrial (MGD per year)	32.9	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
170	2010 Water Delivered by the City of Livermore - Residential (MGD per year)	1,043.7	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
171	2010 Water Delivered by the City of Livermore - Commercial (MGD per year)	315.7	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
172	2010 Water Delivered by the City of Livermore - Industrial (MGD per year)	0.0	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
173	1992 California Standard for Residential Lavatory Faucets (gallons/minute)	2.5	1992 Energy Policy Act
174	2010 California Standard for Residential Lavatory Faucets (gallons/minute)	2.2	CAPCOA 2010
175	Mandatory CALGreen Standard for Residential Lavatory Faucets (gallons/minute)	1.65	CAPCOA 2010
176	1992 California Standard for Commercial Lavatory Faucets (gallons/minute)	2.5	1992 Energy Policy Act
177	2010 California Standard for Commercial Lavatory Faucets (gallons/minute)	0.5	CAPCOA 2010
178	Mandatory California Standard Commercial Lavatory Faucet(gallons/minute)	0.4	CAPCOA 2010
179	Voluntary California Standard Commercial Lavatory Faucet(gallons/minute)	0.35	CAPCOA 2010
180	1992 California Standard for Residential Kitchen Faucets (gallons/minute)	2.5	1992 Energy Policy Act
181	2010 California Standard for Residential Kitchen Faucets (gallons/minute)	2.2	CAPCOA 2010
182	Mandatory CALGreen Standard for Residential Lavatory Faucets (gallons/minute)	1.8	CAPCOA 2010
183	1992 California Standard for Commercial Kitchen Faucets (gallons/minute)	2.5	1992 Energy Policy Act
184	2010 California Standard for Commercial Kitchen Faucets (gallons/minute)	2.2	CAPCOA 2010

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
185	Mandatory CALGreen Standard for Commercial Lavatory Faucets (gallons/minute)	1.8	CAPCOA 2010
186	Voluntary CALGreen Standard for Commercial Lavatory Faucets (gallons/minute)	1.6	CAPCOA 2010
187	Average Per Capita Kitchen Faucet Duration (minutes/day)	4	2010 Green Building Code
188	Average Per Capita Kitchen Faucet Use	1	2010 Green Building Code
189	Average Per Capita Lavatory Faucet Duration (minutes/day)	0.25	2010 Green Building Code
190	Average Per Capita Lavatory Faucet Use	3	2010 Green Building Code
191	Number of employees per faucet	40	2010 Green Building Code
192	Percent Hot Water Use for Faucets and Showers (%)	70%	ICELI 2010
193	Percent Hot Water Use for Dishwashers (%)	100%	Based on professional experience
194	Percent of Homes with Electric Water Heaters	11%	EIA 2005
195	Electricity Use to Heat Gallon of Hot Water (kWh)	0.19	ICLEI 2010
196	Natural Gas Use to Heat Gallon of Hot Water (therms)	0.0098	ICLEI 2010
197	1992 California Standard for Showerheads (gallons/minute)	2.5	1992 Energy Policy Act
198	2010 California Standard for Showerheads (gallons/minute)	2.5	CAPCOA 2010
199	Mandatory California Standard for Showerheads (gallons/minute)	2	CAPCOA 2010
200	Average Shower Time (min/day/person)	8	2010 Green Building Code
201	1992 California Standard for Residential Toilets (gallons/flush)	1.6	1992 Energy Policy Act
202	2010 California Standard for Residential Toilets (gallons/flush)	1.6	CAPCOA 2010
203	Mandatory CALGreen Standard for Residential Toilets (gallons/flush)	1.28	CAPCOA 2010
204	1992 California Standard for Commercial Toilets (gallons/flush)	1.6	1992 Energy Policy Act

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
205	2010 Current California Standard Commercial Toilet (gallons/flush)	1.6	CAPCOA 2010
206	Mandatory 2010 CALGreen Commercial Toilet (gallons/flush)	1.28	CAPCOA 2010
207	Voluntary 2010 CALGreen Commercial Toilet (gallons/flush)	1.12	CAPCOA 2010
208	Flushes per commercial toilet per day (men)	1	2010 Green Building Code
209	Flushes per commercial toilet per day (women)	3	2010 Green Building Code
210	1992 GPF for baseline urinals	1.6	1992 Energy Policy Act
211	2010 GPF for baseline urinals	1	CAPCOA 2010
212	GPF for low-flow urinals (CALGreen Mandatory)	0.5	CAPCOA 2010
213	GPF for low-flow urinals (CALGreen Voluntary)	0.5	CAPCOA 2010
214	Flushes per commercial urinals per day (men)	2	2010 Green Building Code
215	Average Dishwasher Size in 1992 (Standard Dishwashers) (gallons/cycle / cubic foot)	15	ConSol 2010
216	2010 California Standard for Standard Dishwashers (gallons/cycle / cubic foot)	6.5	CAPCOA 2010
217	Voluntary CALGreen Standard for Standard Dishwashers (gallons/cycle / cubic foot)	5.8	CAPCOA 2010
218	ENERGY STAR Standard Dishwasher (gallons/ cycle / cubic foot)	5	CAPCOA 2010
219	ENERGY STAR Compact Dishwasher (gallons/ cycle / cubic foot)	3.5	CAPCOA 2010
220	2010 California Standard for Compact Dishwashers (gallons/cycle / cubic foot)	4.5	CAPCOA 2010
221	Voluntary CALGreen Standard for Compact Dishwashers (gallons/cycle / cubic foot)	3.5	CAPCOA 2010
222	Ratio of Compact to Standard Dishwashers (unit less)	50%	ICF International assumption
223	Average Dishwasher (runs per unit per week)	5	Dethman & Associates 1999
224	Average Dishwasher (runs per person per day)	0.1	Aquacraft, Inc 1999
225	Residential Graywater Use (showers, bathtubs, and washbasins) (gallons per day per residential occupant)	25	CAPCOA 2010

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
226	Laundry Machine Water Use (gallons per day per residential occupant)	15	CAPCOA 2010
227	Average Lawn Size for Homes with Lawn (acres/home)	0.20	Chapman 2005
228	Annual Gallons of Water Used per Acre (gallons/acre)	652,000	ICLEI 2010
229	Percent residential water usage for landscaping	57%	ConSol 2010
230	Percent commercial water usage for landscaping	35%	YUDELSON 2010
231	Dishwashers per Multi Family Home	0.58	California Energy Commission 2010
232	Dishwashers per Single Family Home	0.74	California Energy Commission 2010
Detailed Off-road Data			
233	Fuel Consumption for Heavy Duty Equipment for 1 Hour at Idle—High Idle (gallons)	1.2	Environmental Protection Agency 2009a
234	Fuel Consumption for Heavy Duty Equipment for 1 Hour at Idle—Low Idle (gallons)	0.6	Environmental Protection Agency 2009a
235	Emissions from One Hour of Operation for One Mid-Sized Tractor (kg CO_2)	64.11	URBEMIS: modeled tractor for one hour
236	Equipment Operating time (hours/day)	8	Based on professional experience
237	Percent idling time for average CA heavy-heavy-duty diesel truck	29.40%	Environmental Protection Agency 2009a
238	BAU heavy duty vehicle idling time (min)	5	Based on CARB regulation for heavy duty trucks
Detailed Wastewater Data			
239	Heating Value of Methane (BTU/cubic foot of CH4)	1,012	CAPCOA 2010
240	Fraction of Methane in Biogas (%)	0.65	CAPCOA 2010
241	Efficiency Factor (unitless)	0.85	CAPCOA 2010
242	CH4 Unflare: Contribution from CH4 which is captured for flaring, but remains unconverted due to incomplete combustion (MT/cubic feet)	3.93E-06	CAPCOA 2010
243	CO_2 Flare: Contribution from CO2 generated from the flaring of methane (MT/cubic feet)	5.44E-05	CAPCOA 2010
244	Percent of 2005 Methane that was converted to electricity (%)	33%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
245	Percent of 2020 Methane that will be converted to electricity (%)	90%	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire

Table C-1. Master List of Quantification Assumptions

Number	Parameter	Assumption	Source (if applicable)
246	Percent of 2005 Methane that was flared (%)	100%	ICF Assumption
247	Percent of 2020 Methane that will flared (%)	100%	ICF Assumption
248	2005 Wastewater Treated and Collected at the LWRP (AF)	7,953	City of Livermore Candidate Measures for the Community Climate Action Plan - Data Needs Questionnaire
249	2005 Wastewater Digester Gas (CF)	64,623,000	Stoops pers. comm.
Detailed Waste Data			
250	2020 BAU Diversion Rate	63%	CalRecycle
251	Landfilled Waste (2005 BAU) (tons)	133,578	ICF International 2010
252	Landfilled Waste (2006 BAU) (tons)	134,887	ICF International 2010
253	Landfilled Waste (2007 BAU) (tons)	136,209	ICF International 2010
254	Landfilled Waste (2008 BAU) (tons)	137,544	ICF International 2010
255	Landfilled Waste (2009 BAU) (tons)	138,892	ICF International 2010
256	Landfilled Waste (2010 BAU) (tons)	140,253	ICF International 2010
257	Landfilled Waste (2011 BAU) (tons)	141,627	ICF International 2010
258	Landfilled Waste (2012 BAU) (tons)	143,015	ICF International 2010
259	Landfilled Waste (2013 BAU) (tons)	144,417	ICF International 2010
260	Landfilled Waste (2014 BAU) (tons)	145,832	ICF International 2010
261	Landfilled Waste (2015 BAU) (tons)	147,261	ICF International 2010
262	Landfilled Waste (2016 BAU) (tons)	148,704	ICF International 2010
263	Landfilled Waste (2017 BAU) (tons)	150,162	ICF International 2010
264	Landfilled Waste (2018 BAU) (tons)	151,633	ICF International 2010
265	Landfilled Waste (2019 BAU) (tons)	153,119	ICF International 2010
266	Landfilled Waste (2020 BAU) (tons)	154,620	ICF International 2010
Detailed Urban Forestry Data			
267	First year tree planting will occur as a result of Land-Use-3	2013	ICF Assumption
268	Number of tree planting years till 2020	7	ICF Assumption
269	Annual energy savings per tree from reduced urban heat island effect (kWh)	7	ICLEI 2010
270	CAPCOA annual sequestration rates (MT CO_2e/year)		
271	Soft Maple	0.04330	CAPCOA 2010

Table C-1. Master List of Quantification Assumptions			
Number	**Parameter**	**Assumption**	**Source (if applicable)**
272	Hardwood Maple	0.05210	CAPCOA 2010
273	Pine	0.03190	CAPCOA 2010
274	Douglas Fir	0.04470	CAPCOA 2010
Detailed Green Roof Data			
275	Average roof space to floor space per home (square feet)	2,386	U.S. Census n.d.
276	Percent of roof space that can be covered by a green roof	25%	ICF Assumption
277	Annual energy savings per square foot of rooftop garden (kWh/sq ft)	0.70	ICLEI 2010
Addition Detailed Cost Data			
278	Discount rate	5%	Assumption
279	PG&E average residential electricity rate ($/kWh)	$0.157	CEC 2012
280	PG&E average residential natural gas rate ($/therm)	$1.188	CEC 2012
281	PG&E average commercial electricity rate ($/kWh)	$0.168	CEC 2012 (assuming small/medium commercial customer)
282	PG&E average commercial natural gas rate ($/therm)	$0.928	CEC 2012
283	PG&E average street lighting rate ($/kWh)	$0.163	CEC 2012
284	Price of diesel ($/gal)	$4.25	Assumption, based on recent range of diesel prices in Livermore

State-1: Title 24 Standards for Non-Residential and Residential Buildings

Measure Description

Requires that building shells and building components be designed to conserve energy and water.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Title 24 update for 2014 is 25% better than 2008 standards for single-family residential, 14% better than 2008 standards for multi-family residential and 30% better than 2008 standards for non-residential buildings
- Stringency of the residential Title 24 standards will be increased by 17% in 2017 2020.
- Stringency of the nonresidential Title 24 standards will be increased by 7% in 2017 2014 and 2020.

Analysis Details

GHG Analysis

Energy efficiency upgrades as a result of the Title 24 standards will reduce electricity and natural gas consumption, thereby resulting in GHG emissions savings.

Baseline Emissions

Baseline emissions were not utilized in the analysis of this measure.

Emissions Reductions

The 2014 single-family residential Title 24 Standard will be increased by 25% and the multi-family residential standard will be increased by 14% relative to the 2008 standard. The 2014 nonresidential standard will be increased by 30% during this same timeframe. Between 2014 and 2020, both standards will be updated twice (2017 and 2020). Assuming a 17% and 7% tri-annual increase in the stringency of the residential and non-residential Title 24 standards, respectively, 2020 residential energy use would be reduced to 54.0% of the 2008 baseline code.[4] Non-residential energy use would likewise be reduced to 60.5% of the 2005 baseline code. However, because the Title 24 code is revised on a tri-annual basis, only a fraction of total energy use is subject to each code revision. To avoid-double counting, estimated energy reductions were multiplied by the annual fraction of electricity subject to each code revision. The average reduction in residential energy use in 2020 as a result of the Title 24 Standards was therefore estimated to be 18.0%, and the average non-residential reductions were estimated to be 19.5%.

Energy reductions achieved by Title 24 were calculated by multiplying 18.0% and 19.5% by the City's 2020 BAU electricity and natural gas consumption for residential and non-residential development, respectively. GHG emissions reductions were quantified by multiplying the total energy reductions by the appropriate utility emission factors.[5]

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of the Title 24 standards.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of residential and non-residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

[4] Assumes 100% in 2005 and a 17% reduction every three years beginning in 2008.

[5] Utility emission factors account for decreased carbon intensities as a result of the State's RPS.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Resource Conservation: Increased building efficiency would reduce water consumption, which would help conserve freshwater.

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts help prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy-efficient structures improve general comfort by equalizing room temperatures and reducing indoor humidity.

State-2: Senate Bills 1078/107/X 1-2 (Renewable Portfolio Standard)

Measure Description

Obligates investor-owned utilities (IOUs), energy service providers (ESPs), and Community Choice Aggregations (CCAs) to procure 20% of retail sales from eligible renewable sources by 2013, 25% by 2016. EO S-14-08 also sets forth a longer range target of procuring 33% of retail sales by 2020.

Assumptions

See Table C-1.

Analysis Details

GHG Analysis

Implementation of the Renewable Portfolio Standard (RPS) will increase the proportion of renewable energy within PG&E's energy supply mix. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to the City by PG&E will be cleaner and less GHG intensive.

<u>Baseline Emissions</u>

The City of Livermore's existing GHG Inventory (Appendix B) and scaling by ICF International estimates that community-wide building energy consumption in 2020 would generate approximately 269,682 MT CO_2e.

<u>Emissions Reductions</u>

Achievement of the RPS will reduce the carbon intensity of PG&E's 2020 CO_2 emission factor from 493 pounds per MWh to 375 pounds per MWh (City of Livermore 2005a; California Energy Commission 2007). Similar reductions will be achieved by the statewide CH_4 and N_2O emission factors (Table C-1). GHG emissions that would be generated by community-wide electricity consumption in 2020 will therefore be lower as a result of the RPS-adjusted emission factors.

GHG emissions generated from electricity consumption were calculating assuming implementation of the RPS by multiplying 2020 community-wide electricity consumption by the RPS-adjusted emissions factors. The difference in emissions between the 2020 BAU and 2020 RPS scenarios represents the emissions reductions achieved by this measure.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The RPS provides California with a flexible, market-based strategy to increase renewable energy generation and distribution. As discussed above, renewable energy provides the same amount of power as tradition sources (e.g., coal), but does not emit any GHGs or other criteria pollutants. Renewable energy therefore represents a clean source of power for the State and the City of Livermore. The following benefits are expected from implementation of the RPS (IEA 2007; U.S. EPA 2009b).

Reduced Air Pollution: PG&E generates power through a combination of sources, but the majority of electricity is provided by fossil fuels (e.g., coal, natural gas). The extraction and processing of fossil fuels generates localized pollutants emissions at the place of mining and at the source of power generation. These pollutants may be dispersed into the atmosphere, where they can be transported over long distances and result in regional air pollution. Reducing the amount of fossil fuels processed at power stations through increased generation of renewable energy would contribute to cumulative reductions in criteria pollutants throughout the State.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to: fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constrains and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, substations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering local economies from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for local and regional economies.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

State-3: AB 1109 (Huffman) Lighting Efficiency and Toxics Reduction Act

Measure Description

Structured to reduce statewide electricity consumption in the following ways: 1) At least 50% reduction from 2007 levels for indoor residential lighting, and 2) At least 25% reduction from 2007 levels for indoor commercial and outdoor lighting, by 2018.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered..

- Approximately 5.20% of electricity is used for commercial outdoor lighting (CEC 2006).
- Approximately 28.90% of electricity is used for commercial indoor lighting (CEC 2006).
- Approximately 20.00% of electricity is used for residential indoor lighting (CEC 2006; NEED 2011).

Analysis Details

GHG Analysis

Lighting requires the production of electricity to power the lights, which represents an indirect source of GHG emissions. Different light fixtures have different efficacies; in other words, certain bulbs can utilize less energy to obtain the same output. Replacing less efficient bulbs with energy-efficient ones therefore reduces energy consumption, and thus GHG emissions.

Baseline Emissions

Electricity usage from outdoor lighting in commercial developments within the City was estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 5.2% (CEC 2006). Electricity usage from indoor lighting in residential and commercial developments within the City was estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 20.00% and 28.90%, respectively (CEC 2006; NEED 2011).

Emissions Reductions

AB 1109 will reduce indoor residential lighting by at least 50%. Energy reductions within the residential sector were calculated by multiplying the baseline indoor energy consumption for residential lighting by 0.50. AB1109 will reduce both outdoor and indoor commercial lighting by at least 25%. Energy reductions within the commercial sector were calculated by multiplying the baseline energy consumption for commercial lighting by 0.25. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate utility emission factors.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of AB1109.

Reduced Energy Use: Energy-efficient lighting (e.g., compact fluorescent lamps [CFL]) consumes, on average, 75% less electricity than incandescent bulbs.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity).

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

Increased Quality of Life: CFLs have a much longer lifetime than incandescent bulbs, resulting in reduced bulb turn-over and the need to purchase new fixtures.

State-4: AB 1470 Solar Water Heating and Efficiency

Measure Description

Creates a $25 million per year, 10-year incentive program to encourage the installation of solar water heating systems that offset natural gas use in homes and businesses throughout the state.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Solar water heaters reduce natural gas use by 130 therms (CARB 2008).
- An average of 0.013 water heaters per home will be replaced as a result of AB 1470 (CARB 2008; California Department of Finance 2000).

Analysis Details

GHG Analysis

California relies heavily on natural gas for water heating. Rooftop solar water heating technologies are designed to reduce fuel consumption, and thus GHG emissions. It is estimated that by creating a mainstream market, California can save more than 1 billion therms of natural gas per year—24% of the state's residential natural gas usage. (Huffman et. al. 2007)

<u>Baseline Emissions</u>

Baseline emissions were not utilized in the analysis of this measure.

<u>Emissions Reductions</u>

CARB estimates that implementation of AB 1470 would result in the installation of 200,000 solar water heaters by 2020. Assuming that an average of 0.013 heaters per home would be replaced as a result of AB 1470, and that Livermore would have 34,742 single- and multifamily homes in 2020 (Rademaker pers. comm.), a total of 434 water heaters would be replaced with solar systems. Each solar water heater will reduce natural gas use by 130 therms (CARB 2008). Natural gas reductions were therefore calculated by multiplying 130 therms by 434. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate utility emission factors.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of AB 1470.

Reduced Energy Use: Solar water heaters consume, on average, 130 therms less natural gas than non-solar units.

Reduced Air Pollution: Reduced energy use would contribute to corresponding reductions in local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

State-5: AB 1493 (Pavley I)

Measure Description

Pavley I will reduce GHG emissions from automobiles and light duty trucks by 30% from 2002 levels by the year 2016. The regulations affect 2009 models and newer.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Pavley I will reduce statewide emissions from passenger vehicles by 27.7 million MT CO_2e (California Air Resources Board 2011).

Analysis Details

GHG Analysis

Engine efficiency improvements will reduce fuel consumption, thereby reducing GHG emissions from fossil fuel combustion.

<u>Baseline Emissions</u>

The City of Livermore's GHG Inventory Update quantified emissions associated with on-road transportation in 2020 under BAU conditions (Appendix B). Pavley I applies to light-duty vehicles, medium duty vehicles, and motorcycles. Accordingly, baseline emissions from these sources were quantified by multiplying BAU emissions from the transportation sector by 0.84.[6]

<u>Emissions Reductions</u>

CARB estimates that implementation of Pavley I will reduce statewide emissions from passenger vehicles by 27.7 million MT CO_2e, or by approximately 17% (California Air Resources Board 2011). GHG reductions achieved by Pavley I within Livermore were therefore quantified by multiplying baseline emissions calculated above s by 0.17.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of Pavley I.

Reduced Energy Use: Pavley I would increase the fuel efficiency of passenger vehicles, which would reduce the amount of fossil fuels consumed per mile travelled.

Reduced Air Pollution: Efficient vehicles burn less fuel per mile travelled then less efficient vehicles. Air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide[7], and ozone precursors[8], would therefore be reduced.

Public Health Improvements: Fossil fuel combustion releases several toxic air containments known to cause adverse human health effects. Improvements in vehicle efficiency would reduce the amount of fuel combusted, resulting in corresponding reductions in toxic air containments.

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[6] Value based on an EMFAC2007 model run for Alameda County in 2020. Light-duty auto assumed to represent "light-duty auto (LDA)", "light-duty trucks (LDT1)" and "light-duty trucks (LDT2)"; medium duty assumed to represent "medium-duty trucks" (MDV); motorcycles assumed to represent "motorcycles" (MC) .

[7] Sulfur dioxide contributes to acid rain.

[8] Ozone precursors (reactive organic compounds and nitrogen oxides) contribute to smog formation.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

State-6: Advanced Clean Cars

Measure Description

Introduces new standards for model years 2017–2025, and will increase fuel economy up to 62 miles per gallon by 2025.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Advanced Clean Cars will reduce statewide emissions from passenger vehicles by 3.8 million MT CO_2e (California Air Resources Board 2011).

Analysis Details

GHG Analysis

Engine efficiency improvements will reduce fuel consumption, thereby reducing GHG emissions from fossil fuel combustion.

Baseline Emissions

The City of Livermore's GHG Inventory Updated quantified emissions associated with on-road transportation in 2020 under BAU conditions (Appendix A). The Advanced Clean Cars initiative applies to light-duty vehicles, medium duty vehicles, and motorcycles. Accordingly, baseline emissions from these sources were quantified by multiplying BAU emissions from the transportation sector by 0.84.[9]

Emissions Reductions

CARB estimates that implementation of the Advanced Clean Cars initiative will reduce statewide emissions from passenger vehicles by 3.8 million MT CO_2e[10], or by approximately 2.5% (California Air Resources Board 2011). GHG reductions achieved by the Advanced Clean Cars initiative within Livermore were therefore quantified by multiplying baseline emissions by 0.025.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of the Clean Cars Initiative.

Reduced Energy Use: The Clean Cars Initiative would increase the fuel efficiency of passenger vehicles, which would reduce the amount of fossil fuels consumed per mile travelled.

Reduced Air Pollution: Efficient vehicles burn less fuel per mile travelled then less efficient vehicles. Air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide[15], and ozone precursors[16], would therefore be reduced.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Improvements in vehicle efficiency would reduce the amount of fuel

[9] Value based on an EMFAC2007 model run for Alameda County in 2020. Light-duty auto assumed to represent "light-duty auto (LDA)", "light-duty trucks (LDT1)" and "light-duty trucks (LDT2)"; medium duty assumed to represent "medium-duty trucks" (MDV); motorcycles assumed to represent "motorcycles" (MC) .

[10] Reductions calculated based on the existing Pavley II standard, which applies to model years 2017 to 2020 and will improve fuel economy to 43 miles per gallon. New standards for model years 2017 to 2025 have neither been officially proposed nor quantified. Actual reductions achieved by State-6 will therefore likely be higher than those quantified.

combusted, resulting in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

State-7: Low Carbon Fuel Standard

Measure Description

Requires a 10% reduction in the carbon intensity of California's transportation fuels by 2020.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Low Carbon Fuel Standard (LCFS) will reduce statewide emissions from transportation-based fuels[11] by 15 million MT CO_2e (California Air Resources Board 2011).

Analysis Details

GHG Analysis

The LCFS is a policy-based strategy that targets carbon emissions generated through the lifecycle of transportation fuels (i.e., from extraction to production to consumption). The standard assigns a maximum level of GHG emissions per unit of fuel produced for several refiners and importers. Companies that exceed the LCFS through development of biofuels and other clean technologies are able to sell their excess credits, creating a flexible and dynamic market for low-carbon transportation fuels. (Sperling and Yeh 2009)

The U.S. Fresno Federal District court ruled in December 2011 that the LCFS violates the Commerce Clause of the U.S. Constitution and issues an injunction preventing California from implementing the LCFS. CARB appealed this ruling in early January, 2012. While the legal issues are being resolved, given the pending appeal by CARB, it is assumed for the time being that the LCFS will be ultimately implemented by 2020 as proposed. If the LCFS were ultimately to be blocked from implementation due to federal legal constraints, then the goal for reduction for the CAP would be adjusted downward accordingly.

Baseline Emissions

The City of Livermore's GHG Inventory Update quantified emissions associated with on-road and off-road transportation in 2020 under BAU conditions (Appendix A). Reductions achieved by overlapping state and local measures (e.g., Pavley I, Trans-1) were subtracted to obtain baseline emissions for the transportation and off-road sectors.

Emissions Reductions

CARB estimates that implementation of the LCFS will reduce statewide emissions from transportation-based fuels[17] by 15 million MT CO_2e, or by approximately 8.9% (California Air Resources Board 2011). GHG reductions achieved by the LCFS within Livermore were therefore quantified by multiplying baseline transportation and off-road emissions by 0.089.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of LCFS.

Reduced Air Pollution: The LCFS would reduce the carbon content of transportation fuels by 10%. The combustion of hydrocarbons generates numbers air pollutants, including particulate matter, carbon monoxide, sulfur dioxide[15], and ozone precursors[16]. Reducing the carbon content of transportation fuels would therefore reduce local and regional air pollution.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Improvements in vehicle efficiency would reduce the amount of fuel combusted, resulting in corresponding reductions in toxic air containments. Additionally, reductions in

[11] Excludes aviation fuel, residual fuel oil, and lubricants.

ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing the carbon-content of transportation fuels would reduce the consumption and demand for imported petroleum.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, fuel prices would likely be subject to fluctuations and frequent price spikes. Biofuels and other renewable technologies would contribute to the diversification of the energy supply mix, thereby buffering local economies from the volatile global energy market.

Economic Development: The development of biofuels and other clean technologies would create new jobs, taxes, and revenue for local and regional economies.

State-8: Vehicle Efficiency Strategies

Measure Description

The AB 32 Scoping Plan includes vehicle efficiency measures (in addition to Pavley and LCFS) that focus on maintenance practices. The Tire Pressure Program will increase vehicle efficiency by assuring properly inflated automobile tires to reduce rolling resistance. The Low Friction Oils Program will increase vehicle efficiency by mandating the use of engine oils that meet certain low friction specifications. The Heavy-Duty Vehicle GHG Emission Reduction Program will increase heavy-duty vehicle (long-haul trucks) efficiency by requiring installation of best available technology and/or CARB approved technology to reduce aerodynamic drag and rolling resistance.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Tire Pressure Program will reduce statewide emissions from passenger vehicles by 0.6 million MT CO_2e (California Air Resources Board 2011).
- Low Friction Oils Program will reduce statewide emissions from passenger vehicles by 2.8 million MT CO_2e (California Air Resources Board 2011).
- Heavy-Duty Vehicle GHG Emission Reduction Program will reduce statewide emissions from heavy-duty vehicles by 0.9 million MT CO_2e (California Air Resources Board 2011).

Analysis Details

GHG Analysis

Improvements in engine efficiency and vehicle technology will reduce fuel consumption, thereby reducing GHG emissions from fossil fuel combustion.

<u>Baseline Emissions</u>

The City of Livermore's GHG Inventory Update quantified emissions associated with on-road transportation in 2020 under BAU conditions (Appendix B). The Tire Pressure and Low Friction Oils programs primarily affect light-duty vehicles, whereas the Heavy-Duty GHG Emissions Reduction Program affects heavy-duty vehicles. Baseline emissions from light-duty autos and heavy-duty vehicles were quantified by multiplying BAU emissions from the transportation sector by 0.75 and 0.13, respectively.[12]

<u>Emissions Reductions</u>

Tire Pressure

CARB estimates that implementation of the Tire Pressure Program will reduce statewide emissions from passenger vehicles by 0.6 million MT CO_2e, or by approximately 0.39% (California Air Resources Board 2011). GHG reductions achieved by the Tire Pressure Program within Livermore were therefore quantified by multiplying baseline emissions from passenger vehicles by 0.0039.

Low Friction Oils

CARB estimates that implementation of the Low Friction Oils Program will reduce statewide emissions from passenger vehicles by 2.8 million MT CO_2e, or by approximately 1.8% (California Air Resources Board 2011). GHG reductions achieved by the Low Friction Oils Program within Livermore were therefore quantified by multiplying baseline emissions from passenger vehicles by 0.018.

Heavy-Duty Vehicle GHG Emissions Reductions

CARB estimates that implementation of the Heavy-Duty Vehicle GHG Emission Reduction Program will reduce statewide emissions from heavy-duty vehicles by 0.9 million MT CO_2e, or by approximately 2.2% (California Air Resources Board 2011). GHG reductions achieved by the Heavy-Duty Vehicle GHG Emission Reduction Program within Livermore were therefore quantified by multiplying baseline emissions from

[12] Value based on an EMFAC2007 model run for Alameda County in 2020. Light-duty auto assumed to represent "light-duty auto (LDA)", "light-duty trucks (LDT1)" and "light-duty trucks (LDT2)".

heavy-duty vehicles by 0.022.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of AB 32 Transportation Reduction Strategies.

Reduced Energy Use: The AB32 Transportation Reduction Strategies would increase the efficiency of passenger vehicles and heavy-duty trucks, which would reduce the amount of fossil fuels consumed per mile travelled.

Reduced Air Pollution: Efficient vehicles burn less fuel per mile travelled then less efficient vehicles. Air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide[15], and ozone precursors[16], would therefore be reduced.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Improvements in vehicle efficiency would reduce the amount of fuel combusted, resulting in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

State-9: AB 32 Landfill Methane Program

Measure Description

CARB's Landfill Methane Rule requires gas collection and control systems on landfills with greater than 450,000 tons of waste-in-place. The measure also establishes statewide capture performance standards.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Two landfills (see below) would install a methane system with a capture efficiency of 75%.

Analysis Details

GHG Analysis

Methane capture systems can reduce the amount of methane released from the decomposition of waste. CARB estimates that approximately 53 landfills will be affected by the Landfill Methane Rule, resulting in a statewide reduction of 0.8 million MT CO_2e in 2020 (California Air Resources Board 2008).

<u>Baseline Emissions</u>

Baseline emissions were not utilized in the analysis of this measure.

<u>Emissions Reductions</u>

According to CalRecycle, in 2005 the City disposed of waste that was directed to over 15 landfills. The City does not have jurisdiction over which landfills are used for its waste disposal. A review of the waste-in-place at these landfills indicates that the following two landfills would be subject to CARB's Landfill Methane Rule:

- Foothill Sanitary Landfill.
- North County Landfill.

Neither of these landfills currently has methane capture systems. Pursuant to the Landfill Methane Rule, it was assumed that by 2020, both landfills would install a methane system with a capture efficiency of 75%.[13] GHG emissions generated by City waste in 2020 were re-calculated by multiplying the percentage of the City's waste sent to the two landfills listed above and the City's 2020 BAU waste emissions from the City's GHG Inventory Update.

Cost Analysis

Costs not estimated.

Co-Benefit Analysis

The following benefits are expected from implementation of the Landfill Methane Rule.

Reduced Air Pollution: Capture systems prevent methane from migrating into the atmosphere and contributing to local smog.

Resource Conservation: Anaerobic digesters help prevent groundwater contamination by reducing the leaching of organic pollutants. The integrity of freshwater systems would therefore be conserved.

Increased Quality of Life: Methane capture helps reduce odors and other hazards associated with landfill gas emissions.

[13] Based on the Clean Air and Climate Protection protocol for default methane capture efficiency assumptions.

Energy-1: Energy Efficiency Voluntary Programs to Promote Retrofits for Existing Residential Buildings

Measure Description

Incentivize, or otherwise support voluntary energy efficiency retrofits of existing residential buildings to achieve reductions in natural gas and electricity usage. Adopt standards and/or promote voluntary programs that retrofit indoor lights, electric clothes dryers, energy-star thermostats, window seals, duct sealing, air sealing, and attic insulation.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Market penetration of 20% for energy audits.
- 50% of homes that conducts audits will perform retrofits.
- Homes will perform the following retrofits
  - Replace high use incandescent lamps with compact fluorescent lamps.
  - Replace electric clothes dryers with natural gas dryers.
  - Install of a programmable thermostat.
  - Replace windows with double-pane solar-control low-E argon gas wood frame windows.
  - Seal ducts and air leaks.
  - Replace natural gas furnaces with an ENERGY STAR-labeled model.
  - Insulate the attic.
- Anticipated energy reductions associated with the above retrofits are 1,687 kWh and 195 therms per single family home (US DOE 2011).

Analysis Details

GHG Analysis

Residential electricity and natural gas consumption are indirect sources of GHG emissions. Power plants emit GHGs in the production and delivery of energy to residences. Retrofitting existing residences would increase home energy efficiency, which would decrease energy consumption and GHG emissions.

<u>Baseline Emissions</u>

Baseline emissions are the emissions associated with residential electricity and natural gas consumption in 2011.

<u>Emissions Reductions</u>

Energy savings associated with retrofitting were estimated using the Home Energy Saver™ (HES), which is based on models and data developed at DOE's Lawrence Berkley National Laboratory (U.S. DOE 2011). HES estimates energy savings, emission reductions, and costs associated with various energy-efficient measures. For this analysis, energy-efficient upgrades were assumed to be conducted on an average single family home in the City of Livermore, built in 1979.[14] Upgrades assumed to be performed included upgrading to CFLs in all high-use indoor lights; switching to a gas clothes dryer; installing an ENERGY STAR-labeled programmable thermostat; installing energy-efficient windows, duct and air sealing; switching to an ENERGY STAR gas furnace; and installing attic insulation.

The HES calculated the annual electricity and natural gas savings. To determine the total energy reduction from this measure, the energy savings per home were multiplied by the number of homes in the City, and the penetration rate chosen by the City (20% of homes conduct an energy audit, approximately 50% of those homes retrofit). The total energy reductions were multiplied by utility emission factors to determine the total GHG emissions reductions.

[14] For other assumptions, the model defaults were employed.

Cost Analysis

Total initial costs to homeowners are estimated to range from $12.4 to $21.9 million. These retrofits are expected to result in energy cost savings of about $1.1 million per year, delivering a payback period of 6 to 15 years. Cost-per-ton is estimated to range from -$17/MT$CO_2$e (net savings) to $253/MT$CO_2$e (net costs). Total costs are estimated to range from – $0.6 million (net savings) to $8.9 million (net costs).

Initial costs associated with conducting home energy audits were estimated based on the total number of participating homes (as calculated by the GHG Analysis), the cost per square foot for home audits, and the average single family home size (U.S. Census 2011c). The cost per square foot for home energy audits depends on building size and the complexity of home energy systems, and can range from $0.03 for a light and heating, venting, and air conditioning (HVAC) audit to $0.50 for a comprehensive audit (AECOM 2010).

Initial capital costs associated with energy-efficient retrofitting were estimated for the advanced upgrade options described above. The retrofit cost per home was estimated to range from about $3,047 to $6,833 for advanced retrofits (U.S. DOE 2011a).

Annual energy cost savings were calculated by multiplying the mitigated electricity and natural gas usage for each retrofit level—as calculated by HES—by the average residential PG&E utility rates. A lifetime of 18 years was assumed for this measure, based on the lifetimes of individual energy-efficient upgrades reported in CPUC (2009).

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-1.

Reduced Energy Use: Energy retrofits would improve the efficiency of residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient homes have higher properity values and resale prices than less efficient homes.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts and air leaks helps prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy-efficient homes improve general comfort by equalizing room temperatures and reducing indoor humidity.

Energy-2: Energy Efficiency Voluntary Programs for Existing Commercial Development

Measure Description

Under this measure, the City would promote voluntary programs for existing commercial facilities to improve building-wide energy efficiency. In addition, the City would adopt a program that encourages existing commercial facilities improve building-wide energy efficiency by 20% by 2020 (compared to 2005). Increased energy efficiency in commercial facilities would result in decreased energy consumption.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Market penetration of 20% for energy audits and retrofits.
- Electricity and natural gas usage by existing commercial development remains constant between 2005 and 2020

Analysis Details

GHG Analysis

Existing buildings generate a considerable amount of GHG emissions. Older developments are typically less energy-efficient and therefore consume greater amounts of electricity and natural gas, relative to newly constructed facilities.

<u>Baseline Emissions</u>

Electricity and natural gas consumption associated with existing commercial development in 2005 were quantified in the GHG Inventory. Energy consumption from overlapping measures was subtracted from the existing year consumption. The 2005 consumption was assumed to remain constant in 2020 and represent 2020 baseline emissions.

<u>Emissions Reductions</u>

The magnitude of GHG emissions achieved by this measure is dependent on the degree of implementation. It was assumed that 20% of existing commercial facilities would perform an energy audit, and of those, 100% would actual perform the energy retrofits. Energy reductions from overlapping measures were subtracted from the baseline electricity and natural gas usage to avoid double counting. Energy reductions from a 20% reduction in building energy consumption were quantified by multiplying baseline electricity and natural gas usage by the percentage of participating commercial facilities (20%) and then by the goal reduction in energy consumption (20%). GHG savings were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Cost Analysis

Total initial costs to retrofit existing non-residential buildings are estimated at $4.1 million to $6.6 million, including the cost of energy audits. These retrofits are expected to result in significant energy cost savings for non-residential buildings of $2.4 million per year, with a payback period of 2 to 3 years. Costs-per-ton is estimated to range from -$569/MTCO$_2$e (net savings) to -$510/MTCO$_2$e (net savings). Total costs are estimated to range from -$23.7 million (net savings) to -$21.2 million (net savings).

Initial costs of conducting building energy audits were estimated based on the total square footage of participating commercial buildings (as calculated by the GHG Analysis, based on existing commercial development in 2005 and the penetration rate), and the cost per square foot for energy audits. The cost per square foot for building energy audits depends on building size and the complexity of energy systems, and can range from $0.03 for a light and HVAC audit to $0.50 for a comprehensive audit (AECOM 2010).

Initial capital costs associated with energy-efficient retrofits or retrocommissioning are estimated to range from $0.81 to $1.01 per square foot for a 5–20% energy efficiency improvement (AECOM 2010; Gregerson 1997).[15]

Annual energy cost savings were calculated by multiplying the mitigated electricity and natural gas usage—as calculated by the GHG Analysis—by the average commercial PG&E utility rates. A lifetime of 18 years was assumed for this measure, based on the lifetimes of individual energy-efficient upgrades reported in CPUC (2009).

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-2.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of commercial buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts and air leaks helps prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy efficient structures improve general comfort by equalizing room temperatures and reducing indoor humidity. Employee satisfaction and out may therefore be increased.

[15] The lower bound cost is based on estimated costs of retrocommissioning, as reported by Gregerson (1997), and adjusted to 2011 dollars using the Bureau of Labor Statistics Consumer Price Index Inflation Calculator.

Energy-3: Exceed Title 24 Requirements for New Buildings

Measure Description

Under this measure, the City would periodically update and strengthen its Green Building Ordinance to reduce energy consumption. Existing Livermore Green Building Ordinance includes the Voluntary Tier 1 standard in Title 24. This measure would require the City to "stay ahead" of Title 24 future requirements by periodically updating the Green Building Ordinance to exceed Title 24 Standards (or any subsequent standards that replace the current Title 24 Standards) by 15% through 2020.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered:

- Single-family homes that exceed the Title 24 standards between 2008 and 2020 by 15% will achieve a 1.35% reduction in electricity use and a 13.65% reduction in natural gas use in 2020 (CAPCOA 2010:Table BE-1.2).
- Multifamily homes that exceed the Title 24 standard s between 2008 and 2020 by 15% will achieve a 1.80% reduction in electricity use and a 13.20% reduction in natural gas use in 2020 (CAPCOA 2010:Table BE-1.2).
- Commercial facilities that exceed the Title 24 standards between 2008 and 2020 by 15% will achieve a 4.05% reduction in electricity use and a 10.65% reduction in natural gas use in 2020 (CAPCOA 2010:Table BE-1.1).

Analysis Details

GHG Analysis

Energy consumption is not only dependent on the type and size of building, but also the climate zone in which the building is located. According to CAPCOA, Livermore is located within the CEC Forecast Climate Zone 4 (CAPCOA 2010). For single-family homes, multifamily homes, and commercial establishments, the CEC has published anticipated percent deductions in energy use resulting from a 1% exceedence of the 2008 Title 24 energy efficiency standards. Values for Climate Zone 4 were utilized for this analysis and obtained from Tables BE-1.1 and BE-1.2 in CAPCOA (2010).

<u>Baseline Emissions</u>

Electricity and natural gas consumption associated with new residential and commercial development in 2020 was quantified by scaling 2005 energy consumption data to 2011 and 2020, and subtracting the 2011 values from the 2020 values. The resulting emissions can be found by multiplying the consumption values by the appropriate utility emission factor. Individual values for single-family and multifamily homes were not available. Consequently, rates were calculated by scaling total residential electricity and natural gas use by 1.39 and 1.23, respectively (EIA 2009). Reductions achieved by overlapping State (e.g., Title 24) measures were subtracted from the final usage values to obtain baseline energy consumption.

<u>Emissions Reductions</u>

Energy deductions for exceeding the 2008 Title 24 standards by 1% were obtained from CAPCOA (2010). Separate values were provided for single-family homes, multifamily homes, and commercial developments. Because Energy-1 assumes the standard will be exceeded by 15%, the reductions for a 1% improvement over the 2008 Title 24 standard were multiplied by 15. These values were then multiplied by baseline energy consumption for each building type to obtain total energy reductions associated with the measure. For example, baseline electricity usage by new single-family homes is estimated to be 6,083 MWh. The anticipated energy reduction for exceeding the 2008 Title 24 standard by 15% is 1.35%. Mitigated electricity usage for new single-family homes was therefore determined by multiplying 6,083 MWh by 1.35%. GHG emissions reductions achieved by this measure were quantified by multiplying the energy reductions for each building type by the appropriate utility emission factors.

Cost Analysis

Initial costs to building owners include costs associated with energy-efficient upgrades, as well as the cost of initial energy audits. Total initial capital costs to building owners are estimated to range from about $6.5 to $10.8 million (including the cost of an energy audit). The simple payback period of this measure overall is estimated as 13 to >20 years. This measure is estimated to result in total costs of $0.3 million (net costs) to $4.5 million (net costs). Costs per ton are estimated to range from \$16/$MTCO_2e$ (net costs) to \$254/$MTCO_2e$ (net costs).

Initial costs associated with conducting home energy audits were estimated based on the total number of participating homes (as calculated by the GHG Analysis), the cost per square foot for home audits, and the average single family home size (U.S. Census 2011c). The cost per square foot for home energy audits depends on building size and the complexity of home energy systems, and can range from $0.03 for a light and heating, venting, and air conditioning (HVAC) audit to $0.50 for a comprehensive audit (AECOM 2010). Initial capital costs associated with energy-efficient upgrades for residential buildings were estimated to range from about $1,634 to $2,267 for single-family homes and from $902 to $1,882 for multi-family homes (U.S. DOE 2011a). Initial capital costs for commercial building retrofits are estimated to range from $0.59 to $3.13 per square foot for a 5 to 20% energy efficiency improvement (AECOM 2010; Gregerson 1997).[16]

Annual energy cost savings were calculated by multiplying the mitigated electricity and natural gas usage—as calculated by HES—by the average residential PG&E utility rates. A lifetime of 20 years was assumed for this measure, based on individual energy-efficient upgrade lifetimes reported in DEER (2008).

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-3.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of residential and non-residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Resource Conservation: Increased building efficiency would reduce water consumption, which would help conserve freshwater.

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts and air leaks helps prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy-efficient structures improve general comfort by equalizing room temperatures and reducing indoor humidity.

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[16] The lower bound cost is based on estimated costs of retrocommissioning, as reported by Gregerson (1997), and adjusted to 2011 dollars using the Bureau of Labor Statistics Consumer Price Index Inflation Calculator.

Energy-4: Streetlights

Measure Description

Under this measure, the City would adopt municipal lighting standards to reduced electricity consumption. The measure would require the following for municipal lighting:

- **Street Lighting:** Require 15% reduction in electricity use by street lighting 2020.
- **Airport lighting:** Consider retrofitting outdoor runway and taxiway lighting fixtures from incandescent to LED

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Penetration rate of 25% for streetlight bulb replacement.
- Installation of an outdoor CFL fixture achieves a 75% reduction in energy usage, relative to an incandescent bulb (EPA 2011).
- A total of 7,400 streetlights will operate in the City in 2020 (City of Livermore 2012).
- Streetlights are assumed to operate 11 hours per day, 365 days per year (ICLEI 2010).
- The BAU streetlight profile for incandescent bulbs will be 100% High Pressure Sodium Cutoff (192 watts) (City of Livermore 2012)
- The wattage of a LED street light is 121

Analysis Details

GHG Analysis

Lighting requires the production of electricity to power the lights, which represents an indirect source of GHG emissions. Different light fixtures have different efficacies; in other words, certain bulbs can utilize less energy to obtain the same output. Replacing less efficient bulbs with energy-efficient ones therefore reduces energy consumption, and thus GHG emissions.

<u>Baseline Emissions</u>

The number of existing and future streetlights within the City was determined based on information provided by City staff. Baseline electricity consumption by City streetlights was calculated using the following equation:

Energy Consumption = [(Incandescent lights) * (Streetlight profile) * (wattage)] + [(LED lights) * (wattage)] * 365 days * 11 hours

<u>Emissions Reductions</u>

To determine energy reductions, it was assumed that 25% of streetlights would be replaced with energy-efficient fixtures. Electricity consumption associated with these new LED bulbs was quantified assuming an average LED wattage of 0.12. The difference in electricity usage between the LED bulbs and the BAU electricity usage represents the energy reductions achieved by the measure. GHG emissions savings were calculated by multiplying the energy reductions by the appropriate utility emission factors.

Cost Analysis

Several elements factor in to the overall cost of this measure. More energy-efficient bulbs are typically more expensive than less efficient bulbs, and thus, the installation of more efficient ones incurs incremental (additional) materials costs. In terms of maintenance costs, however, because the rated life of more efficient bulbs is typically longer than less efficient ones, more efficient bulbs generally result in maintenance cost savings. In addition, because the replacement of less efficient bulbs with energy-efficient ones reduces energy consumption, energy cost savings are also realized.

Total capital costs to the City to replace streetlights are estimated at $0.65 to $1.5 million, with an estimated payback period of about 5 to13 years. Annual cost savings to the City (including both reduced maintenance needs and energy cost savings) are estimated at about $0.14 to $0.12 million. Cost per ton is estimated to range from -$842/MTCO$_2$e (net savings) to $207/MTCO$_2$e (net cost). Total costs are estimated to range from -$0.88 million (net savings) to $0.22 million (net cost).

The number of streetlights to be replaced was estimated by the GHG Analysis. To estimate initial costs, this number was multiplied by the incremental cost per fixture, which ranged from $350 to $825, as reported in DOE street lighting case studies for San Francisco and Palo Alto (Energy Solutions 2008; PNNL 2010). Annual incremental maintenance cost savings per fixture were also estimated based on reported values from these case studies, which ranged from approximately $15 to $27 per fixture.

Annual energy cost savings were calculated by multiplying the mitigated electricity usage—as calculated in the GHG Analysis—by PG&E utility rates.[17] A lifetime of 17 years was assumed for this measure, based on the rated life and estimated annual hours of operation.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-4.

Reduced Energy Use: Energy-efficient lighting (e.g., CFL fixtures) consumes, on average, 75% less electricity than incandescent bulbs.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity).

Increased Property Values: Energy efficient bulidings have higher properity values and resale prices than less efficient buildings.

Increased Quality of Life: CFLs have a much longer lifetime than incandescent bulbs, resulting in reduced bulb turn-over and the need to purchase new fixtures.

[17] In the absence of streetlight utility rates, small commercial rates were applied.

Energy-5: Voluntary Residential and Non-Residential Rooftop Solar

Measure Description

Under this measure, the City would encourage businesses and residents to install rooftop solar on existing buildings using Power Purchase Agreements (PPAs) and other low or zero up-front cost options for installing solar photovoltaic systems. This measure would reduce reliance on sources of energy that emit GHGs, thereby reducing GHG emissions.

This measure assumes 10% of existing commercial electricity use and 5% of existing residential electricity use were provided entirely by solar electricity in 2020. This measure would include any existing residential or non-residential solar retrofits that are installed between 2005 and 2020.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Market penetration rate of 5% for residential electricity
- Market penetration rate of 10% for commercial electricity.

Analysis Details

GHG Analysis

Utilizing electricity generated by renewable resources displaces electricity demand that would ordinarily be provided by PG&E. Although PG&E purchases a substantial amount of energy from renewable sources, electricity supplied by PG&E still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (CAPCOA 2010).

<u>Baseline Emissions</u>

2005 electricity usage was provided in the City's GHG inventory, and consumption BAU for 2011 was projected using population growth for residential electricity and job growth for commercial electricity. Electricity savings from overlapping measures was subtracted from 2011 consumption.

<u>Emissions Reductions</u>

It was assumed that 5% of residential and 10% of commercial total existing electricity consumption will be provided by solar electricity in 2020. Total electricity reductions were determined by multiplying residential and commercial electricity consumption for the existing year (2011) by 5% and 10%, respectively. The resulting GHG emissions reductions were determined by multiplying the electricity reductions by the appropriate utility emission factors.

Cost Analysis

Total First Costs

For this measure, two financing scenarios were estimated: one scenario where the building owner purchases and installs the solar panels, and one scenario where the building owner enters into a power purchase agreement (PPA) with a local company who owns and maintains the solar panels. In general, the financials are more attractive to the building owner by entering into a PPA. Costs were calculated on a per-project basis, and then multiplied by the number of projects. A 25-year lifetime is assumed for these projects.[18]

For the owner-financed scenario, total initial costs to home owners/building developers to install solar panels on residential and non-residential properties are estimated to be $161 million, as calculated by the NREL System Advisor Model (SAM). Initial costs include the direct capital costs (e.g., the cost of the system equipment) as well as the indirect costs (e.g., the cost of labor to install it). These costs are driven by project size (assumed to be 5 kW per residential project and 25 kW per commercial projects). These costs amount to $142,850 per commercial project and $27,320 per residential project.[19] These cost estimates are

[18] NREL Solar Advisor Model (May 2012). https://sam.nrel.gov/.

[19] NREL Solar Advisor Model (May 2012). https://sam.nrel.gov/.

calculated by SAM using default values. The total number of projects undertaken is assumed to be 1,414 residential installations and 855 commercial installations. The number of projects was determined by diving the goal energy savings (kWh) set by the measure by the solar electricity production (kWh) modeled per project.

Commercial projects are eligible for a California PBI via the California Solar Initiative, of $0.03 per kWh, which is the payment level of Tier 10, the Tier at which PG&E is paying out. Residential projects are eligible for the EPBB incentive of $0.25 per watt.[20] The EPBB incentive equates to $1,250 per residential project. The CSI ratchets down to lower incentives over time, so actual incentives received depend on when the projects are initiated. The initial costs are also eligible for a federal ITC of 30% of the initial costs, which results in $42,855 in federal tax savings per residential project and $8,571 in tax savings per commercial project.[21] However, this credit is taken at the end of the initial year to align with a lag time in receiving tax credits for project expenditures.

For the Power Purchase Agreement (PPA) scenario, the total initial cost to home owners/commercial entities was assumed to be zero.

Net Annual Costs

For the owner financed scenario, the value of electricity is drawn from the SAM's PG&E costs database. Livermore is located in PG&E's E-1 - Baseline Region X.[22] Electricity production is based on the nameplate capacity (assumed to be 5 kW per residential project and 25 kW per commercial project) and on Livermore-area climate and latitude information (which affects solar exposure). Livermore-specific climate and latitude information was used. Electricity production decreases slightly each year due to system degradation.

Cost savings are reduced by the annual operating costs, which are assumed to be $100 per project in the initial year for residential projects and $500 per project in the initial year for commercial projects, as calculated by SAM. These costs increase slightly each year to account for inflation. The annual operating costs for a PPA are incorporated into the resident's/commercial entity's electricity costs.

For the PPA scenario (where there are no initial costs), annual operating costs are incorporated into the discounted electricity rate. Savings were estimated using California-based case studies published by a Sunrun (Sunrun 2012), a solar PPA company. The case studies provide a variety of examples of residents who have entered into PPAs with the company. For this analysis, we selected the six case studies located in California that did not have any start-up costs (terms of PPAs vary, and can include upfront costs, often in exchange for lower rates in the future). These case studies provided a range of annual savings of $70 to $326 per kW. These savings were scaled based the assumed system size and number of systems for this measure. Please note this estimate is a rough approximation of savings. As noted previously, terms of PPAs can vary, as can the associated savings. However, most often, customers enter into PPAs because they experience net savings.

Total Costs

Under both financing scenarios, the net cash flow is positive after the initial year for both residential and commercial projects. A 25-year analysis period was used.

With the owner financed scenario, neither the residential nor commercial projects break even. Total net costs are estimated as $43.7 million.

Under the PPA scenario, because there is no initial outlay of capital, there are only net savings to the building owner. Total net savings are estimated as $7.0 to $32.4 million.

Co-Benefit Analysis

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[20] California Solar Initiative - Statewide Trigger Tracker (May 2012). http://csi-trigger.com/.

[21] DSIRE Energy Investment Tax Credit (ITC) http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=1.

[22] NREL Solar Advisor Model (May 2012). https://sam.nrel.gov/.

The following benefits are expected from implementation of Energy-5.

Reduced Air Pollution: Generating community electricity through renewable sources would displace a significant portion of electricity generated by fossil fuels. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to: fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constrains and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: If renewable infrastcuture is added to Stockton-area buildings as a result of this measure, properity and resale values of those structures may be increased.

Energy-6: Voluntary Solar Parking Program

Measure Description

Under this measure, the City would establish a goal for 15% of existing commercial development and multi-family housing complexes to install either solar panels or cool roofs on unused roof space and over carports by 2020 (California Attorney General's Office 2010a). In addition, the City would continue to provide incentives for the installation of solar technology. This measure would reduce reliance on sources of energy that emit GHGs, thereby reducing GHG emissions.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- An average of 1.75 parking spaces is required per multifamily dwelling unit (ICF International assumption).
- The number of covered commercial parking spaces in the City is 550 (Rademaker pers. comm.)
- 5% of multi-family unit parking space is covered (ICF International assumption).
- 25% of covered commercial parking space is stacked (ICF International assumption).
- Parking spaces are 171 square feet (ICF International assumption).
- Each solar system will generate 2,296 kWh per year (SAM Output).
- Penetration rate for multi-family unit parking space is 15%.

Analysis Details

GHG Analysis

Utilizing electricity generated by renewable resources displaces electricity demand that would ordinarily be provided by PG&E. Although PG&E purchases a substantial amount of energy from renewable sources, electricity supplied by PG&E still represents a source of indirect GHG emissions. Carbon neutral sources, such as solar, do not emit GHGs (CAPCOA 2010). Renewable energy supplied through this measure can be used to power building energy or sold to the local utility.

<u>Baseline Emissions</u>

Baseline emissions were not utilized in the analysis of this measure.

<u>Emissions Reductions</u>

In 2011, the City had approximately 8,279 multi-family homes (pers. comm. Rademaker). Based on professional experience in preparing CAPs for other jurisdictions in California, it was assumed that 15% of the multi-family homes will comply with the measure, that there are 1.75 parking spaces per multi-family home, and that all spaces are 171 square feet.

Total available roof space available for PV installation at multi-family homes was therefore calculated by multiplying the number of dwelling units by the number and size of required parking. This value was then multiplied by .05, as it was assumed that 5% of the multi-family homes have covered parking space.

In 2011, the City had 550 covered commercial parking spaces (pers. comm. Rademaker). It was assumed that 25% of the covered commercial parking is stacked and therefore unsuitable for PV installation. Total roof space available for PV installation at commercial parking space was calculated by multiplying the number of covered commercial spaces (550) by the assumed parking area of each space (171 feet), and subtracting 25% of the parking space that is assumed to be stacked parking.

The SAM model was used to calculate the energy potential of each solar installation.[23] This value was multiplied by the available number of multi-family and commercial parking spaces to determine energy

[23] These costs were adjusted to 2011 dollars using the Bureau of Labor Statistics Consumer Price Index Inflation Calculator.

reductions achieved by the measure. GHG reductions were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Cost Analysis

For this measure, two financing scenarios were estimated: one scenario where the building owner purchases and installs the solar panels, and one scenario where the building owner enters into a power purchase agreement (PPA) with a local company that owns and maintains the solar panels. The financials are more attractive to the building owner by entering into a PPA.

Total First Costs

Under the owner financed scenario, total initial costs to building developers/owners to install solar panels on residential and commercial carports are estimated to be approximately $25.5 million Costs were developed using the NREL SAM. Costs were calculated on a per-project basis, and then multiplied by the number of projects. A 25-year lifetime is assumed for these projects, and they and are expected to have no payback period. Initial costs include the direct capital costs (e.g., the cost of the system equipment) as well as the indirect costs (e.g., the cost of labor to install it). These costs are driven by project size (assumed to be 1.7 kW per project). These costs amount to $9,714 per commercial project and $9,289 per residential project. These cost estimates are calculated by SAM using default values. The total number of projects undertaken is assumed to be 2,723 (including both residential and commercial installations), based on assumptions used in the GHG Analysis for total area available for installations, as well as the assumed average size of a parking space (171 square feet).

Commercial projects are eligible for a California PBI via the California Solar Initiative, of $0.03 per kWh, which is the payment level of Tier 10, the Tier at which PG&E is paying out. Residential projects are eligible for the EPBB incentive of $0.25 per watt. The EPBB incentive equates to $425 per residential project. The CSI ratchets down to lower incentives over time, so actual incentives received depend on when the projects are initiated. The initial costs are also eligible for a federal ITC of 30% of the initial costs, which results in $2,914 in federal tax savings per residential and commercial project. However, this credit is taken at the end of the initial year to align with a lag time in receiving tax credits for project expenditures.

Because this measure targets carports and rooftops, it was assumed that sufficient infrastructure is already in place on which to install the panels. If solar panels are installed in an uncovered parking lot, additional infrastructure would need to be installed, such as the addition of a pole or other structure on which to hang the panels. This additional cost typically amounts to about $1.30 per watt, or about $2,230 per parking space.

For a Power Purchase Agreement (PPA) scenario, the total initial cost to multi-family residences and commercial entities is assumed to be zero.

Net Annual Costs

For the owner financed scenario, the value of electricity is drawn from the model's PG&E costs database. Livermore is located in PG&E's E-1 - Baseline Region X. Electricity production is based on the nameplate capacity (assumed to be 1.71 kW per project, as determined by the GHG calculations) and on Livermore-area climate and latitude information (which affects solar exposure). Livermore-specific climate and latitude information was used. Electricity production decreases slightly each year due to system degradation. Cost savings are reduced by the annual operating costs, which are assumed to be $34 per project in the initial year, as calculated by SAM. These costs increase slightly each year to account for inflation.

The annual operating costs for a PPA are incorporated into the resident's/commercial entity's electricity costs. ICF modeled three financing scenarios: one where the initial cost of the project is paid in cash (0% financing), one where 25% of the initial costs are paid in cash and the rest is financed (75% financing scenario), and a PPA scenario where there are no initial costs and operating costs are incorporated into the discounted electricity rate. These three financing scenarios represent the bounds of the cost estimate range. Under both financing scenarios, the net cash flow is positive after the initial year for both residential and commercial projects.

Total Costs

Under both financing scenarios, the net cash flow is positive after the initial year for both residential and commercial projects. A 25-year analysis period was used.

With the owner financed scenario, neither the residential nor commercial projects break even. Total net costs are estimated as $9.5 million.

Under the PPA scenario, because there is no initial outlay of capital, there are only net savings to the building owner. Total net savings are estimated as $3.6 to $17.0 million.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-6.

Reduced Air Pollution: Solar systems provide a direct source of renewable electricity. If this energy is consumed onsite, electricity usage supplied by PG&E would be reduced. The energy may also be sold to the utility, where it would be incorporated into their overall energy supply mix. In either scenario, electricity is displaced by a renewable source, which would reduce fossil fuel combustion at power stations and contribute to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to: fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constrains and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Facilities that generate a portion of their electrical demand from domestic, renewable sources would likely be buffered by any potential energy insecurities.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Facilities that diversify their energy supply mix through the generation of renewable energy would likely be buffered from the volatile global energy market.

Economic Development: Solar panel installation would create new jobs within the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: Bulidings with renewable infrasturcutre have higher properity values and resale prices than conventioanl buildings.

On Road-1: Idling Restrictions

Measure Description

Under this measure, the City would adopt an ordinance that limits idling time for heavy-duty trucks beyond CARB regulations. The recommended idling limit is 3 minutes. The reduced idling time would in turn reduce fuel usage and the associated GHG emissions.

Assumptions

Quantification of this measure employs the assumptions 1, 2, 70-72, 76, 145, 146, 233, 234, 236-238 in Table C-1.

- The BAU idling time is 5 minutes, and the goal idling time is 3 minutes.
- Heavy duty trucks idle 29.4% of their operating time (EPA 2009a)

Analysis Details

GHG Analysis

Vehicles idle during rest periods, which require fuel and results in GHG emissions. Regulating idling time would therefore reduction fuel consumption and GHG emissions. This measure primarily affects medium- and heavy-duty vehicles.

Baseline Emissions

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update. Reductions achieved by overlapping state measures were subtracted to obtain baseline emissions for the transportation sector.

Emissions Reductions

Using the percent idling time for an average California heavy duty diesel truck, and idling and running emission factors from the EPA and Climate Registry, the ratio of idling to running fuel consumption (7%) was found. The total amount of fuel consumed from heavy duty trucks in Livermore was found by dividing the total heavy duty emissions from the City's GHG inventory update by diesel carbon intensity factors from the GHGID Model Tool. The total amount of fuel consumed was multiplied by 7% to obtain fuel consumed by idling trucks. GHG emissions due to idling trucks were found by multiplying the idling fuel consumption by the GHGID Model Tool carbon intensity factors. The measure's emissions reductions were found by multiplying idling emissions by a factor of 40%, which was found by dividing the new idling time limit (3 minutes) by the BAU idling limit (5 minutes).

Cost Analysis

Total first costs for this measure ranges from $0 million to $0.13 million, with a payback period of 0 to 1 years. Annual cost savings (from reducing maintenance and fuel needs) for this measure are about $0.22 million per year. Cost per ton is estimated to range from -$454/MTCO$_2$e (net savings) to -$421/MTCO$_2$e (net savings).

Several elements factor into the overall cost of this measure. The number of heavy-duty vehicles and technologies implemented directly affects the cost of the measure.

The number of heavy-duty vehicles was determined from the GHG Analyses and by using formula below. These vehicles were estimated to operate for 8 hours/day and were assumed to spend 29% time daily idling, consuming 0.9 gallons/hour.

Number of Vehicles = [2020 BAU Emissions from Heavy Duty Vehicles (MTCO$_2$e)]/[2011 BAU Emissions from Idling Heavy Duty Vehicles (MTCO$_2$e) per vehicle]

Technology Costs

Technology costs would depend on the response to the anti-idling measure. One feasible measure is to simply shut off engines, which would not have any technology costs. U.S. EPA's Smart Way Transport Partnership has identified a range of technologies including automatic engine shutdown/start up technologies, direct fired heaters, auxiliary power units, and electrification capabilities. The per-unit cost of these technologies varies according to type, and ranges from $1,000/unit for automatic engine shutdowns/start ups to $11,000/unit for electrification. For this measure it was assumed that the high range of average cost would be $1,000/unit (corresponding to automatic engine shutdown) as it is unlikely that this ordinance alone would incentivize installation of more expensive technologies such as electrification.

The O&M costs of using these technologies are not estimated under this measure.

<u>Cost Savings Analysis</u>

Savings are mainly derived from avoided O&M costs. Idling often has the same effect on the vehicle as driving it; that is, the engine and other mechanical parts experience the same wear and tear effects. Reduction in idling over time will provide savings in avoided fuel use, reduction in maintenance costs in relation to oil changes, and engine overhauls.

The calculation of cost savings from a reduction in idling time (from 5 to 3 minutes) has the following steps:

a) Reduction in Fuel Use = (Fuel Consumption/hour x hours/year spent idling x fuel price/gallon)

b) Cost of Oil Changes per year = [(Miles per oil change/ cost of oil change) x (gallons/ hour x hours/year x average fuel economy)]

c) Engine Overhaul Costs = [(Miles per overhaul/ cost of overhaul) x (gallons/hour x hours/year x average fuel economy)]

In the end, total avoidable costs (and thus savings), are calculated this way:

Total Avoidable Cost per vehicle = Savings from Fuel Reduction + Savings from Reduction in Maintenance Costs (equations b + c above)

Total Avoidable Costs for City Vehicle Fleet = Total Avoidable Cost per vehicle x no. of vehicles

Total costs are estimated as -$1.7 million (net savings) to -$1.6 million (net savings).

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-1.

Reduced Air Pollution: Because less petroleum would be consumed by heavy-duty trucks within the city, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Reduced Energy Use: Reduced idling time will reduce fuel consumption.

On Road-2: Transit Oriented Development

Measure Description

Under this measure, the City would expand land use planning to support increased transit use and alternatives to vehicle travel. Specifically, this measure includes land use regulations that would encourage Transit Oriented Development (a mixed-use area designed to maximize access to public transport) at the Vasco and Downtown ACE stations. Such development would reduce the amount of vehicle miles traveled by residents, thereby reducing emissions from automobiles and consequently GHG emissions.

At the Vasco Road ACE Station, development would include a total of 510 new housing units and 16 acres of open space north of ACE station/parking. Housing types anticipated include: 110 clustered townhomes, 84 clustered condos, 200 row-homes, and 116 duets. At the Downtown Ace Station, the Downtown Specific Plan would allow mixed uses with development maximums as follows:

- Commercial: 1,000,000 square feet
- Office: 356,000 square feet
- Entertainment: 2,500 performance art seats and up to 15 movie theatre screens
- Lodging: 300 rooms
- Residential: 3,600 units (approximately 3,200 new units)

For the purposes of the CAP, it is expected that by 2020, the following new uses would have been constructed in the Downtown area, including uses constructed between 2005 and 2011:

- 28,905 square feet of office (constructed)
- 318,014 square feet of commercial (288,014 square feet constructed; an additional
- 30,000 square feet assumed by 2020)
- 500 seat Performing Arts Theater (constructed)
- 13 screen Movie Theater (constructed)
- 959 housing units (250 units constructed, an additional 709 units assumed by 2020)
- 120-room boutique hotel (planned for constructed by 2020)

Assumptions

See Table C-1.

Analysis Details

GHG Analysis

Reductions in VMT from this measure would reduce the amount of GHGs directly emitted from vehicles.

<u>Baseline Emissions</u>

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update.

<u>Emissions Reductions</u>

Based on modeling conducted by Fehr & Peers, On Road-2 was assumed to result in a VMT reduction of 12,215 daily miles. Emission reductions associated with this measure were calculated by dividing the 2020 BAU on-road emissions by the 2020 BAU VMT, and then multiplying by the annual VMT reductions expected from this measure.

Cost Analysis

Costs were not estimated due to the lack of data on the costs of downtown development and infrastructure relative to costs of comparable amount of development outside of the downtown. Thus, the incremental costs of downtown development have not been identified. Costs for downtown development may be less or more than comparable development outside downtown areas. Sometimes, more compact development can minimize the cost of infrastructure due to the presence of existing infrastructure and shorter roadway and utility lengths to serve new development. However, downtown development can incur costs for remediation or removal of prior structures and can incur other costs not experienced in development in outlying areas. The ultimate cost effectiveness of this measure would depend on the balance of the incremental costs of development compared to the fuel and vehicle savings from reduced VMT.

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-2.

Reduced Energy Use: Increased density would reduce the number of private vehicle trips made within the City. As a result, gasoline and diesel consumption would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within the city, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing fuel consumption would lessen the demand for petroleum and ultimately the demand for imported oil.

Increased Quality of Life: Increased density along transit routes, employment corridors, and in the downtown would increase the accessibility of public transportation and basic services. Reductions in the number of vehicle trips may also reduce congestion and travel times.

Smart Growth: Increased density in the urban core is a form of smart growth development that creates more walkable and accessible environments.

On Road-3: Transit Enhancements

Measure Description

Although the City of Livermore is not a transit provider, the City can encourage and require new developments to provide transit amenities within the Project area including the potential for bus stop amenities, transit signal priority at intersections; or encouraging new residences be located within a half-mile walk of an existing or planned transit route.

The Livermore Amador Valley Transit Authority (LAVTA) is the primary transit provider in the City of Livermore. Regular transit service is provided in the Tri-Valley area, serving the Cities of Dublin, Pleasanton and Livermore. Sixteen fixed routes are providing connecting primary activity centers, including the both BART stations in the Tri-Valley. Additional routes serving various schools are also provided. In 2009, service was cut approximately 25 percent. One Bus Rapid Transit (BRT) route was implemented in 2011. There are no plans to expand the number of BRT routes or the level of service on the existing route, and the primary goal of LAVTA over the next few years is to restore service cuts.

For this assessment, it was assumed that by 2020, service would be restored to the same per capita level that was provided in 2005 and that the recently implemented BRT route would continue to operate increasing ridership levels per capita above the 2005 levels. This would result in a potential daily VMT reduction of 4,072 miles above the BAU case.

Assumptions

See Table C-1.

Analysis Details

GHG Analysis

Reductions in VMT from this measure would reduce the amount of GHGs directly emitted from vehicles.

<u>Baseline Emissions</u>

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update.

<u>Emissions Reductions</u>

Based on modeling conducted by Fehr & Peers, On Road-3 was assumed to result in a VMT reduction of 4,072 daily miles. Emission reductions associated with this measure were calculated by dividing the 2020 BAU on-road emissions by the 2020 BAU VMT, and then multiplying by the annual VMT reductions expected from this measure.

Cost Analysis

No cost analysis was completed for this measure as this measure assumes actions by LAVTA that are not directly under the control of the City of Livermore. Costs could be incurred where transit amenities are included in new developments. Traffic light synchronization costs are included in On-Road 4. LAVTA service costs are under LAVTA control, not the City's control.

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-3.

Reduced Energy Use: More attractive transit would encourage motorists to utilize public transportation instead of private vehicles. As a result, the number of vehicle trips made within the City, and thus gasoline and diesel consumption, would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within the City, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Increased Quality of Life: Increased transit service would help reduce transit passenger travel time and may make public transportation more comfortable and enjoyable. Reductions in the number of vehicle trips may also reduce congestion and travel times.

On Road-4: Traffic Signal Synchronization

Measure Description

Under this measure, the City will improve travel speed by enhanced signal synchronization. This measure would reduce idling time for vehicles traveling within and through the city, and the reduced idling time would in turn reduce fuel usage and the associated GHG emissions.

This measure would not reduce VMT, but rather idling time and resultant emissions.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Traffic signal synchronization reduces GHGs by approximately 1% (ICF International assumption)
- The scaling factor applied to the GHG reduction percent is 0.5 (ICF International assumption)

Analysis Details

GHG Analysis

Vehicles idle during periods spent stationary at traffic signal red lights, which requires fuel and results in GHG emissions. Enhancing traffic signal synchronization would decrease the amount of time that cars spend idling and reduce GHG emissions.

<u>Baseline Emissions</u>

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update. Reductions achieved by overlapping state measures were subtracted to obtain baseline emissions for the transportation sector.

<u>Emissions Reductions</u>

Using professional experience from the preparation of CAPs for other jurisdictions, it was assumed that GHG reductions can be reduced by 1% due to traffic signal synchronization. A scaling factor of 0.5 was applied to the percent reduction, to give a reduction in GHGs of 0.5%. This reduction factor was applied to the 2020 GHG emissions from on-road transportation quantified in the Inventory Update.

Cost Analysis

The one-time costs of based on a range of $2,586 per intersection (from an Alameda County synchronization project estimate) $20,000 per intersection (based on an estimate of adaptive traffic control system (ATCS) cost). City of Livermore (2012) provided estimates of the number of traffic signal intersections currently in place (as of 2011) as 92, and projected that there would be 110 traffic signal intersections by 2020. This analysis assumed a linear increase between these two end points. The number of intersections was multiplied by the range of ATCS installation costs per intersection. One-time costs ranged from $0.3 to $2.2 million, and are spread over the time period 2012 to 2020.

Savings in on-road vehicle emissions due to this measure were calculated by the GHG analysis. Reductions in gallons of diesel fuel and gasoline were calculated. These annual savings (which reach $0.31 million by 2020) are experienced by the drivers, while the one-time costs are experienced by the local government.

Total costs are estimated to range from -$0.03 million (net savings) to $1.9 million (net costs).

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-4.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within the city, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Reduced Energy Use: Traffic signalization will improve the efficiency of transit service, reducing wasted fuel.

Increased Quality of Life: Reduced vehicle congestion would improve the efficiency of the transportation network.

On Road-5: Bicycles and Pedestrian System Improvements

Measure Description

Under this measure, the City would complete its bikeway network identified in the General Plan and provide facilities for bicycle commuters, such as showers and bicycle lockers. These measures would encourage alternative modes of communication, thereby reducing vehicle miles traveled and consequently GHG emissions.

Livermore had approximately 60 miles of Class I and Class II bicycle path facilities in 2003 and expects to add approximately 18.5 more miles of off-street and on street facilities, including facilities constructed between 2003 and 2011, closing gaps in the network and connecting new development areas to the existing system by 2020. This measure is expected to decrease daily VMT by approximately 7,736 miles.

Assumptions

See Table C-1.

Analysis Details

GHG Analysis

Cycling is a non-emissions forming mode of transportation that has a high potential for success in Livermore. Reductions in VMT from this measure would reduce the amount of GHGs directly emitted from vehicles.

<u>Baseline Emissions</u>

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update.

<u>Emissions Reductions</u>

Based on modeling conducted by Fehr & Peers, On Road-5 was assumed to result in a VMT reduction of 7,736 daily miles. Emission reductions associated with this measure were calculated by dividing the 2020 BAU on-road emissions by the 2020 BAU VMT, and then multiplying by the annual VMT reductions expected from this measure.

Cost Analysis

Initial capital costs for this measure ranged from $2.5 million to $6.8 million. This included construction of new multi-use trails on service roads or other routes, widening roadways to provide bike lanes, and marking bike lanes with signs and pavement legends. The costs ranged from $20,000 to $500,000 per mile (City of Livermore 2002) and would be incurred by the City.

Annual maintenance costs ranged from $0.25 million to $0.68 million and were estimated to be 10% of the initial capital costs (Moving Cooler 2009). These maintenance costs would be incurred by the City of Livermore and are driven by the need for upkeep of the gravel, signage, and other path maintenance activities. Annual savings were estimated at $1.1 million and were driven by vehicle miles traveled (VMT) reduced. VMT savings were provided by the GHG Analysis and are experienced by residents who reduce their automobile use and the City (as they experience reduced road maintenance costs). These savings come from avoided fuel costs ($0.188/mile; Caltrans 2007) and avoided maintenance costs of roads ($0.239/mile; Caltrans 2007).

Total costs were estimated to range from -$8.7 million (net savings) to $1.0 million (net costs).

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-5.

Reduced Energy Use: Providing network connections and facilities for bicycle commuters, such as showers and bicycle lockers, can encourage them to use non-motorized transportation for short and medium length trips. As a result, the number of vehicle trips made within the City, and thus gasoline and diesel consumption, would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within the City, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity. Walking and bicycling would also provide exercise, which may help reduce obesity and other ailments caused by inactivity.

Increased Quality of Life: Improving the connectivity of the pedestrian and bicycle network would increase public mobility. Amenities like showers and lockers may also make bicycling and walking more enjoyable. Finally, reductions in the number of vehicle trips may reduce congestion and travel times.

Smart Growth: Creating a more walkable and accessible environment is a tenant of smart growth development.

On Road-6: Car Sharing Program

Measure Description

This measure would include promotion of a car-sharing program to allow people to have on-demand access to a shared fleet of vehicles on an as-needed basis.

Car Sharing was assumed to be implemented at both ACE stations on a limited basis and is expected to result in a net-decrease of 407 daily VMT.

Assumptions

See Table C-1.

Analysis Details

GHG Analysis

Reductions in VMT from this measure would reduce the amount of GHGs directly emitted from vehicles.

<u>Baseline Emissions</u>

Emissions associated with on-road transportation in 2020 under BAU conditions were quantified in the Inventory Update.

<u>Emissions Reductions</u>

Based on modeling conducted by Fehr & Peers, On Road-6 was assumed to result in a VMT reduction of 407 daily miles. Emission reductions associated with this measure were calculated by dividing the 2020 BAU on-road emissions by the 2020 BAU VMT, and then multiplying by the annual VMT reductions expected from this measure.

Cost Analysis

Costs were not estimated for this measure as this measure would be implemented by private vendors (like Zipcar). City costs would be limited to providing several parking spaces in key locations, with minimal costs for signage and reduction in parking revenues.

Co-Benefit Analysis

The following benefits are expected from implementation of On Road-6.

Reduced Energy Use: Providing car sharing services will reduce personal vehicle use. As a result, the number of vehicle trips made within the City, and thus gasoline and diesel consumption, would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within the city, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced.

Public Health Improvements: Fossil fuel combustion release several toxic air containments known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air containments. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: In 2009, 51% of petroleum consumed by the U.S. was imported from oversees (EIA 2010). Reducing fuel consumption would lessen the demand for petroleum and ultimately the demand for imported oil.

Increased Quality of Life: Reduced vehicle congestion would improve the efficiency of the transportation network. In addition, the ability to obtain a shared vehicle for use could allow residents to use their vehicles less or own less vehicles, granting them the associated economic benefits of less car maintenance and ownership costs.

Water-1: Reduce Per Capita Urban Water Use 20% below 2005 per Capita levels

Measure Description

Under this measure, the City would implement a mix of voluntary and mandatory measures to reduce urban water use (including indoor and outdoor use) 20% by 2020 (compared to 2005 per capita levels) per the requirements of state regulation (SBX7 7). Decreased urban water use would decrease the amount of energy needed to transport and deliver this water, thereby reducing GHG emissions.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- The City of Livermore 2020 per capita goal is 155.7 gallons per person per day (City of Livermore 2012).
- The Calwater Livermore District 2020 per capita goal is 158 gallons per person per day (City of Livermore 2012).
- The Calwater Bay Area Regional Alliance 2020 per capita goal is 151 gallons per person per day (City of Livermore 2012).

Analysis Details

GHG Analysis

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets). Recognizing that water uses a great deal of electricity to pump, treat, and transport, the state adopted SB X7-7, which requires a 20% reduction in urban per capita use by December 31, 2020. Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

<u>Baseline Emissions and Emissions Reductions</u>

Using the estimated 2020 population from the GHG forecast and the estimated baseline consumption per capita of 195 gallons/capita/day (Livermore Municipal Water 2010 UWMP), the 2020 BAU water consumption was estimated as 6,499 million gallons (MG). A 20% reduction in the per capita level would reduce water consumption in 2020 to 156 gallons/capita/day. Achieving the 2020 goal would therefore reduce city-wide water consumption in 2020 to 5,200 MG.

Electricity savings from reduced water treatment, distribution, and wastewater treatment were quantified by multiplying the anticipated water reductions by the appropriate energy-intensities. Natural gas savings were also calculated from reduced hot water usage. GHG savings were then calculated by multiplying the energy reductions by the appropriate emission factors.

Two scenarios were analyzed for this measure. One scenario evaluated an equal level reduction for all forms of water use (indoor hot water, indoor cold water, outdoor irrigation) and the second scenario assumed that the reduction of outdoor water use would be twice the level of indoor water use. The first scenario resulted in an estimated 11,650 $MTCO_2e$ reduction in GHG emissions while the second scenario resulted in an estimated 6,369 $MTCO_2e$ reduction in GHG emissions. The reason for the large difference is that the first scenario has relatively higher reduction of hot water use than the second scenario and hot water use has higher emissions per gallon due primarily to natural gas consumption for heating. Since the precise balance of water efficiency measures that will be employed over the next 8 years to meet the SB X7 7 goal is not known, for the purposes of this study, the second scenario was used to estimate GHG reductions, as it is more conservative.

Cost Analysis

This measure is not an additional cost of the CAP as it is a requirement per prior state regulation.

Co-Benefit Analysis

The following benefits are expected from implementation of Water-1.

Resource Conservation: Reduced water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Consequently, reductions in water use would reduce electricity consumption.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

Increased Property Values: Energy-efficient buildings have higher property values and resale prices than less efficient buildings.

Wastewater-1: Aeration Diffuser

Measure Description

This measure includes the replacement of inefficient aeration diffusers with high-efficiency blowers.

Assumptions

Replacement of inefficient blowers with high-efficiency blowers will reduce annual GHG emissions by 84,577 pounds of CO_2e.

Analysis Details

GHG Analysis

According to a recent analysis prepared by Chevron, old and fouled diffusers might result in inefficiencies requiring as much as 230 kW of energy. Chevron evaluated two alternatives to replace existing diffusers at the LWRP: FlexAir Magnum Tub Diffusers and FlexAir Mini Panel Diffusers. Installation of either high-efficiency design would result in GHG reductions by reducing energy consumption at the LWRP. (Chevron 2012.)

<u>Baseline Emissions and Emissions Reductions</u>

Chevron estimates that replacement of inefficient blowers with high-efficiency blowers will reduce annual GHG emissions by 84,577 pounds of CO_2e. GHG emissions associated with Wastewater-1 were therefore assumed to equal 38 metric tons. Please note that the Chevron calculations are based on activity data in 2011. Because energy consumption is expected to increase between 2011 and 2020, emissions reductions associated with Wastewater-1 likely underestimate potential reductions in 2020.

Cost Analysis

The Chevron Report only identified annual savings as $13,899. Capital costs or discounted costs/savings over the lifetime of the measure were not identified (Chevron 2012).

Co-Benefit Analysis

The following benefits are expected from implementation of Water-1.

Reduced Energy Use: Utilizing efficient blowers will reduce electricity consumption.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

Waste-1: Waste Diversion

Measure Description

Under this measure, the City would increase the amount of waste diverted from landfills per its previously adopted waste diversion target of 75% by 2015, which would reduce vehicle miles traveled associated with transporting waste to landfills, contribute to land conservation due to the reduced need for landfills, and reduce the use of energy through increased recycling and reuse of waste.

In 2005 (baseline inventory year), the City had a diversion rate of 63%. The City's current goal is to increase the City's diversion rate to 75% and is currently at a rate of 73%.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- The City had an average existing diversion rate of 63% for municipal solid waste in 2005 (CalRecycle n.d.).
- The diversion goal rate adopted by the City Council for 2015 is 75% and this rate was assumed for 2020

Analysis Details

GHG Analysis

Diversion programs reduce the amount of waste deposited in regional landfills. Because waste generates methane emissions during decomposition, reducing the volume of waste sent to landfills directly reduces GHG emissions. In general, waste diversion rates have risen dramatically since the early 1980s. The U.S. achieved 46% diversion in 2008.

<u>Baseline Emissions</u>

Waste volumes for the City in 2020 were projected using the 2005 waste volume from the existing GHG inventory (City of Livermore 2005a), and the population growth rate. According to CalRecycle (n.d.), the City diverted 63% of generated waste in 2005. It was assumed that this diversion rate would remain constant under 2020 baseline conditions.

<u>Emissions Reductions</u>

Implementation of Waste-1 would increase the baseline diversion rate to 75%. The amount of waste diverted under baseline conditions was therefore increased by 12% (75% minus 63%). To determine 2020 emissions from the increased diversion rate scenario, 2020 waste emissions (37,948 $MTCO_2e$) from the City's GHG inventory update (ICF 2010) was divided by 2020 waste volume (154,620 short tons) and then multiplied by the 2020 goal waste volume. Emissions reductions, GHG emissions that would have been generated by the diverted waste if it had been deposited in regional landfills, were determined by subtracting the 2020 goal waste volume emissions (25,641 $MTCO_2e$) from the 2020 baseline waste volume emissions (37,948 $MTCO_2e$).

Cost Analysis

The City has already adopted the 2015 waste diversion goal. As such, the costs to meet this goal are not an additional cost of the CAP.

Co-Benefit Analysis

The following benefits are expected from implementation of Waste-1.

Reduced Air Pollution: The decomposition of landfilled waste emits methane, which can react with other species in the atmosphere to form local smog. By sending less waste to regional landfills, methane emissions would be reduced.

Resource Conservation: Waste that is diverted to recycling centers can be converted into reusable products, thereby reducing the need for raw materials.

Urban Forestry-1: Urban Shade Trees

Measure Description

The City has development regulations and engineering standards that require a minimum number of new trees in new development and parking lots, as well as street trees for new private development. The City's Tree Preservation Ordinance also ensures that existing trees in new development are preserved; if the trees cannot be saved, the ordinance requires they be replaced at a minimum ratio of 3 to 1. Under this measure, the City would continue its existing program, requiring a minimum number of new trees to be planted with new development. A goal of 300 new trees to be planted each year is assumed.

Assumptions

In additional to assumptions listed in Table C-1, the following assumptions were also considered.

- Tree planting programs begin in 2013.
- Urban heat island energy saving factor for planting trees: 7kWh/tree
- Mature trees (as opposed to seedlings) would be planted.
- CAPCOA annual sequestration rates (MT CO_2e per year):
  - Flowering Pear —0.1666
  - Hackberry—0.0795.
  - Modesto Ash—0.0858.
  - Chinese Pistache—0.0381.
  - Sycamore—0.0828.

Analysis Details

GHG Analysis

Trees would both reduce the urban heat island effect and sequester carbon. Trees in cities can reduce summer cooling energy consumption by lessening the effect of the urban heat island effect. Trees also provide the benefit of carbon sequestration, The GHG benefits achieved from sequestration would vary based on the type of tree planted. Mature trees would function to sequester more carbon dioxide from the atmosphere than young trees.

<u>Baseline Emissions</u>

Baseline emissions were not utilized in the analysis of this measure.

<u>Emissions Reductions</u>

The Climate and Air Pollution Planning Assistant (CAPPA) tool created by ICLEI - Local Governments for Sustainability (ICLEI, n.d.), has derived an estimate for the amount of electricity saved due to the planting of one tree in an area affected by the urban heat island effect. This value, 7 kWh per tree planted, was multiplied by the number of trees to be planted by 2020 to determine the total energy saved from the decreased need for cooling buildings. The total energy saved, 14,700 kWh (in 2020), was multiplied by utility emission factors to obtain total GHG emissions reductions.

CAPCOA (2010) has quantified anticipated annual CO_2 accumulation rates associated with various tree species. The City has indicated that Sycamore, Flowering Pear, Modesto Ash, Hackberry, and other species are common in the City. It was assumed that the tree species planted will consist of the common species currently present. The average CO_2 accumulation rate for these species was multiplied by the number of planted trees per year (300) and by the number of planting years (7) to obtain total CO_2 sequestered in 2020.

Cost Analysis

Initial costs for planting, staking, and mulching were estimated at between $142–$197 per public tree.

Costs for planting were divided amongst seven years with initial costs for all years ranged between $298,200 and $413,700. Annual maintenance costs were estimated to range from $4 to $58 per tree, depending on the maturity of the trees; irrigation costs are higher in the first five years, whereas infrastructure repair and litigation/liability costs apply after the trees reach a certain size (McPherson et al. 1999). The higher end of maintenance costs included full pruning, pest and disease control, irrigation, infrastructure repair, litter removal, storm cleanup, litigation liability, and administration costs while the lower cost estimate focused more on basic maintenance such as pruning and irrigation. Operation and maintenance costs were estimated to range between $68,550 and $94,660 in 2020.

Trees have important impacts on their local surroundings but this study focused on direct cost savings to the community through electricity savings achieved by reduced energy use. Each tree was assumed to reduce electricity demand by 7 kWh on average, mostly from reductions in the urban heat island effect and shading. The energy savings result in $2,700 in total annual savings for private residents and businesses by the year 2020.

The total discounted net costs for this measure would be $0.8 million to $1.1million. The total discounted net cost per ton of GHG reduced would range from $266 to $374 per ton. Actual net costs for the City may vary from those estimated. A lifetime of 40 years was assumed for this measure.

For all of the measures in this study, the only benefits quantified were energy or fuel savings, due to the lack of readily available data for quantifying other benefits. Street and shade trees have a wide range of benefits including energy savings, reduction in air pollutants, increase in home prices etc, of which only the energy savings were included in the cost analysis. In order to estimate a rough estimate of the value for this wider range of benefits for this measure, a per-tree lifetime (40 years) net savings ranging from $417 to $597 (average of $507) was assumed, based on an equal mix of small and medium trees planted in the City of Livermore. These values are based on lifetime net savings as reported in a prior tree study (McPherson et al. 1999), grossly adjusted to 2011 dollars and net of building energy savings associated with shading included in the calculation above. This net benefit value includes CO_2 and air quality emission reductions, as well as property value increases. When using this estimate of net benefits, this measure would result in net savings of $0.8 to $1.3 million (instead of a net cost as noted above). The total savings per ton of GHG reduced would range from $124 to $178 per ton (compared to net costs per ton noted above). Actual net savings for the City may vary from those estimated, but the net benefit is expected to be highly positive if the wider range of benefits is included.

Co-Benefit Analysis

The following benefits are expected from implementation of Urban Forestry-1.

Reduced Energy Use: Trees planted adjacent to buildings shade, which cools buildings and reduces the need for summer-time air conditioning use. As a result, less electricity is consumed.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution. Trees planted adjacent to congested roadways may also help filter particulate matter and other local pollutants.

Reduced Urban Heat Island Effect: Urban heat isalnd effect occurs when the ambient temperature in urban areas increases as a reuslt of high energy consumption (e.g., air conditioning use during the summertime). Trees provide shade, which reduces the cooling load of buildings and helps mitigate the urban heat island effect.

Increased Quality of Life: Trees improve the aesthetic quality of buildings, as well as reduce stormwater runoff during periods of heavy rain.

Mun-1: Municipal Energy Efficiency Programs

Measure Description

Under this measure, the City would promote voluntary programs for existing government facilities to improve building-wide energy efficiency.

Analysis Details

GHG Analysis

Emissions Reductions and Cost Savings

Chevron conducted an analysis of GHG reductions and annual cost savings with a range of municipal energy-efficiency measures as shown in the table below:

Municipal Energy-Efficiency Measures, Annual Cost Savings and Associated GHG Reductions[a]

Measure Name	Annual Cost Savings	$MTCO_2e$ Reduction in Municipal Emissions
Solar PV	$610,951	1,310
Chiller Upgrade	$1,293	3
Variable Primary Flow	$16,589	46
HVAC Unit Upgrade	$2,626	5
Solar Thermal Water Heating	$1,465	7
EMS Upgrade at Multi Service Center	$405	1
Interior & Exterior Lighting and Lighting Controls	$99,846	222
Street Lighting	$276,627	746
Total	$1,009,082	2,340

[a] Emissions calculations based on activity data in 2011. Because energy consumption is expected to increase between 2011 and 2020, emissions reductions presented above are likely an underestimate.

Source: Chevron 2012

No calculation of initial capital costs or total discounted costs/savings were provided in the Chevron report.

Co-Benefit Analysis

The following benefits are expected from implementation of Mun-1.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of commercial buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient bulidings have higher properity values and resale prices than less efficient buildings.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts and air leaks helps prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy efficient structures improve general comfort by equalizing room temperatures and reducing indoor humidity. Employee satisfaction and out may therefore be increased.

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Attachment C-1
Fehr & Peers Transportation Memo

FEHR PEERS

MEMORANDUM

Date: May 30, 2012

To: Rich Walter, ICF

From: Kathrin Tellez and Tien-Tien Chan, Fehr & Peers

Subject: ***Livermore Vehicle Miles of Travel with Climate Action Plan (CAP) Implementation***

WC10-2707

This memorandum documents the potential reduction in vehicle miles of travel (VMT) that are expected to occur with implementation of the City of Livermore Climate Action Plan (CAP) by 2020. Existing and projected future conditions under the future Business as Usual (BAU) scenario were documented in our memorandum dated May 25, 2010 (attached). The Climate Action Plan scenario assumes increased transit oriented development (TOD) around the City's two Altamont Commuter Express (ACE) stations, and implementation of the candidate measures included in the *Revised City of Livermore Candidate Measures for the Community Climate Action Plan,* prepared by ICF, dated January 9, 2012 and updated in May 2012.

CONCLUSIONS

The total VMT generated by residents and employees of Livermore business are expected to increase as new housing units are developed and new jobs are created through 2020. VMT per capita (includes residents and employees) is expected to slightly decrease under the BAU scenario by 2020. The CAP transportation measures reduce overall daily VMT in 2020 by approximately 24,430 miles (1 percent reduction), as compared to the 2020 BAU scenario

MODEL PREPARATION

The Alameda County CMA Travel Demand Model ("ACCMA Model"), modified to better reflect the City's land use projections consistent with the General Plan and roadway network characteristics, was used to develop the VMT estimates. Modifications to the Base Year (2005) and BAU model were discussed in our May 25, 2010 memo. The residential population and the number of jobs under each scenario are summarized in Table 1.

TABLE 1 LIVERMORE POPULATION SUMMARY		
Scenario	**Population**	**Employment**
2005 Baseline	80,877	44,389
2020 BAU	98,084	58,995
Source: ACCMA Model, City of Livermore and Fehr & Peers.		

VMT CALCULATIONS

Livermore's greenhouse gas inventory is defined as the total amount of VMT generated by Livermore land uses. This includes:

a) all of the VMT associated with trips made completely internally within Livermore;

b) half of the VMT generated by jobs and residences located within Livermore but that travels to/from external destinations (this is consistent with the SB 375 Regional Targets Advisory Committee (RTAC) decision that the two generators of an inter-jurisdictional trip should each be assigned half of the responsibility for the trip and its VMT); and

c) none of the responsibility for travel passing completely through the City with neither an origin point or a destination within the City (also consistent with RTAC decision).

This means that Livermore will be held responsible for some VMT occurring outside of its borders, if they are related to employees commuting from out of the area to employment centers in Livermore (or vice versa).

CLIMATE ACTION PLAN VMT CALCULATIONS

Discussion with the project team targeted transportation measures that could be fully in place by 2020. The final list of measures, their VMT reductions, and data source for the reduction can be found in **Attachment 1.**

Measures were quantified using published documents and research, such as information presented in the publication *Growing Cooler*, Urban Land Institute, and the publication from the California Air Pollution Control Officers Association (CAPCOA), *Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures*, August 2010. The trip reduction source/analysis method is also noted in Attachment 1. The resulting total VMT and VMT per capita with implementation of the CAP is shown in **Table 2** and compared to the BAU and Base Year condition.

TABLE 2
LIVERMORE VMT PER CAPITA CALCULATIONS

Scenario	Total Daily VMT	Population + Employment	Daily VMT per capita
Existing (2005)	1,642,169	125,266	13.11
2020 BAU	2,035,818	157,079	12.96
2020 CAP	2,011,388	157,079	12.80

Source: Fehr & Peers, 2012.

The total VMT generated by residents and employees of Livermore business are expected to increase as new housing units are development and new jobs are created through 2020. VMT per capita (includes residents and employees) is expected to decrease slightly under the BAU scenario given the increased density assumed under the General Plan and expected job growth within Livermore and adjacent communities. The CAP transportation measures reduce overall daily VMT by 24,430 miles (1 percent reduction), as compared to the 2020 BAU scenario. VMT per capita with CAP implementation is also expected to decrease by about 2 percent as compared to the Base Year, although total VMT will increase. The contribution to VMT reductions from each strategy is presented in **Table 3**. Additional GHG reductions are also expected through the changing vehicle fleet that will achieve better fuel economy in the future.

It should be noted that many of the CAP measures would only be implemented as new developments occur and no transportation measures are mandatory for existing residents. Many CAP measures strive to encourage behavior, or modify City codes in such a way to facilitate a lifestyle with less driving. Additional VMT reductions could occur with implementation of mandatory measures, but it is not likely that those measures would be implemented over the life of the plan.

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TABLE 3 SUMMARY OF VMT REDUCTIONS WITH CAP MEASURES	
Measure	**Potential VMT Reduction per day in 2020**
On-Road 2: Transit Oriented Development	12,215
On-Road 11: Car Sharing Program	407
On-Road 3, 12, 15: Transit Enhancements	4,072
On-Road 5 and 6: Bicycle and Pedestrian System	7,736
TOTAL	24,430
Source: Fehr & Peers, 2012.	

VOLUNTARY MEASURES

The VMT reductions that are expected to result with implementation of the CAP mostly apply to new development proposed within the City and the potential for slight modifications to existing resident travel behavior. There are, however, additional modifications to travel behavior that the average citizen can undertake that could result in large VMT reductions should sufficient numbers of people make small changes to their daily travel routines, such as walking their children to school one day a week, working from home one day a month and taking an alternative mode of transportation, such as biking, transit or carpooling, to work one day at month. **Table 4** summarizes the potential VMT reductions from voluntary measures.

TABLE 4 OTHER MEASURES		
Strategy	**Quantity**	**Potential Daily VMT Reduction**
Safe Routes to School	For each 10% of students walk/bike instead of being driven to/from school (0% included in CAP)	12,215
Voluntary TDM	Each 1 percent participation by residents and workers (0% included in CAP) for commute trips	11,197
Source: Fehr & Peers, 2012.		

This completes our assessment of the VMT reductions that are likely to occur with implementation of the City of Livermore CAP. Please call Kathrin or Tien-Tien with any questions.

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ATTACHMENT 1 – DETAILED STRATEGY INFORMATION

The following provides additional information related to the VMT reduction calculations within the major transportation strategy categories.

On-Road 1: This measure would reduce idling time for large trucks and although it would reduce greenhouse gas emissions, it would not reduce VMT. Therefore, no VMT reduction was calculated for this measure.

On-Road 2: This measure includes Transit Oriented Development at the Vasco and Downtown ACE stations. At the Vasco Road ACE Station, development includes a total of 510 new housing units and 16 acres of open space north of ACE station/parking. Housing types anticipated include: 110 clustered townhomes, 84 clustered condos, 200 row-homes, and 116 duets.

At the Downtown Ace Station, the Downtown Specific Plan would allow mixed uses with development maximums as follows:

- Commercial: 1,000,000 square feet
- Office: 356,000 square feet
- Entertainment: 2,500 performance art seats and up to 15 movie theatre screens
- Lodging: 300 rooms
- Residential: 3,600 units (approximately 3,200 new units)

For the purposes of the CAP, it is expected that by 2020, the following new uses would have been constructed in the Downtown area, including uses constructed between 2005 and 2011:

- 28,905 square feet of office (constructed)
- 318,014 square feet of commercial (288,014 square feet constructed; an additional 30,000 square feet assumed by 2020)
- 500 seat Performing Arts Theater (constructed)
- 13 screen Movie Theater (constructed)
- 959 housing units (250 units constructed, an additional 709 units assumed by 2020)
- 120-room boutique hotel (planned for constructed by 2020)

No BART extension or enhancements of ACE service was assumed for this measure. On-Road 11 is a supportive measure.

Potential vehicle trip and vehicle miles of travel (VMT) reductions are detailed in the publication from the California Air Pollution Control Officers Association (CAPCOA), *Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures*, August 2010, which is a compilation of numerous data sources including the Urban Land Institute (ULI) publication *Growing Cooler (2008),* and nationwide and statewide data summarized by EPA.

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The research indicates that increases in density can reduce VMT by up to 30 percent, increasing location efficiency within a region, such as infill development in a downtown area, can reduce VMT by up to 65 percent, increasing the diversity of land uses can reduce VMT by up to 30 percent, and increasing destination accessibility can reduce VMT by up to 20 percent. The reductions typically apply to new development; however, providing increased local shopping opportunities within an established neighborhood can alter the travel behavior of existing residents.

This measure is expected to result in a net-decrease in VMT daily of approximately 12,215.

On-Road 3, 12 and 15: Although the City of Livermore is not a transit provider, the City can encourage and require new developments to provide transit amenities within the Project area including the potential for bus stop amenities, transit signal priority at intersections; or requiring that all new residences be located within a half-mile walk of an existing or planned transit route.

The Livermore Amador Valley Transit Authority (LAVTA) is the primary transit provider in the City of Livermore. Regular transit service is provided in the Tri-Valley area, serving the Cities of Dublin, Pleasanton and Livermore. Sixteen fixed routes are providing connecting primary activity centers, including the both BART stations in the Tri-Valley. Additional routes serving various schools are also provided. In 2009, service was cut approximately 25 percent. One Bus Rapid Transit (BRT) route was implemented in 2011. There are no plans to expand the number of BRT routes or the level of service on the existing route, and the primary goal of LAVTA over the next few years is to restore service cuts.

For this assessment, it was assumed that by 2020, service would be restored to the same per capita level that was provided in 2005 and that the recently implemented BRT route would continue to operate increasing ridership levels per capita above the 2005 levels. This would result in a potential daily VMT reduction of 4,072 above the BAU case.

On Road-4: This measure would reduce emissions by reducing vehicle stops and delays along corridors through signal timing coordination improvements. Specific corridors where this measure could be implemented have not been identified, so the VMT that this measure could apply to was not calculated.

On-Road 5 and 6: Cycling is a non-emission forming mode of transportation that has a high potential for success in Livermore. By completing the bikeway network identified in the General Plan, existing gaps in the network can be filled. Beyond this, providing facilities for bicycle commuters – such as showers and bicycle lockers – can encourage them to use this mode for short and medium-length trips. The City of Livermore had approximately 60 miles of Class I and Class II facilities in 2003 and expects to add approximately 18.5 more miles of off-street and on-street facilities, including facilities constructed between 2003 and 2011, closing gaps in the network and connecting new development areas to the existing system by 2020. This measure is expected to decrease daily VMT by approximately 7,736 miles.

On Road-9: This measure would encourage the use of fringe benefits to reduce commute trips, including telecommuting, alternative work schedules, guaranteed ride home programs, and free or low-cost transit passes. As this measure is not required of existing or new employers, a reduction was not included in the CAP calculations. However, a separate calculation was conducted to determine the benefit for each 1 percent of commute trips that switched to a non-single occupant vehicle mode of travel and is discussed in detail in the Voluntary Measures section below.

On Road-10: This measure would promote the provision of alternative fuel infrastructure, which would not reduce VMT. This is a supporting component of Measures State-6 through State-9 and additional reductions could double count potential emission reductions.

On Road-11: Car Sharing was assumed to be implemented at both ACE stations on a limited basis and is expected to result in a net-decrease of 402 daily VMT.

On Road-14 and 16: This measure supports actions to be taken by others, such as development and implementation of congestion road pricing for the I-580 High Occupancy Toll Lanes and ramp metering. The ultimate timing and implementation of these measures is not under the control of the City. Therefore, no VMT reduction was calculated for this measure.

On Road-17: This measure related to municipal air travel off-sets, which do not reduce VMT. Therefore, no VMT reduction was calculated for this measure.

On Road-18: This measure is related to the City's vehicle fleet and is a supporting component of Measures State-6 through State-9. This measure is not expected to decrease VMT.

VOLUNTARY MEASURES

Safe Routes to School

Since the 1960s, the percentage of school-aged children walking or bicycling to school has decreased from 42 percent to 16 percent. Reasons for this drop have included an increase in distance to schools, traffic-related safety concerns, concerns about crime, and conflicting school policies. As a reaction to this increased automotive usage, cities began developing Safe Routes to School Programs to encourage the use of other travel modes for students. Both the State and Federal Government provide funding for Sate Routes to Schools. Individual projects can include the enhancement of pedestrian crossings, encouragement activities such as a walking school bus, and educational programs including teaching students bicycle safety.

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There is one empirical study conducted by Marin County which estimated travel mode shifts related to the implementation of a Safe Routes to School program. This study (*Safe Routes to School Program Evaluation*, August 2004) determined that the implementation of this program reduced single-occupant automobile usage by 13 percent at schools based on surveys. Based on this result, we have conservatively estimated a VMT reduction of 10 percent as applied to school trips. However, this program has a very limited application as the percentage of overall trips and VMT is approximately 6 percent. Therefore, the anticipated reduction in overall Citywide daily VMT is 12,215 for each 10 percent of students that convert to walking, biking or taking transit to school.

Trans 8 – Additional Safe Routes to School and other travel demand management (TDM)

Modifications to travel behavior that the average citizen can undertake could result in large VMT reductions. Changes to daily commute routines, such as, working from home one day a month, working a compressed schedule, and/or using an alternative mode of transportation, such as biking, transit or carpooling, to work one day at month could result in significant reductions should a large enough proportion of the population alter their travel behavior.

This calculation considers the VMT reduction that could occur from each one percent participation in voluntary TDM for Livermore residents employed in Livermore or elsewhere, and people employed in Livermore that reside outside the City. The estimated VMT reduction for each one percent participation is estimated to be 11,197.

MEMORANDUM

Date: Friday, May 25, 2010

To: Rich Walter, ICF

From: Mark Feldman and Tien-Tien Chan, Fehr & Peers

Subject: Livermore Climate Action Plan Transportation Baseline and Future Year VMT Estimates

WC10-2707

This technical memo documents the base year and future business as usual VMT estimated by Fehr & Peers as part of the City of Livermore Climate Action Plan. The Alameda County CMA Travel Demand Model ("ACCMA Model"), modified to reflect the City Staff's land use projections and network characteristics, was used to develop the VMT estimates. This memo consists of the following sections:

1. Data Collection
2. Modifications Made to the ACCMA Model
3. Base Year (2005) VMT Estimates
4. Base Year Comparison to ICLEI Report
5. 2020 Business As Usual VMT Estimates
6. Sensitivity Tests

This memo updates and replaces the memo dated April 26, 2010 to include the results of two additional sensitivity tests.

Data Collection

Fehr & Peers collected Travel Analysis Zone (TAZ) data for years 2005 and 2020 from City of Livermore Staff. The following data was collected for the TAZs located within the City Limits in the ACCMA model:

- Single Family Households
- Multi-Family Households
- Total Households
- Residential Developed Acres (2005 only)
- Non-Residential Developed Acres (2005 only)
- Retail Jobs
- Service Jobs
- Manufacturing Jobs

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- Agricultural Jobs
- Wholesale Jobs
- Other Jobs
- Total Jobs

The City of Livermore adhered to the following instructions as documented in our data requests memo (2/8/10):

- Residential Developed Acres included all parcels developed with residential uses
  - Parking lots and structures for residential buildings are included
  - Vacant lots are not included
- The Non-Residential Acres field included all parcels developed with non-residential uses
  - Parking lots and structures for non-residential buildings are included
  - Vacant lots are not included

We conducted a check on the data provided, verifying that land use totals within each category and the growth between the two model years were reasonable.

Modifications Made to the ACCMA Model

<u>Land Use</u>

For the Livermore TAZs (#1992-1375), Fehr & Peers replaced the model data as received with the data provided by the City of Livermore. The following variables were also updated based on the data provided by the City of Livermore:

- Household population
- Employed residents
- Household Income Quartile Splits
- Populations within specific age ranges

These variables were calculated using proportions from the ACCMA model as originally received, and applying them to the number of total households within each TAZ provided by the City.

Since 2020 data for residential and non-residential acres were not provided, these were calculated separately by the following methods:

- Residential acres were estimated by a percentage change based on percentage change of total households from 2005 to 2020
- Nonresidential acres were estimated by a percentage change based on percentage change of total jobs from 2005 to 2020

For TAZs outside of Livermore, the 2005 ACCMA model year data was used for our Year 2005 scenarios. The ACCMA model does not have year 2020 data, so it was agreed that for our Year 2020 scenarios, interpolation between years 2015 and 2035 was sufficient for this analysis.

<u>Network</u>

The ACCMA model networks were modified based on instructions provided by the Engineering Division at the City of Livermore. The following changes were made to each network:

<u>2005 Roadway Network</u>

1. Removed the ability to make through movements from Vasco Road to Greenville Road by using East Avenue Lawrence Livermore and Sandia National Laboratories.
2. Connected Las Positas Road, between First Street and Vasco Road, two lanes in the WB direction, one lane in the EB direction.
3. Reduced Constitution Drive to one lane in each direction
    a. Reduced Collier Canyon Road/Heritage Drive to one lane east of Constitution Drive and west of Collier Canyon Road
    b. Reduced Collier Canyon Road to one lane south of N. Canyon Pkwy and north of Heritage Court
4. Increased Holmes Street north of Wetmore Road to 2 lanes in the NB direction only
5. Increased Las Positas Road between Las Colinas Road and Livermore Avenue to two lanes in the WB direction
6. Made Railroad Avenue a four lane road along the entire length

<u>2020 Roadway Network (For Livermore, started with 2035 network and made the following updates. Outside of Livermore the 2015 Network is being used):</u>

1. Reduced P Street between Pine Street and Chestnut Street to one lane in each direction
2. Reconfigured Kitty Hawk Road to connect to Isabel Avenue (right in, right out) between Airway Boulevard and the future Isabel / I-580 Interchange
3. Removed the ability to make through movements from Vasco Road to Greenville Road by using East Avenue Lawrence Livermore and Sandia National Laboratories.
4. Made Isabel Avenue a 4 lane facility
5. Made Stanley Boulevard a 4 lane facility
6. Reduced Holmes Street to one lane in the southbound direction between Alden Lane and Wetmore Road
7. Made Vasco Road lanes as follows: Two lanes from Tesla Road to East Ave, four lanes from East Avenue to six lanes from Las Positas Road to Northfront Road, four lanes from Northfront Road to Dalton Avenue, two lanes north of Dalton Avenue.
8. Maintained improvements to Vasco interchange and Isabel interchange “phase 1”, but reverted Greenville and First Street interchanges to current configuration.
9. Implemented an eastbound truck climbing lane on I-580 over the Altamont pass from just west of Greenville Road to I-205.

Base Year (2005) VMT Estimates

After making the above modifications for 2005, Fehr & Peers conducted a model run to calculate base year daily VMT by speed bin and VHT/VHD estimates. Using select link analysis, three types of vehicle trips were tracked separately:

1. Vehicle trips that remained internal to Livermore.
2. Vehicle trips with one end in Livermore and one end outside of Livermore (IX/XI trips).
3. Vehicle trips with neither end in Livermore (XX trips).

Using the set of “accounting rules” recommended for VMT inventories in Climate Action Plans by the Bay Area Regional Transportation Advisory Committee (RTAC), VMT from trips of type 1, 2 and 3 were counted 100%, 50%, and 0% respectively towards Livermore-generated VMT. Table 1 shows the 2005 Livermore Baseline VMT estimates by speed bin. Table 2 shows the estimated daily vehicle hours traveled (VHT) and vehicle hours of delay (VHD) using the same accounting rules.

TABLE 1
BASE YEAR DAILY VMT BY SPEED BIN

Speed Bin		VMT		
From	**To**	**Internal (counted 100%)**	**IX/XI (counted 50%)**	**Total**
0	5	0	596	596
5	10	1,552	1,471	3,023
10	15	1,792	1,660	3,452
15	20	2,238	25,061	27,299
20	25	2,165	17,471	19,636
25	30	40,046	55,755	95,801
30	35	82,868	99,306	182,174
35	40	105,057	152,496	257,553
40	45	0	110,885	110,885
45	50	4,720	134,276	138,996
50	55	50	146,052	146,102
55	60	7,837	378,660	386,497
60	65	22,782	247,373	270,155
Total		271,107	1,371,062	**1,642,169**

Source: Fehr & Peers, 2010.

TABLE 2
BASE YEAR DAILY VHT AND VHD

	Vehicle Hours Traveled (VHT)	**Vehicle Hours Delayed (VHD)**
Internal (counted 100%)	7,473	278
IX/XI (counted 50%)	30,043	4,138
Total	**37,516**	**4,416**

Fehr & Peers, 2010

Base Year Comparison to ICLEI Report

The above VMT estimate of approximately 1.64 million per day was compared to the estimate from the *City of Livermore Greenhouse Gas Emissions Analysis*, published by ICLEI in 2008. The ICLEI annual estimate of 782 million VMT was divided by 365 to obtain a daily VMT of approximately 2.14 million, about 30% higher than the ACCMA model.

However, the methodology behind the ICLEI estimate differs from the estimate in Table 1 significantly. The ICLEI estimate relied primarily on Caltrans HPMS data, which is tied to traffic

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counts. In other words, the 2.14 million VMT represents VMT on roadways within the City of Livermore, regardless of the trip origin and/or destination. The differences between this estimate and the 1.64 million estimate from the ACCMA model reflect the following:

1. The ICLEI VMT includes trips which neither start or end in Livermore (XX trips). Whereas the ACCMA model VMT does not include these trips
2. The ICLEI VMT includes only the portion of IX/XI trips which occurs on roadways in Livermore, whereas the ACCMA model VMT includes 50% of the *entire* trip lengths from those trips.

As an additional step, we checked the VMT from the model using the ICLEI method, including all VMT on Livermore roads, regardless of trip origin or destination. The VMT estimate from that analysis was 2.27 million, less than 6% different from the ICLEI estimate made on that basis. This helps confirm that the 1.64 million VMT estimate from the model using the RTAC-recommended method differs from the ICLEI estimate due primarily to the differences between the estimation methods, and that the ACCMA model is a reasonable tool for the analysis, producing similar numbers to previously-established tools.

2020 Business As Usual (BAU) VMT Estimates

Using the modifications discussed for Year 2020, Fehr & Peers ran the resulting ACCMA model and obtained a Year 2020 BAU VMT estimate, representing the future VMT without any specific greenhouse gas-reduction measures. Tables 3 and 4 show the results of this run:

TABLE 3
2020 BUSINESS AS USUAL DAILY VMT BY SPEED BIN

Speed Bin		VMT		
From	**To**	**Internal (counted 100%)**	**IX/XI (counted 50%)**	**Total**
0	5	0	2,151	2,151
5	10	0	667	667
10	15	683	17,613	18,296
15	20	2,724	20,315	23,039
20	25	517	18,120	18,637
25	30	46,278	66,468	112,746
30	35	108,594	151,104	259,698
35	40	139,443	225,588	365,031
40	45	0	178,608	178,608
45	50	9,877	253,397	263,274
50	55	11,283	247,027	258,310
55	60	18,094	302,905	320,999
60	65	9,768	204,594	214,280
Total		347,261	1,688,557	**2,035,818**
% Increase from Base Year		28%	23%	**24%**

Source: Fehr & Peers, 2010.

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TABLE 4
2020 BUSINESS AS USUAL DAILY VHT AND VHD

	Vehicle Hours Traveled (VHT)	Vehicle Hours Delayed (VHD)
Internal (counted 100%)	9,291	186
IX/XI (counted 50%)	39,400	7,221
Total	**48,691**	**7,407**
% Increase from Base Year	**30%**	**68%**

Fehr & Peers, 2010

Tables 3 and 4 show that in the absence of any greenhouse gas reduction strategies, VMT for the City of Livermore would increase by 24% from 2005 to 2020, VHT would increase by 30%, and VHD would increase by 68%. Although the VMT per (person + job) would decrease slightly, from 13.1 to 13.0, the slight decrease for each resident or employee in Livermore is not enough to offset the VMT increase as a result of the projected growth in the CIty.

Sensitivity Tests

Fehr & Peers conducted several sensitivity tests on the 2005 base year ACCMA model. Five tests were conducted to determine the model's sensitivity to various potential greenhouse gas reduction strategies. This testing provides insight into which emission reduction strategies may be addressed through the travel model and which would need to be addressed through other methods.

The tests can be described as follows:

1. Increased residential development to Year 2020 levels, as provided by the City of Livermore, but kept non-residential uses at 2005 levels.
2. Increased levels of development in Dublin and Pleasanton by 20%
3. Increased the level of retail development in Livermore 100%, to provided a more optimal balances between retail and other non-residential uses
4. Extended the Dublin / Pleasanton BART line to a new station at the northwest corner of Isabel Avenue and Stanley Boulevard in Livermore. Added residential TOD with 3000 apartment dwelling units adjacent to the BART station, and scaled the residential uses down throughout the rest of Livermore to maintain the citywide dwelling unit total.
5. Started with sensitivity test 4, doubled the frequencies of all WHEELS buses that serve the City of Livermore.

Results from the tests are presented in Table 5. We report both numerical VMT and VMT generated by the residential and non-residential sectors separately, on a per person and a per job basis respectively. Note that non-home-based trips are not possible to separate between those generated by Livermore residents and otherwise, so those are reported separately as well on a per (person + job) basis. Total VMT is also reported on a per (person + job) basis.

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TABLE 5
2005 ACCMA MODEL SENSITIVITY TESTS

Sensitivity Test	Base Run	Test #1	Test #2	Test #3	Test #4	Test #5
Description	No change	Households increased to 2020 level	Density increased 20% in Dublin and Pleasanton	Doubled retail jobs	Extension of BART + TOD	Extension of BART + TOD + Bus Frequencies
Total Livermore VMT	1,642,171	1,833,330	1,641,488	1,839,896	1,629,070	1,623,862
Total Livermore VMT per (person + job)	13.1	12.9	13.1	13.9	13.0	13.0
Residential VMT per person	9.0	9.2	9.0	8.2	8.6	8.6
Commercial VMT per job	8.4	8.2	8.5	10.1	8.7	8.6
Non-Home-Based VMT per (person + job)	4.3	4.0	4.3	4.9	4.4	4.3

Fehr & Peers, 2010.

Table 5 suggests that only modest VMT reductions, if any, can be obtained through increased levels of density, land use balancing, and even significant transit improvements. As greenhouse gas reduction strategies are discussed for the year 2020, it will therefore be important to propose strategies above and beyond the types analyzed in the sensitivities above, such as employee-based housing, larger scale TOD, demand management programs, and other measures that can shift travel modes away from private vehicles.

Fehr & Peers has developed off-model methods for predicting BART Ridership. If a BART extension is included in the GHG-reduction strategies, these methods will be tested to see if they suggest that the ACCMA model is understating the VMT benefits of a BART extension to Livermore.

Appendix D
References

Appendix D
References

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