City of
SACRAMENTO

Climate Action Plan for Internal Operations

2016 Update

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Adopted by the Sacramento City Council on June 14, 2016

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TABLE OF CONTENTS

Figures

Tables

ABBREVIATIONS

Abbreviation	Term
BAU	business-as-usual
CACP	Clean Air and Climate Protection Software
CAP	climate action plan
CEC	California Energy Commission
CO_2e	carbon dioxide equivalent
CPUC	California Public Utilities Commission
DOU	Department of Utilities
DPR	Department of Parks and Recreation
DPW	Department of Public Works
EECBG	Energy Efficiency and Conservation Block Grant
EO	Executive Order
EPA	Environmental Protection Agency
EV	electric vehicle
g	gram
GHG	greenhouse gas emissions
GPCD	gallons per capita per day
GW	gigawatt
GWh	gigawatt hours
GWP	global warming potential
HVAC	Heating, ventilation, and air conditioning
ICLEI	International Council for Local Environmental Initiatives
IO	internal operations
IO CAP	Climate Action Plan for Internal Operations
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
kW	kilowatt
kWh	kilowatt hour

Abbreviation	Term
lb	pound
LED	light-emitting diode
LEED	Leadership in Energy & Environmental Design
LFG	landfill gas
LGOP	Local Government Operations Protocol
CH_4	methane
MG	million gallons
MG	million gallons
MMBTU	million British thermal units
MMSCF	million standard cubic feet
MT	metric ton, or tonne
$MTCO_2e$	metric tons of carbon dioxide equivalent
MW	megawatt
MWh	megawatt hour
N_2O	nitrous oxide
PG&E	Pacific Gas & Electric Company
PV	photovoltaic
RPS	Renewables Portfolio Standard
SB	Senate bill
SMP	Sustainability Master Plan
SMUD	Sacramento Municipal Utility District
VFD	variable frequency drives
WCEF	West Coast Electric Fleets
WCP	Water Conservation Plan

EXECUTIVE SUMMARY

The City of Sacramento (City) has a long-standing commitment to foster sustainability in government operations and community activities. This update to the City of Sacramento Internal Operations Climate Action Plan (IO CAP, 2016 IO CAP Update) demonstrates the City's leadership and implementation of adopted policies. Since adoption of the City's first Sustainability Master Plan in 2007, the City has led by example with internal projects that reduce reliance on fossil fuels while reducing operating costs and greenhouse gas (GHG) emissions. General Plan policies commit the City to continue striving for ongoing reductions in municipal GHG emissions, calling for implementation of this IO CAP to achieve a 22 percent reduction in municipal GHG emissions below 2005 levels by 2020 as identified in General Plan Environmental Resources (ER) Policy 6.1.6. To ensure sustained progress, General Plan policies further commit to regular reviews and updates of the City's GHG emissions inventory at least once every five years. This IO CAP serves as the first update to the City's GHG emissions inventory, consistent with General Plan Environmental Resources (ER) Policy 6.1.6.

The City's internal operations result in GHG emissions from the consumption of energy in buildings and facilities, fuel combustion in vehicle fleet, and decomposing waste in City-operated landfills. Reducing GHG emissions through conservation, efficiency, and technology improvements equip the City to sustain progress and achieve further reductions in operating costs, efficiencies in maintenance, and improvements in air and water quality.

In 2010, the City completed its first IO CAP with strategies to reduce GHG emissions in City operations 22 percent below 2005 levels by 2020. In 2012, the City subsequently adopted its first community-wide Climate Action Plan (CAP), which included a target and strategies to achieve a 15 percent reduction below 2005 levels by 2020 for all sources of GHG emissions within the community as a whole.

More recently, in March 2015, the City adopted the 2035 General Plan Update, which included new sustainability targets and an updated community-wide CAP integrated with the General Plan. These new targets include reducing GHG emissions from internal operations by 22 percent below 2005 levels by 2020 (consistent with the 2010 IO CAP target), along with a long-term objective of achieving GHG reductions of 83 percent below 2005 levels by 2050. Reduction targets are established in General Plan Policy ER 6.1.6, which also calls for maintenance and implementation of this IO CAP.

This 2016 IO CAP Update reviews the City's progress toward meeting the adopted 2020 target for internal operations by benchmarking municipal emissions in 2013, reviewing the status of actions recommended in the 2010 IO CAP, and analyzing additional actions necessary to meet the City's long-term, post-2020 targets. The result is a path to achieve a 33 percent reduction in GHG emissions below 2005 levels by 2020 that builds upon the progress achieved to date, while allowing the City to align with long-term 2050 GHG reduction goals. The City will monitor and evaluate attainment of both the adopted General Plan target and the more aggressive reduction opportunities identified in this IO CAP.

UPDATES TO GHG EMISSION INVENTORY AND REDUCTION TARGETS

By 2013, the City exceeded its original 2020 emissions reduction target for internal operations seven years in advance of the 2020 target date. Total annual GHG emissions from internal operations were benchmarked for the year 2005 in a countywide GHG inventory at 78,584 metric tons of carbon dioxide equivalents ($MTCO_2e$) and again in 2013 at 59,755 $MTCO_2e$. Between 2005 and 2013, annual emissions fell by 24 percent, exceeding the original 15 percent reduction target. These reductions also exceed the targets adopted in the 2015 General Plan Update.

Most of the reductions realized during this time were in the vehicle fleet sector, but the City also achieved significant reductions in facility and streetlight/signal energy use. While some of these reductions can be explained by implementation of actions included in the 2010 IO CAP, changes in electricity emission factors and seasonal or annual variability, such as energy required for stormwater drainage, may have influenced the reduction. In 2013, approximately 45 percent of total emissions were from electricity and natural gas usage in the City's buildings and facilities, 23 percent were from fuel used in the City's vehicle fleet, 23 percent were from waste-in-place at a City-owned landfill, and 8 percent were from electricity usage in the City's streetlights & signals. Off-road vehicle and equipment emissions were not included in the 2005 inventory and excluded from the 2013 inventory for comparability, but would add another 1 percent to annual emissions in 2013.

With the new 2050 GHG emissions reductions target for internal operations included in the City's 2035 General Plan Update, this IO CAP Update provides a path for municipal emissions to achieve a 33 percent reduction from 2005 levels by 2020. This near-term 2020 reduction potential could encourage the City to continue innovation and implementation on a new trajectory towards the General Plan goal of achieving 83 percent below 2005 levels by 2050. To attain a 33 percent reduction, the City would need to reduce annual emissions to 52,651 $MTCO_2e$ in 2020, a 12 percent reduction from 2013 levels.

Achieving these GHG reductions by 2020 involves more than just reducing emissions from existing City operations. City services are likely to grow in line with the City's population. Based on the level of reductions achieved through 2013 and input from various City departments, the City estimates that, under a business-as-usual (BAU) scenario, City operations would generate 58,448 $MTCO_2e$ per year in 2020. The BAU forecast assumes no additional action beyond those implemented to date. The BAU scenario also takes into account changes in future electricity emission factors from local utilities, pursuant to the statewide Renewable Portfolio Standard (RPS) goals. Accordingly, the City would need to reduce future emissions by a total of 5,796 $MTCO_2e$ from the 2020 BAU scenario, equivalent to a 12 percent reduction below 2013 levels.

UPDATED ACTION STRATEGIES

Strategies for reducing GHG emissions from the City's internal operations were identified for each sector in the GHG emissions inventory. Many action strategies presented in the 2010 IO CAP have been completed through the benchmark year (2013) and are assumed to continue through the year 2020. New and revised past action strategies are presented in this 2016 IO CAP Update and are estimated to have potential to reduce emissions to 52,590 $MTCO_2e$, or 33 percent below 2005 levels by 2020, even with growth in services due to increases in population.

The local electric utility also plays an important role in reducing emissions from the City's purchased electricity. The Sacramento Municipal Utility District (SMUD) has committed to improving its renewable energy portfolio over time, consistent with the statewide RPS of 33 percent renewable energy sources by 2020. In 2013, SMUD achieved a 30 percent renewable portfolio and anticipates meeting the RPS goal of 33 percent by 2020 (SMUD 2015). These reduced emissions factors are taken into account in estimates of future emissions for both the BAU and CAP action scenarios.

This IO CAP identifies a total of 11 specific action strategies in four major sectors of the City's operations. In total, action strategies are identified to reduce 2020 BAU emissions by 5,821 $MTCO_2e$. These new action strategies would achieve GHG reductions beyond any actions taken before 2013. An additional action in the urban forestry sector was also identified, but not included in the total reductions because a benchmark for this sector was not established in previous years. The anticipated reductions from each sector are summarized in the following list.

- **Building Energy:** Significant reductions can be achieved by implementing additional energy efficiency and conservation measures in the City's existing buildings and planned expansions anticipated by 2020. 957 $MTCO_2e$ in emissions reductions from the 2020 BAU scenario are identified, equivalent to reducing 1,290 $MTCO_2e$ from 2013 levels. Key building energy strategies include:
  - Green Building Policy for New City Buildings
  - Energy Efficiency Retrofits
    - Convention Center Lighting Retrofit
    - Swimming Pool VFDs
    - Hart Senior Center HVAC Replacement
    - Panatoni HVAC replacement
    - Kinney Police Station LED retrofit
    - Miscellaneous Facility Retrofits
- **Water Management:** Continued improvements in water management efficiencies and reductions in community-wide water demands are estimated to reduce 1,641 $MTCO_2e$ in emissions from the 2020 BAU scenario, equivalent to reducing 2,840 $MTCO_2e$ from 2013 levels. Key water management strategies include:
  - Pumping efficiency & system optimization
  - Low-Maintenance Landscaping
  - Watering Reductions in City Parks
  - Long-term Water Saving Strategies and Drought-Response
- **Streetlights and Signals:** Continuing a long-standing commitment to improve energy efficiency in the City's traffic signal systems, the strategies in the action plan result in about 1,655 $MTCO_2e$ in GHG reductions from the 2020 BAU scenario, a reduction of 1,338 $MTCO_2e$ below 2013 levels for this sector. The two key strategies include:
  - LED technology used at all new traffic signals installations
  - Convert remaining streetlights to LED and use LED technology at all new streetlight installations.
- **Vehicle Fleet and Fuels:** Building upon the City's Sustainable Fleet policies already in effect, continued improvements in fleet vehicle efficiency and alternative fuels are identified for this sector, reducing GHG emissions by 7,120 $MTCO_2e$ from the 2020 BAU scenario, a reduction of 5,872 $MTCO_2e$ from 2013 emissions in this sector. Key strategies include:
  - Fleet Efficiency and Electric Fleet Pledge
  - Alternative Fuels: Renewable natural gas purchase contracts and replacement of diesel solid waste vehicles
- **Urban Forestry:** Growing the City's urban forest has a positive effect on the local and global community by sequestering carbon and also providing shade for buildings. The estimated net growth in the City's urban forest as a result of City action is anticipated to reduce GHG emissions by 422 $MTCO_2e$.

PAST ACTIONS AND ACCOMPLISHMENTS

In the 2010 IO CAP, the City committed to reduce emissions from internal operations by 15 percent from 2005 levels by 2020. Yet as of 2013, the City already achieved a 24 percent reduction from 2005 levels, a reduction of 19,486 $MTCO_2e$ based on a recent inventory update (see Appendix B). As detailed further in the following sections of this IO CAP, the majority of these reductions reflect reductions in City facility energy use, vehicle fleet fuel use, and energy use in streetlights and traffic signals. Key actions that have contributed to reductions to date include:

- Solar photovoltaic (PV) installations on City facilities
- Energy efficiency retrofits in City facilities
- Conversion of streetlights and traffic signals to LED technology
- Implementation of vehicle fleet telemetrics (100 percent implemented in 2013)
- Containerization of green waste
- Shift to a 4/10 schedule for solid waste and recycling programs

These actions and programs are assumed to continue and sustain their emissions savings into the future. Additional information is available in Appendix B and the 2010 IO CAP on these past and continuing actions. Although not included as a key action, another significant factor in the City's early achievement of the 2010 IO CAP goal for 2020 may be due to a reduction in the size and scale of City services and operations during the economic recession spanning the years 2008-2012. The reductions from these actions and external influences are benchmarked in the City's emissions inventory in 2013.

CHAPTER 1: INTRODUCTION

1.1 VISION

The City of Sacramento (City) has a long-standing commitment to foster sustainability in government operations and community activities. The City first completed a Sustainability Master Plan (SMP) in 2007 that provided the initial impetus for the City to “lead by example” in its own operations. Strategies in the SMP addressed improving energy and fuel efficiency, reducing waste, and implementing other strategies to reduce demands on natural resources and maintain and enhance quality of life. Part of this original vision was to improve the sustainability of Sacramento’s local government operations by achieving significant greenhouse gas (GHG) emissions reductions and contributing towards meeting California’s statewide climate change goals.

Reductions of GHG emissions can be accomplished with conservation of energy or fuel, efficiency in operations, or lower-carbon forms of fuel and energy. Strategies for the vehicle fleet can include reductions in vehicle miles traveled (VMT) and switching to lower-carbon forms of fuel such as electricity or compressed natural gas (CNG). Other strategies may include efficiency and conservation of both water and energy in existing buildings and facilities, increasing the use of renewable resources for electricity generation, and reducing solid waste generation. These strategies serve to reduce long-term internal operating costs while mitigating the City’s contribution to global climate change.

1.2 PURPOSE, SCOPE, AND CONTENT OF CAP

The City of Sacramento’s Climate Action Plan for Internal Operations (IO CAP) addresses the City’s progress and plan for achieving both local and State sustainability goals through local government operations. First prepared in 2010 and updated in 2015, the purpose of this IO CAP is to implement policies in the General Plan Environmental Resources (ER) Element. Specifically, this IO CAP implements Policy ER 6.1.6 with an update to the City’s GHG emissions inventory and demonstration of the City’s commitment to reduce municipal GHG emissions. This IO CAP also implements Policy ER 6.1.8, with evaluation of the feasibility and effectiveness of new programs to reduce GHG emissions. This IO CAP Update includes analysis of GHG reduction targets, updates to calculation methods, and new actions to meet the revised targets.

This IO CAP demonstrates implementation of General Plan with the following key sections:

- **Chapter 1: Introduction.** Summarizes local and state regulatory context, recent policy changes, and information on climate change effects.
- **Chapter 2: GHG Emissions Inventory.** Presents the original 2005 baseline inventory for municipal operations and a new benchmark GHG inventory for municipal operations in 2013.
- **Chapter 3: GHG Reduction Targets and Forecast.** Provides an analysis of GHG emissions forecasts and reduction targets for municipal operations.
- **Chapter 4: GHG Reduction Strategies.** Summarizes progress since adoption of the 2010 IO CAP and analyzes both existing and new strategies for municipal operations.
- **Chapter 5: References.** Identifies key sources of information.
- **Chapter 6: Appendices.** Includes additional documentation and methods for calculations in the 2016 IO CAP update.

1.3 BACKGROUND

The City adopted the first version of the IO CAP in 2010, executing Phase 1 of the City's overall climate action planning program that began under the City's 2030 General Plan. The City's Phase 2 CAP, adopted in 2012, also addressed GHG reductions from community-wide sources as well as the need for adaptation and community resilience to the effects of climate change. This update to the 2010 IO CAP incorporates policy updates related to GHG reduction targets, adjusts emissions forecasts based on current trajectories, and proposes new actions to meet the revised targets.

The 2010 IO CAP examined the City's internal operations and identified strategies to reduce GHG emissions in a cost effective manner for municipal buildings; vehicle fleet; streetlights and signals; parks maintenance; water, sewer, and drainage pumping; and other facilities and operations that are within the City's immediate control. This effort aimed to reduce emissions 15 percent below 2005 levels by 2020 and 83 percent below 2005 levels by 2050. These local targets would be equivalent to reducing emissions to 1990 levels by 2020 and 80 percent below 1990 levels by 2050, consistent with the statewide Assembly Bill (AB) 32 (Global Warming Solutions Act of 2006) and Executive Order (EO) S-03-05 targets, as further described below.

The City of Sacramento 2035 General Plan Update, adopted in March 2015, incorporates key policies and programs from the City's 2012 Phase 2 CAP for community-wide activities. Although originally adopted in 2012 as Phase 2 of the City's climate action efforts, the City now implements the CAP through the 2035 General Plan. With this integrated approach, 2035 General Plan policies now identify strategies and targets to reduce GHG emissions from the community and internal operations.

1.4 CO-BENEFITS

Action strategies in the IO CAP reduce GHG emissions while also yielding a number of "co-benefits." These co-benefits can be primary motivators for implementation. Not only do strategies provide environmental benefit, but they also yield important cost-savings and maintenance benefits. Some examples include:

- Energy efficiency and conservation strategies in City buildings and facilities allow the City to serve as better fiscal stewards, reducing the costs of operations. Lowering utility bills frees up City funds for other important maintenance and improvement needs.

- Energy-efficient technologies such as LED lighting have a longer useful life with fewer maintenance needs, reducing ongoing City costs and staff time for replacements and maintenance.

- Energy efficiency and conservation strategies in City buildings and facilities assist in adaptation to longer-term effects of climate change, which could include increased and extended peak demand periods because of hotter average summer temperatures and more severe heat waves.

- Expanding renewable energy generation at City facilities can reduce energy costs over the life of a project while diversifying the City's energy portfolio and improving the reliability of the City's energy supply.

- Switching to cleaner fuels and achieving fuel reductions through reduced idling and vehicle miles traveled will help to improve the region's air quality and improve public health, and also improve the City's resiliency in the event of disruptions in fuel supply or significant fluctuations in fuel prices.

- Conserving water and switching to lower-maintenance landscaping will assist in adapting to the longer-term effects of climate change, which could include more severe and extended periods of drought because of reduced snow-pack in the Sierra Nevada and reduced precipitation levels in the Sacramento Valley.

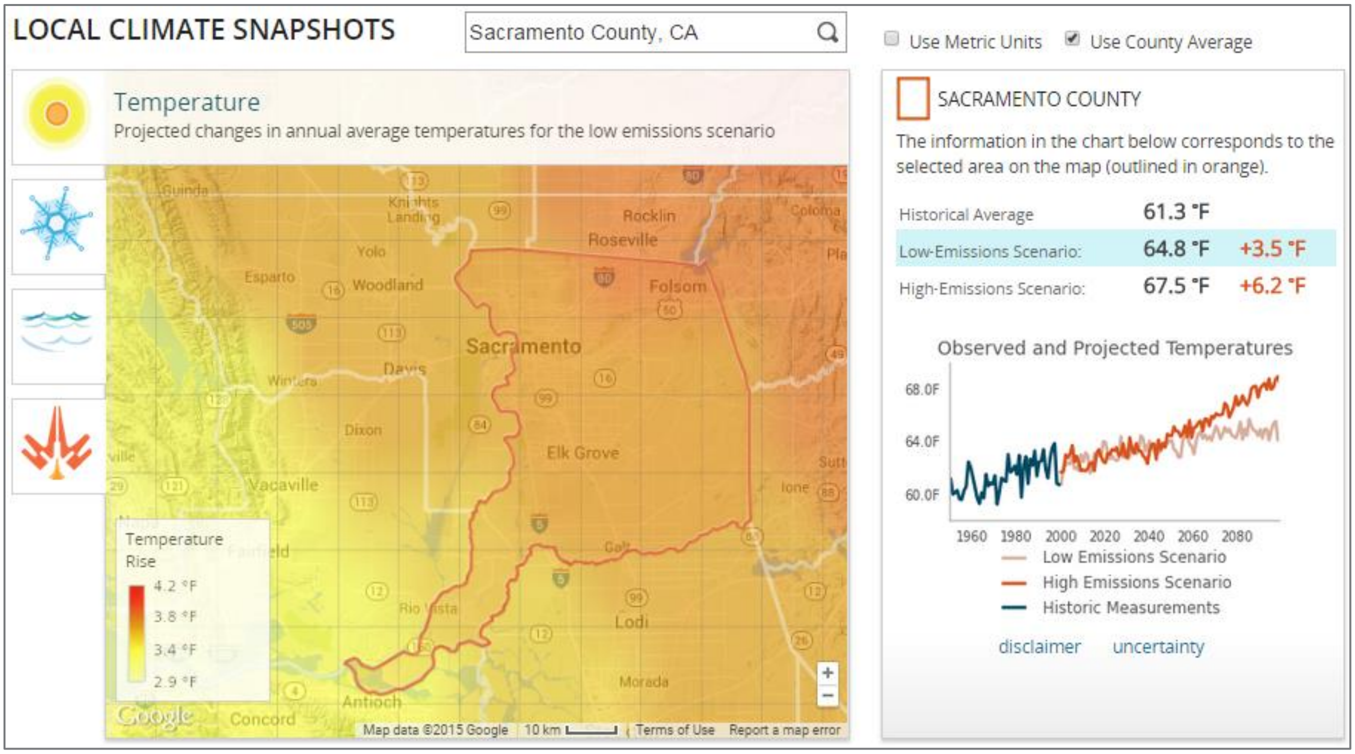
- Planting additional trees and expanding the urban forest will serve to enhance the City's existing reputation as a "tree city" and help in adapting to potentially hotter average summer temperature and extended heat waves in the future.

1.4.1 Global Climate Change in Sacramento

Global climate change is a complex issue of growing importance that could have substantial environmental, economic, and social consequences if no action is taken. Numerous studies have shown a strong correlation between increased concentration of GHGs and increasing average global temperatures. Warming average global temperatures could result in a variety of environmental effects locally and globally. Potential risks for the Sacramento region could include:

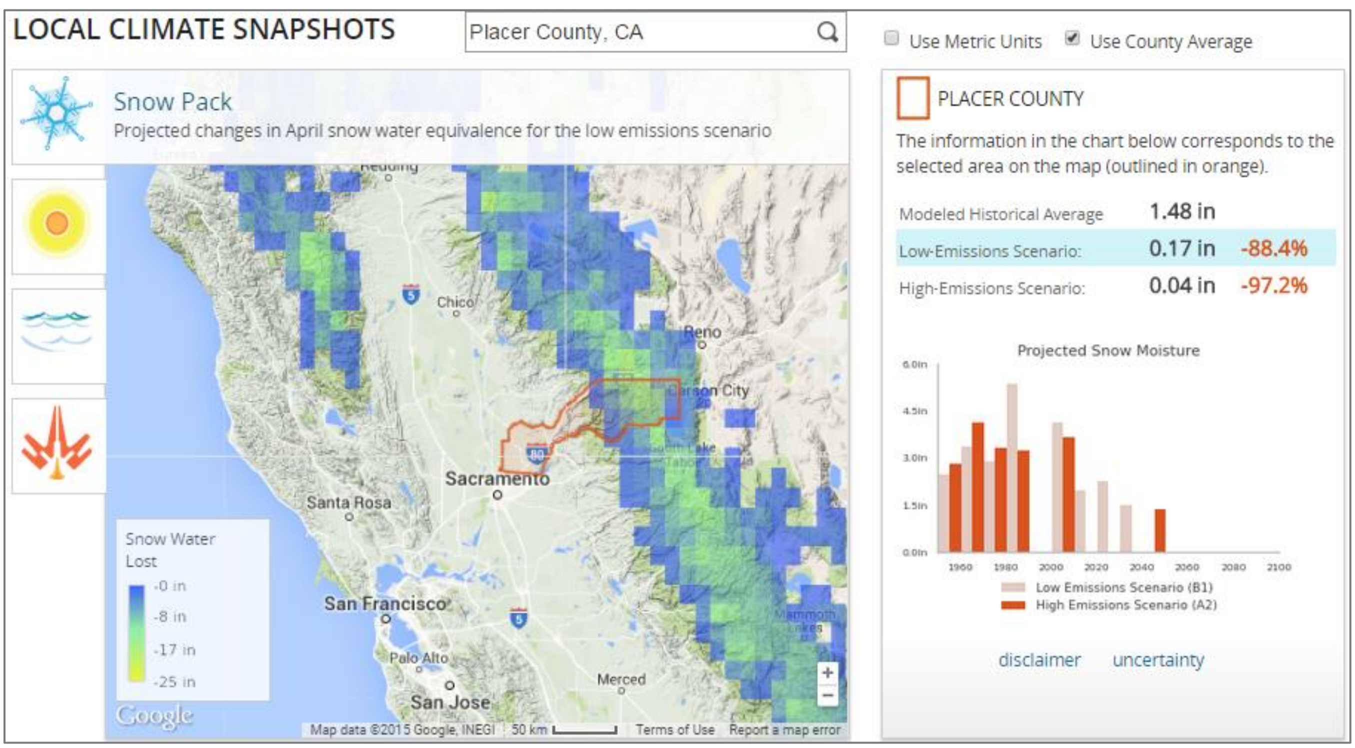
- More frequent and intense heat waves, and hotter summer temperatures (see Figure 1 below);
- More frequent and persistent droughts;
- Decreasing snow pack in the Sierra Nevada mountains and associated risks to statewide water supplies (see Figure 2 below);
- Significant increases in sustained peak electrical power demand and greater stress placed on local utilities and emergency responders;
- Changing and unpredictable flooding patterns because of less winter snow pack and more runoff in rivers and streams during the wet season; and
- Higher sea levels and associated changes in the Sacramento-San Joaquin Delta region and potential increases in saltwater intrusion in the Sacramento River.

While the level of severity or types of impacts are still not fully understood, there is growing consensus that the impacts will be adverse and impose significant costs to our economy and public services and operations. The State estimates that an extreme weather event could cost $725 billion, with direct property losses of $400 billion and devastating impacts to the economy, natural resources, and livelihoods. If even a fraction of these impacts were to occur in the Sacramento region, lack of preparation could deliver a price tag of over a billion dollars. (OPR 2011, CNRA 2014).



Source: Cal-Adapt 2015

Figure 1 Projected Temperature Increase in Sacramento County (1961-2099)



Source: Cal-Adapt 2015

Figure 2 Projected Decrease in Sierra Nevada Snowpack in Northern California (1961-2099)

1.4.2 Responses to Climate Change

The potential effects of climate change and the magnitude of costs to deal with these changes warrant prompt action. Advance preparation can equip the City to respond in a cost-effective manner, helping to avoid the potential for compounding costs, and position the City for success in light of uncertainty. Taking action to address climate change involves:

- GHG mitigation: Reducing local GHG emissions, which are part of the overall cumulative global carbon footprint contributing to climate change; and
- Adaptation: Preparing for how the City can respond and adapt to changes that are likely already occurring and will likely continue to occur in Sacramento.

The City's Phase 2 community-wide CAP, now integrated within the 2035 General Plan Update, employs both GHG mitigation and adaptation strategies to address climate change at a community-wide scale. This IO CAP Update is focused primarily on GHG mitigation. However, numerous strategies designed for GHG mitigation also provide climate adaptation co-benefits. For example, measures to increase energy and water efficiency and conservation will help to reduce overall energy and water demand during peak periods under warming conditions. Such proactive strategies position the City to prepare for potential curtailment programs as utilities adapt to the effects of a changing climate over time. Utilities may require increased levels of participation in demand management and conservation to address the increased severity and frequency of drought and extreme heat events in the Sacramento region, which could occur as a result of climate change.

1.5 STATE AND LOCAL POLICIES

1.5.1 Assembly Bill 32

In 2006, former Governor Schwarzenegger signed Assembly Bill (AB) 32, also known as the California Global Warming Solutions Act. This landmark legislation established an overall goal to reduce statewide GHG emissions to 1990 levels by 2020 (or an equivalent of 15 percent below 2005 levels by 2002). The year 1990 is also an important baseline year identified by the United Nations Intergovernmental Panel on Climate Change (IPCC). The IPCC identifies 1990 as a benchmark year against which global GHG emissions should be reduced 80 percent by 2050 to stabilize average global temperatures from increasing more than 2 degrees Celsius (°C)[1].

AB 32 identified the California Air Resources Board (ARB) as the lead agency for coordination and implementation of AB 32. The ARB drafted the AB32 Scoping Plan, adopted in December 2008 and updated in May 2014, to identify the key statewide action strategies for achieving AB 32's 2020 and 2050 targets. Local governments were identified in the Scoping Plan as having an important role in helping to achieve the AB 32 target through local land use and building permitting authority, regulation of water and energy use, economic development and job training, and other locally-based activities.

1.5.2 Executive Orders S-3-05 and B-30-15

Governor Arnold Schwarzenegger signed Executive Order (EO) S-3-05 in 2005 to highlight the risk of climate change and commit to attainment of GHG reduction targets. EO S-3-05 asserts that California is vulnerable to the impacts of climate change, noting that increased temperatures could reduce the Sierra Nevada snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To

[1] http://www.ipcc.ch

prepare for these risks, the EO established statewide GHG reduction targets. Specifically, the EO called for statewide emissions to be reduced to 2000 levels by 2010, 1990 levels by 2020, and 80 percent below 1990 levels by 2050.

On April 20, 2015, Governor Edmund G. Brown Jr. signed EO B-30-15 to establish a statewide GHG reduction target of 40 percent below 1990 levels by 2030. The Governor's EO aligns California's GHG reduction targets with those of leading international governments such as the 28-nation European Union, which adopted the same target in October 2014. California is on track to meet or exceed the current target of reducing GHG emissions to 1990 levels by 2020, as established in AB 32. According to EO B-30-15, attaining California's new emission reduction target of 40 percent below 1990 levels by 2030 will set California on a trajectory to reach the ultimate goal of reducing emissions 80 percent below 1990 levels by 2050. As summarized in EO B-30-15, this target is consistent with the scientifically-established level that is necessary to limit global warming below 2°C, the threshold the IPCC has identified as the tipping point for major, catastrophic climate change impacts.

1.5.3 California Renewable Energy Portfolio Standard (Senate Bill X1-2)

In 2011, Governor Brown signed Senate Bill (SB) X1-2, which requires retail sellers of electricity to provide at least 33 percent of their electricity supply (portfolio) from renewable sources by 2020. This requirement applies to investor-owned utilities, publicly-owned utilities such as the Sacramento Municipal Utilities District (SMUD), and community choice aggregators. The California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) jointly implement the statewide Renewable Portfolio Standard (RPS) program through rulemakings and monitoring the activities of electric energy utilities in the state.

1.5.4 City of Sacramento Sustainability Master Plan

In December 2007, the Mayor and City Council adopted the City's SMP. The SMP began as the City's road map to creating a sustainable community. Pursuant to the SMP, an annual Sustainability Implementation Plan was published to provide updates on the City's progress in achieving the SMP goals and strategies. The goals and long term targets set forth by the SMP were influential in shaping the goals and targets in the City's 2010 IO CAP and 2012 community-wide CAP, and are now reflected in the 2035 General Plan (City of Sacramento 2015a).

1.5.5 City of Sacramento Climate Action Plans

Following adoption of the SMP in 2007, the City adopted the first of its climate action plans in 2010 with the first version of this IO CAP. Adoption of the IO CAP in 2010 served as Phase 1 of the City's overall climate action planning program that began under the City's 2030 General Plan. The City's Phase 2 CAP, adopted in 2012, addressed GHG reductions from community-wide sources as well as the need for adaptation and community resilience to the effects of climate change.

The 2010 IO CAP examined the City's internal operations and identified strategies to reduce GHG emissions in a cost effective manner for municipal buildings; vehicle fleet; streetlights and signals; parks maintenance; water, sewer, and drainage pumping; and other facilities and operations that are within the City's immediate control. This effort aimed to reduce emissions 15 percent below 2005 levels by 2020 and 83 percent below 2005 levels by 2050. These local targets would be equivalent to reducing emissions to 1990 levels by 2020 and 80 percent below 1990 levels by 2050, consistent with the statewide targets in AB 32 and S-03-05.

In 2015, the City integrated the community-wide Phase 2 CAP into the Sacramento 2035 General Plan. The General Plan is now the primary mechanism for implementation of the Phase 2 CAP for community activities.

The City maintains this separate IO CAP as a strategic plan to support implementation of General Plan policies related to municipal GHG emissions, as further described below.

1.5.6 Sacramento 2035 General Plan

The City of Sacramento adopted the Sacramento 2035 General Plan on March 3, 2015, which served as the first five-year update to the 2030 General Plan. The reduction of GHG emissions to minimize global climate change is a fundamental objective underlying policies throughout the 2035 General Plan. With adoption of the 2035 General Plan, the City integrated the Phase 2 CAP for community-wide activities into the General Plan. Although originally adopted separately as Phase 2 of the City's climate action efforts, the City now implements the CAP through the 2035 General Plan. The 2035 General Plan identifies key strategies to reduce GHG emissions from the community and internal operations. The General Plan also establishes new GHG reduction targets for both community activities and municipal operations by 2020, 2035, and 2050.

With respect to internal operations, Policy Environmental Resources (ER) 6.1.6 in the 2035 General Plan calls for the City to maintain implementation of its Phase 1 CAP to reduce municipal GHG emissions 22 percent below 2005 baseline level by 2020, and strive to reduce GHG emissions 49 percent and 83 percent by 2035 and 2050, respectively. Policy ER 6.1.8 tasks the City with ongoing evaluation of new policies, programs, and regulations that achieve the City's long-term GHG emission reduction goals. In addition, the Utilities (U) Element provides Policies U 6.1.3 and U 6.1.4, which specifically establish targets for the City's vehicle fleet to emit 75 percent less GHG emissions than 2005 levels by 2020 and for City facilities to use 25 percent less energy than 2005 levels by 2030, respectively. To support these targets, the General Plan listed several policies and programs that would reduce GHG emissions. Relevant policies and programs are listed for reference in Appendix A.

CHAPTER 2: GHG EMISSIONS INVENTORY

Annual GHG emissions generated by the City's internal operations have been quantified and are presented as the City's GHG emissions inventory. While the City's GHG emissions from internal operations are the subject of this plan, these emissions are best understood in the context of Sacramento's community-wide emissions as a whole. The discussion below summarizes the 2005 baseline year inventories evaluated for both community-wide sources within city limits and the City's internal operations; followed by the City's 2013 internal operations inventory, which was prepared as part of this 2016 IO CAP to assess the City's progress in GHG emissions reductions.

Carbon dioxide (CO_2) is the most prevalent GHG and largest contributor to climate change; however, five other primary and more potent GHG's are also analyzed for consistency with state protocol to meet the AB 32 target: methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Of these, CH_4 and N_2O are the most common. The effect of these and other primary GHGs are normalized by their global warming potential (GWP) as they relate to CO_2 and are generally considered high-GWP gases because of the greater capability than CO_2 to prevent solar energy from reflecting back into space. For comparability, all GHG emissions are converted in carbon dioxide equivalent (CO_2e) for normalization in terms of GWP. This plan uses metric tons of carbon dioxide equivalent *(*$MTCO_2e$*)* as the standard unit of measurement and mainly quantifies the emissions of CO_2, CH_4, and N_2O for both the GHG inventory and reduction measures.[2] GWP values from the IPCC Second Assessment Report are used in this analysis for consistency with previous inventories, where GWP values of 310, 21, and 1 are used for N_2O, CH_4, and CO_2, respectively (International Panel on Climate Change, IPCC, 2007).

2.1 2005 GHG INVENTORY

In partnership with the Sacramento Municipal Utility District (SMUD), the County and City of Sacramento worked with the six additional incorporated cities located in Sacramento County to complete an integrated countywide GHG emissions inventory for the baseline year of 2005 (Sacramento County, 2009). The inventory was conducted in 2008 and 2009 utilizing International Council for Local Environmental Initiatives' (ICLEI) Clean Air Climate Protection (CACP) modeling software, released in 2003, which was developed by ARB and ICLEI based on standard general reporting protocols in effect at the time of inventory preparation.

The countywide inventory included a comprehensive GHG emissions baseline for the entire county, as well as a specific inventory for each individual jurisdiction within the county. For each jurisdiction, a specific breakdown of GHG emissions by sector was provided for community-wide emissions, along with an internal operations GHG emissions inventory as a subset of each community-wide emissions profile. The City of Sacramento used the 2005 inventory as the basis for both the IO CAP (Phase 1) and community-wide CAP (Phase 2).

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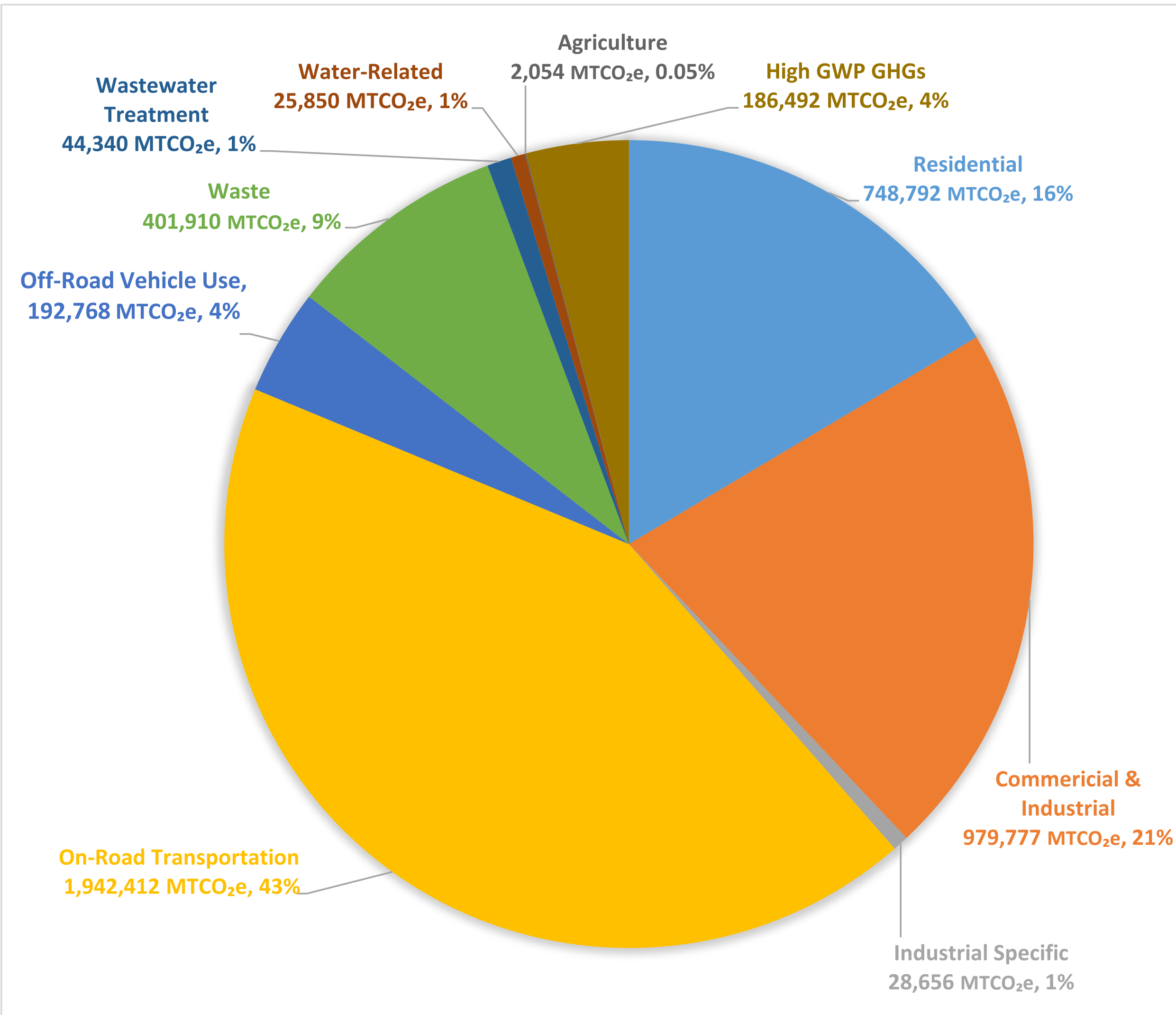
[2] A metric ton (MT or tonne) is equal to 1,000 kilograms (kg) or 2,204.62 pounds (lb).

2.1.1 2005 Community-Wide Inventory

Figure 3 and Table 1 below show the City of Sacramento's community-wide GHG inventory for the calendar year of 2005. Total community-wide emissions in 2005 were 4,553,051 $MTCO_2e$. The largest sector was vehicular fuel combustion in transportation, with on-road sources (43 percent) and off-road vehicles (4 percent) combining for a total of 47 percent. The second largest sector was electricity and natural gas, with residential (16 percent) and commercial and industrial (21 percent) combining for a total of 38 percent. Waste accounted for 9 percent, while high-GWP emissions (primarily refrigerants) contributed 4 percent. Wastewater treatment and water-related emissions each represent 1 percent or less of the community-wide total.



Source: Sacramento County 2009

Figure 3 **2005 GHG Emissions Inventory for the City of Sacramento**

Table 1 2005 City of Sacramento Community-wide GHG Emissions Inventory, By Sector

Sector	Description	$MTCO_2e$	% of Total
On-Road Vehicles	Fuel combustion by cars, light trucks, heavy trucks, buses, and other on-road transport vehicles	1,942,412	43%
Off-Road Vehicle Use	Fuel combustion by construction equipment, boats, all-terrain and recreational vehicles, and equipment such as lawnmowers and landscaping equipment	192,768	4%
Commercial and Industrial Buildings	Electricity, natural gas consumption by commercial and industrial buildings[a]	979,777	21%
Residential Buildings	Electricity and natural gas consumption by residential buildings	748,792	16%
Waste	Methane generated from waste disposed in landfills during 2005, as well as from waste-in-place in existing landfills[b]	401,910	9%
Wastewater Treatment	Methane and nitrous oxide from treatment of City-generated sewage by the Sacramento Regional Wastewater Treatment Plant	44,340	1%
Water Related	Electricity for pumping related to intake, treatment and pumping of water; and stormwater/drainage pumping	25,850	1%
High Global Warming Potential GHGs	Chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) used as substitutes for ozone-depleting substances primarily in coolants and refrigerants	186,492	4%
Industrial Specific	Consumption of electricity and natural gas by industrial buildings[a]	28,656	1%
Agricultural	Enteric fermentation and manure management for cattle and swine and use of fertilizers in city limits	2,054	0.05%
2005 TOTAL		**4,553,051**	**100%**

Notes:

Due to rounding, totals may not equal the sum of component parts.

[a] Companies that fall within the industrial sector may, by law, choose not to disclose energy use. In that case, energy consumed by the industrial sector is included in the combined commercial/industrial sector to maintain confidentiality. The Industrial-Specific sector includes those emissions where industrial energy use was disclosed and documented.

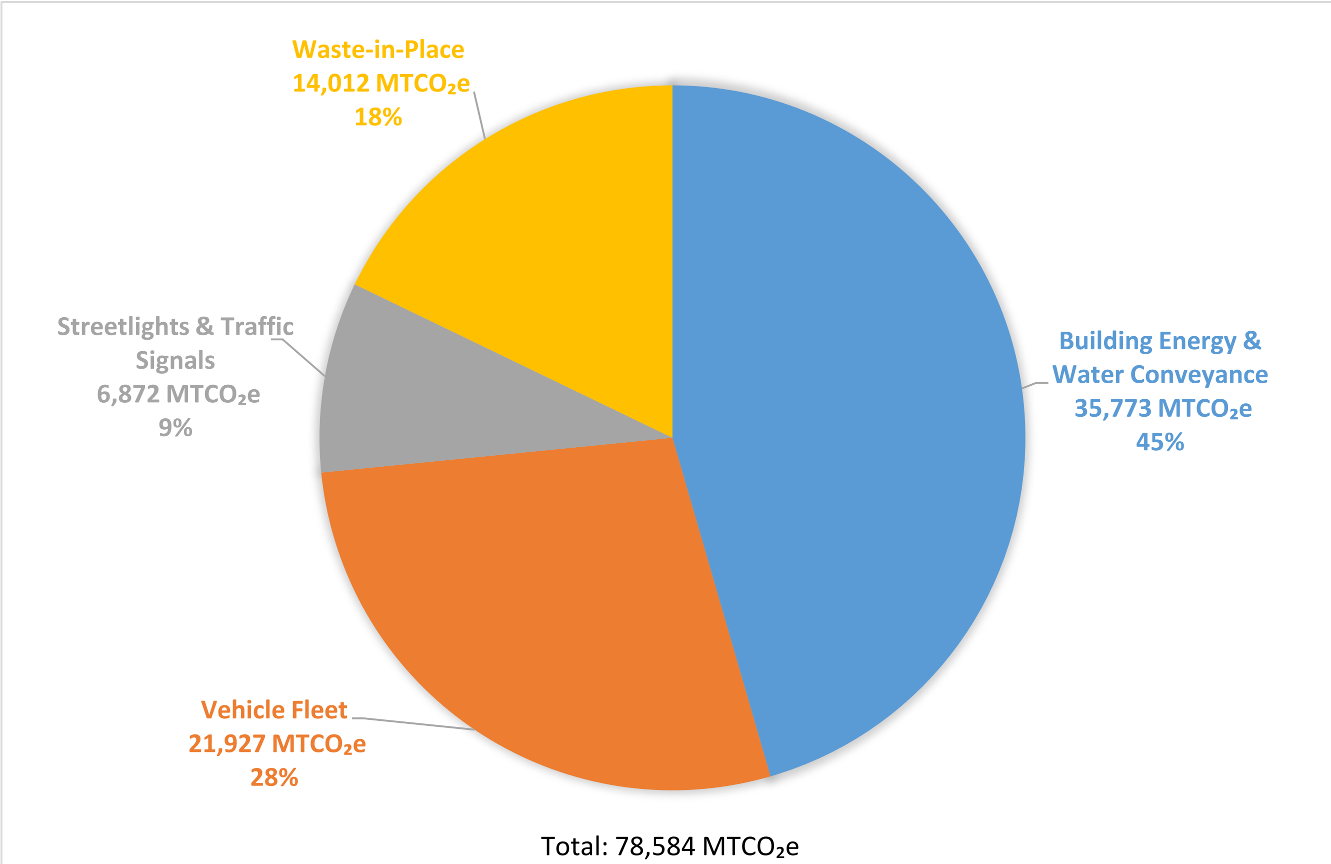
[b] Transportation-related emissions from waste collection and hauling is included in on-road transportation for all trips within the City limits. Emissions from hauling of solid waste outside the County to landfills in Nevada were not included in this inventory.

Source: Sacramento County 2009

2.1.2 2005 Internal Operations Inventory

Figure 4 and Table 2 below show the City's GHG emissions inventory for internal operations in 2005 by sector. The internal operations inventory is essentially a subset of the City's community-wide inventory, but the sector categories differ from the community-wide inventory because this aspect of the inventory was conducted consistent with local government reporting protocols, and due to the granularity of data available to the City for internal operations.

In 2005, City buildings represented the largest sector of operational emissions, at 46 percent. The "Buildings" emissions category, as analyzed in the 2009 Sacramento County report, included emissions from energy use in buildings as well as major as pumping activities in the City's water, sewer and drainage facilities. Vehicle fleet operations represented the second largest sector at 28 percent. Unlike the community-wide inventory, the City's 2005 GHG inventory did not include off-road vehicles, such as construction and landscaping equipment. Waste-in-place emissions from the former City landfill at Sutter's Landing amounted to approximately 18 percent of total, consisting primarily of methane as a result of anaerobic decomposition. Streetlights and traffic signals represented the fourth largest sector at 9 percent.



Source: Sacramento County 2009

Figure 4 **2005 GHG Emissions for City of Sacramento Internal Operations**

Table 2 2005 City of Sacramento Internal Operations GHG Emissions Inventory,1 By Sector

Sector	Description	$MTCO_2e$	Percent
Buildings and Facilities	Electricity and natural gas used by City buildings and facilities	35,773	46%
Vehicle Fleet	Gasoline, diesel, LNG, and other fuels used in City vehicles (mid-size auto, heavy trucks, and light trucks only)	21,927	28%
Landfill Waste-in-Place	Methane generated from waste disposed in prior years in the 28th Street City landfill at Sutter's Landing (closed in 1997).	14,012	18%
Traffic Signals and Streetlights	Electricity used by streetlights and signals in public right of way or adjacent to City facilities	6,872	97%
2005 Total		**78,584**	**100%**

Notes:

Due to rounding, totals may not equal the sum of component parts.

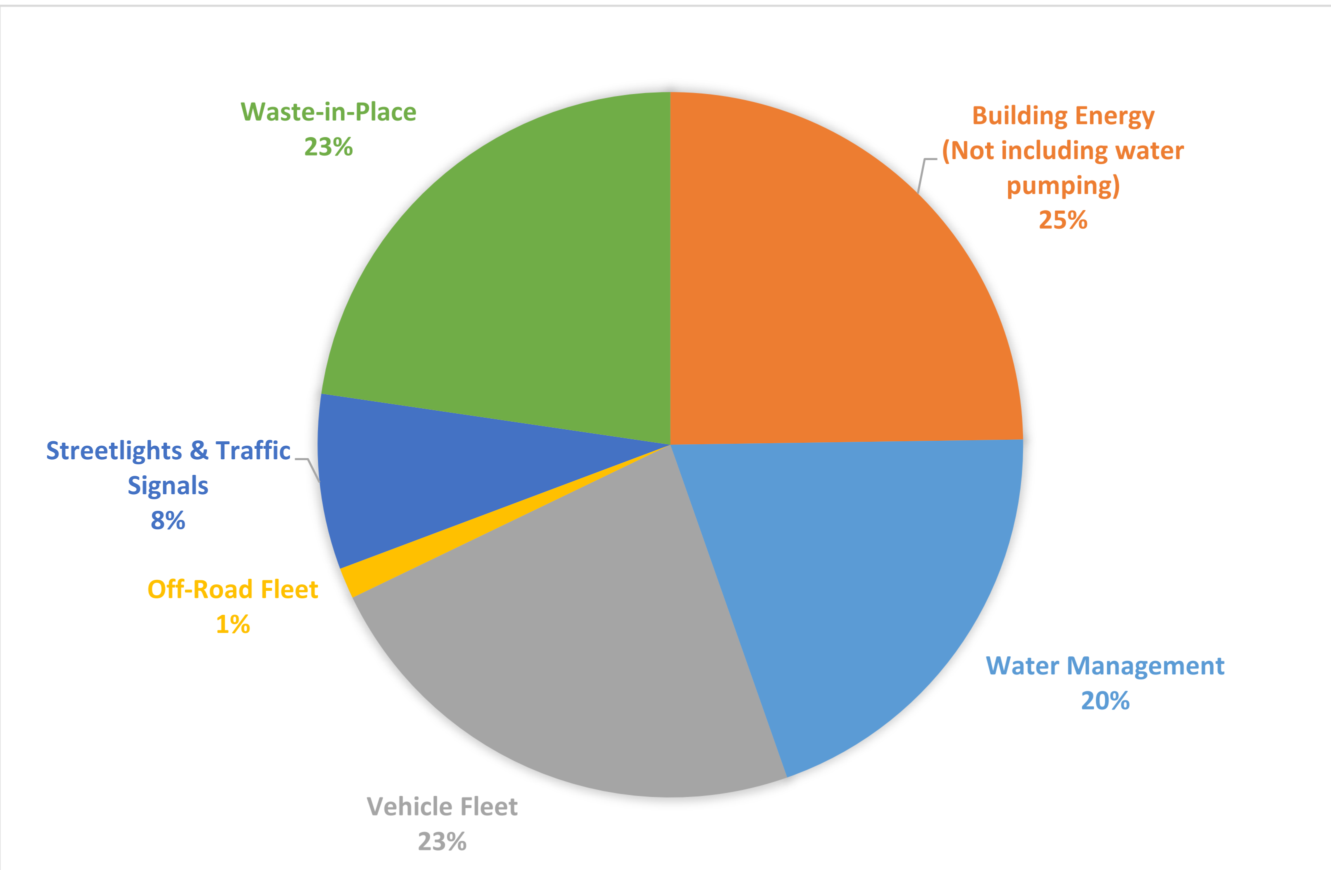
Source: Sacramento County 2009

As noted earlier, the internal operations emissions data presented above are a subset of the community-wide inventory, so no "double-counting" is occurring between community-wide and internal operations. Additional information regarding the 2005 Sacramento GHG inventories can be found in the previous 2010 IO CAP (City of Sacramento 2010).

2.2 2013 GHG INVENTORY UPDATE – INTERNAL OPERATIONS

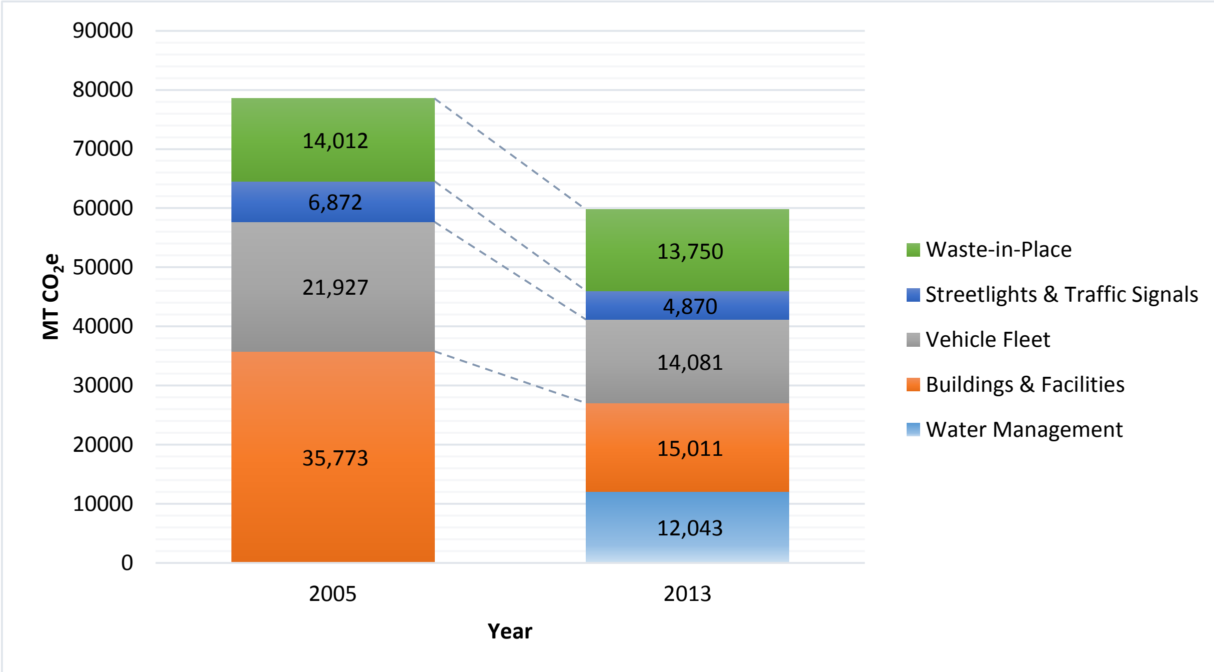
As part of the 2016 IO CAP Update, the City completed a new GHG inventory for internal operations for the calendar year of 2013. The 2013 inventory serves as a benchmark to measure progress toward the 2020 target. In 2013, the City's internal operations resulted in an estimated 59,098 $MTCO_2e$, a 24 percent net decrease from the City's emissions in 2005. In total, the 24 percent decline in municipal GHG emissions from 2005 to 2013 exceeded the City's 2020 target of a 15 percent reduction from 2005 levels.

The internal operations inventory captures GHG emissions related to internal operations at the City from building energy use, City vehicle fleet, off-road vehicles and equipment, streetlight and traffic signal energy use, water management, and solid waste activities. The 2013 inventory includes two new sectors that were not previously identified or included in the 2005 inventory: water management and off-road vehicle fleet. Previously, the 2005 inventory aggregated energy for water use in the buildings and facilities sector. The 2005 inventory did not capture GHG emissions from off-road equipment, such as landscaping or off-road construction equipment operated by the City. Figures 5 and 6 and Table 3 present the City's 2013 internal operations GHG inventory by sector, with comparisons to the previous 2005 inventory. The off-road sector is shown as an informational item for 2013 in Table 3, but is excluded from Figure 6 for consistency in comparisons to 2005.



Source: Data compiled by Ascent Environmental, Inc. in 2015

Figure 5 **City of Sacramento Internal Operations 2013 GHG Emissions Inventory**



Source: Data compiled by Ascent Environmental, Inc. in 2015

Note: 2013 excludes off-road emissions, for comparability to 2005.

Figure 6 Comparison of Internal Operations GHG Emissions Inventories (2005 and 2013)

Table 3 City of Sacramento Internal Operations GHG Emissions Inventories (2005 and 2013)

Sectors	2005	2013	Difference	% Reduction from 2005
Buildings & Facilities	35,773	15,011	-8,719	-24%
Water Management[a]		12,043		
Vehicle Fleet	21,927	14,081	-7,846	-36%
Streetlights & Traffic Signals	6,872	4,870	-2,002	-29%
Waste-in-Place	14,012	13,750	-262	-2%
Total	**78,584**	**59,755**	**-18,829**	**-24%**
Off-Road Fleet[b]		862	862	NA
Total with Off-Road Fleet		60,617	-17,967	NA

Notes: Units in metric tons of CO_2 equivalent.

[a] The water management sector includes energy consumption associated with water intake, treatment and distribution, and sewer and drainage system operations. Water-related emissions were included within the buildings and facilities sector in the 2005 internal operations inventory, but have been quantified separately in the 2013 inventory update.

[b] Off-road emissions were not included in the 2005 inventory.

Source: Sacramento County 2009, Ascent Environmental 2015; compiled by Ascent Environmental, 2015

2.2.1 Data Sources and Methods

In addition to incorporating new sectors for off-road fleet and water management, the 2013 inventory includes several updates to data sources, assumptions, and methods. These differences were necessary for accuracy, consistency with newer protocols, and data availability. New methods were available for estimating GHG emissions from the vehicle fleet and solid waste sectors, which better reflect actual emissions due to newer and more precise GHG emissions factors and calculations.

The City of Sacramento was the primary data source for the 2013 GHG emissions inventory. Electricity and natural gas consumption was supplied by the City's EnergyCAP database. EnergyCAP is a repository that compiles data from utility providers and reports electricity and natural gas use for all municipal utility accounts, including buildings, water management, and streetlights and traffic signals. For the vehicle and off-road fleet sectors, the City's Department of General Services provided 2013 vehicle mileage, fuel consumption, model year, and fuel types for each individual fleet vehicle. By comparison, the 2005 inventory used reports from SMUD, Pacific Gas and Electric (PG&E), and aggregate fuel consumption data to calculate emissions.

Methods for calculation of the City's 2013 GHG inventory are consistent with the latest guidance from the California Air Resources Board Local Government Operations Protocol (LGOP), Version 1.1 (2010). The LGOP was released in June 2010, one year after the publication of the City's 2005 GHG inventory in the *Greenhouse Gas Emissions Inventory for Sacramento County.* For consistency and comparability between the 2005 inventory, the 2013 inventory uses the same GHGs (CO_2, CH_4, and N_2O) and GHG emissions factors as the 2005 inventory. Appendix B provides a more detailed comparison of the differences in data sources, calculation methods, and emission factors between the 2005 and 2013 inventories.

2.2.2 2013 Internal Operations Inventory by Sector

BUILDINGS & FACILITIES

In 2013, municipal building and facility energy use resulted in 15,011 $MTCO_2e$, comprising the largest percentage of the City's total annual internal operations emissions (25 percent). These emissions include electricity, natural gas, and diesel fuel energy used at City-owned and operated buildings and facilities in 2013. Buildings and facilities in this sector include City-owned and operated offices, corporation yards, and parking lot facilities, in addition to irrigation systems at City-owned parks. Electricity use supported lighting, appliances, and equipment in City buildings and facilities. Natural gas was most often used for space heating and water heating. Diesel fuel was used for a City-operated back-up generator, which is used for intermittently during power outages and for regular testing. The building and facility energy sector consumed 35.2 gigawatt hours (GWh) of electricity and 800,546 therms of natural gas, and approximately 9,300 gallons[3] of diesel fuel. Electric vehicle charging was also metered in total building electricity consumption, but is subtracted from total building electricity based on the total kilowatt hours (kWh) of charging estimated under the vehicle fleet sector. All electricity was purchased from the Sacramento Municipal Utility District (SMUD) in 2013 unless the City indicated otherwise.

Approximately 87 percent of building and facility emissions were from the electricity and natural gas consumption at City-owned and operated buildings and libraries[4], contributing a total of 13,010 $MTCO_2e$ in 2013. Energy use at parking lots lot and park facilities contributed an additional 12 percent of total building and facility GHG emissions, while all other facilities comprised less than 2 percent of GHG emissions from this sector. Additionally, on-site solar photovoltaic cells generated 4.87 megawatt-hours (MWh), of which 4.81 MWh were used on-site and the remaining was returned back to the utility grid.

WATER MANAGEMENT

The City provides several water-related utility services to residents and businesses in the form of water intake, treatment, and distribution; wastewater collection and conveyance; and stormwater drainage. In 2013, pumping and other activities associated these water-related services (referred to hereafter as the "water management" sector) conveyed approximately 61,018 million gallons (MG) of water and wastewater

[3] Actual fuel use not known. Gallons were calculated by dividing total CO_2 emissions by the average emission factor for a gallon of diesel fuel (10.21 kg CO_2/gal), available from The Climate Registry (The Climate Registry 2014). Total CO_2 emissions were estimated using ARB's OFFROAD emission factors based on the equipment type, total hours of generator usage, and the generator horsepower rating. Additional explanation can be found under the vehicle fleet methods discussion further below.

[4] Electricity and natural gas are mainly provided by two separate vendors. The City purchases electricity from SMUD and natural gas from PG&E.

and consumed 47.4 GWh of electricity, resulting in emissions of 12,043 $MTCO_2e$. This sector comprised 20 percent of the City's total municipal GHG emissions in 2013. Water management activity represented the second largest sector of emissions in the city after building and facility energy use.

STREETLIGHTS & TRAFFIC SIGNALS

In 2013, the operation of streetlights and traffic signals in the City required approximately 19.2 GWh or electricity and resulted in 4,870 $MTCO_2e$, contributing 8 percent of the City's total annual GHG emissions. This sector captures electricity for all streetlights and traffic signals operated by the City.

VEHICLE FLEET

The City's 2013 vehicle fleet consisted of a variety of vehicle types using both conventional and alternative fuels. Fuel consumption from vehicle fleet operations contributed approximately 14,081 $MTCO_2e$ in 2013, comprising 23 percent of the City's annual operational GHG emissions. In 2013, the City operated 1,819 on-road vehicles including maintenance trucks, vans, solid waste collection vehicles, police and fire vehicles, and light duty passenger vehicles. In addition, several alternative fuel on-road vehicles were in use in 2013, including 7 electric vehicles, 40 gasoline-hybrids, and 266 flex fuel vehicles that run on ethanol-gasoline blended fuel (E85).[5]

OFF-ROAD VEHICLES AND EQUIPMENT

City operations also include operation of off-road vehicles and equipment, such as construction equipment, off-road utility vehicles, and landscaping equipment. Off-road fleet operations in 2013 resulted in additional GHG emissions of 862 $MTCO_2e$, due to the consumption of diesel, propane, gasoline, and electricity. The City's off-road fleet emissions are shown here for informational purposes. This sector was not included in the previous 2005 inventory, and is therefore excluded from comparisons to the 2005 baseline inventory.

WASTE-IN-PLACE

The City's GHG emissions from solid waste capture waste-in-place emissions at the City-owned-and-operated 28th Street Landfill. Waste-in-place emissions are the result of anaerobic decomposition of organic material from the existing accumulated waste in a landfill. The anaerobic decomposition occurs at covered landfills where the deposited waste is not exposed to the oxygen in the atmosphere.

Previously, the 28th Street Landfill served as the disposal location for solid waste generated within the City between 1968 and 1994. Since the 28th Street Landfill's permanent closure in 1997, a methane gas recovery system was installed and operated by a third-party contractor that collects and disposes of much of the gas that is generated from the closed landfill. From the early 1990s until 2010, the City sold a portion of the captured landfill gas to Blue Diamond Almond for their industrial operations, flaring the remaining captured CH_4. However, in 2013, due partially to the declining quality of landfill gas, the landfill flared all CH_4 that was captured through its landfill gas (LFG) collection system, rather than sell it for combustion. Fugitive CH_4 emissions resulting from the LFG collection and flaring in 2013 resulted in an estimated 13,750 $MTCO_2e$. Approximately 316 million standard cubic feet (MMSCF) of methane emissions were captured and flared in 2013. The IPCC considers any CO_2 emissions from flaring or fugitive emissions from landfills to be of biogenic origin and not significant to overall solid waste emissions (IPCC 2006).

[5] E85 = 85 percent ethanol and 15 percent gasoline.

CHAPTER 3: GHG REDUCTION TARGETS AND FORECAST

As summarized in Chapter 2, in 2013 the City exceeded the original IO CAP target of reducing GHG emissions 15 percent below 2005 levels by 2020. The 2035 General Plan further commits to a 22 percent reduction in municipal GHG emissions below 2005 levels by 2020. State and local goals continue to evolve with increasing guidance for post-2020 targets. In addition, the City strives to serve as a regional leader in modeling innovative, cost-efficient operations.

Under Executive Orders B-15-30 and S-3-05, California aims to reduce statewide GHG emissions 40 percent below 1990 levels by 2030 and 80 percent below 1990 levels by 2050. The City of Sacramento's recently-updated 2035 General Plan includes similar goals. In the Environmental Resources (ER) Element of the General Plan, Policy ER 6.1.6 commits to reduce community-wide and municipal GHG emissions 49 percent below 2005 levels by 2035 and 83 percent below 2005 levels by 2050. To support sustained GHG reductions towards more aggressive post-2020 goals, this IO CAP Update evaluates three targets for internal operations. These targets present near-, mid-, and long-term benchmarks, including analysis of a reduction potential for 2020 that exceeds the adopted General Plan:

- Exceed the adopted General Plan target of 22 percent below 2005 levels by 2020 (Policy ER 6.1.6) with attainment of 33 percent below 2005 levels by 2020,
- 49 percent below 2005 levels by 2035 (Policy ER 6.1.6), and
- 83 percent below 2005 levels by 2050 (Policy ER 6.1.6).

As the City implements this IO CAP, the City will evaluate progress towards each target. Annual monitoring and reporting will allow the City to assess both near-term accomplishments and progress towards long-term reduction goals for 2050. This IO CAP primarily focuses on strategies to achieve 2020 reduction targets, but also demonstrates options for the City to continue progress beyond 2020 towards future targets for 2035 and 2050, consistent with Policy ER 6.1.6 in the 2035 General Plan.

3.1 SECTOR SPECIFIC TARGETS

In addition to overall GHG emissions reduction targets, the City's 2035 General Plan also identified sector-specific targets for the City's internal operations. Sector-specific targets are both quantitative and qualitative, with quantitative targets established for vehicle fleet and facility operations. According to the Utilities (U) Element of 2035 General Plan, the City shall reduce:

- GHG emissions from the City's vehicle fleet by 75 percent below 2005 levels by 2020 (Policy U 6.1.3), and

- Energy use from City-owned and operated facilities by 25 percent below 2005 levels by 2030 (Policy U 6.1.4).

As shown in Table 1, in 2013 the City reduced vehicle fleet emissions by 36 percent from 2005 levels. To achieve the City's target to reduce vehicle fleet emissions by 75 percent, the City would need to reduce another 39 percent from vehicle fleet emissions from 2005 levels. With respect to energy use targets, the City reduced energy consumption by 15,612 MWh for electricity and 382,236 therms for natural gas compared to 2005 levels by the year 2013. The City's goal to reduce energy use from facilities plays an important role in achieving reductions in GHG emissions. State policies to increase the percentage of renewable electricity sources and increased accessibility of on-site solar energy installation will also have a significant influence on emissions related to energy use.

3.2 GHG EMISSIONS FORECAST

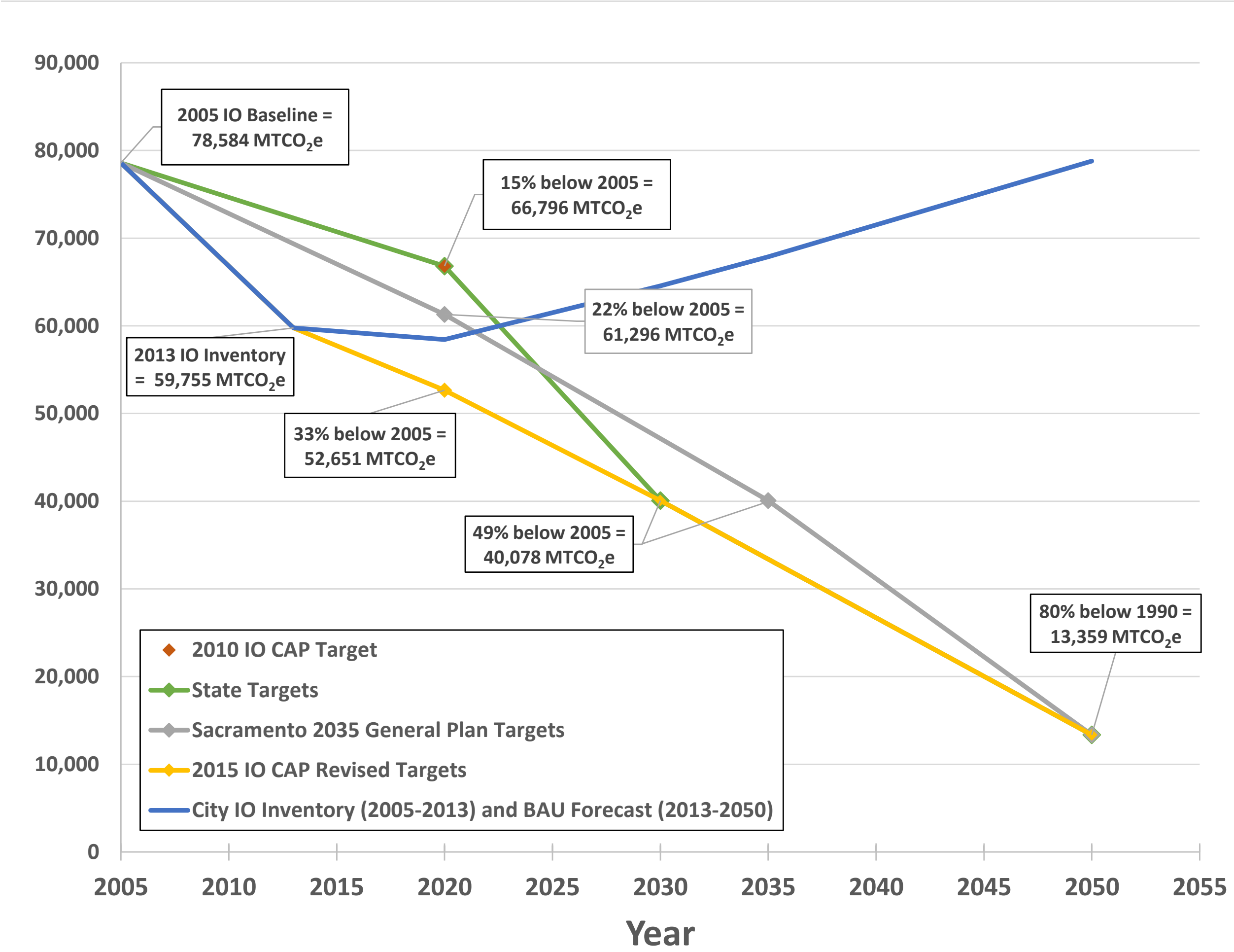
The 2010 IO CAP anticipated that the City's internal operations would grow at an average rate of 1 percent per year from 2005 to 2020, factoring in a period of significant expansion in City operations that occurred between 2005 and 2008 and a period of reductions in staffing and services in 2009-2011 during the economic recession. From 2011 to 2013, staffing levels decreased by approximately 9 percent. At the time of this writing in 2015, with only five years remaining until 2020, the City has a clearer picture of growth potential for various sectors within internal operations.

With respect to building facilities, the City plans on rebuilding and expanding two existing fire stations (Fire Stations 14 and 15), but does not anticipate any net new City facilities between 2013 and 2020. This includes any new water management structures. However, the City's population continues to grow and has grown at an average rate of 1 percent per year between 2010 and 2015 (Department of Finance 2015: Table 2). The City's 2035 General Plan allots for a population growth up to 640,400 by 2035, which is 35 percent higher than the City's population in 2013 (City of Sacramento 2015b: 2-2). Interpolating for 2020, the City's population could grow by up to 11.29 percent from 2013 to 2020, or 1.6 percent per year.

Even without much growth in City building energy use, most City services, such as water conveyance and police and fire services, would likely increase due to population and associated physical growth in key development areas. Thus, the City anticipates that the distance traveled by the City's vehicle fleet, number of streetlights and signals, and amount of water supply and wastewater conveyed by the City would also increase at 1.6 percent per year through 2020. With respect to vehicle fleet, this growth rate is applied to all existing vehicles. There is no anticipated net growth in the number of vehicles in the fleet by 2020, but activity associated with existing vehicles would grow commensurate with population. Additionally, it is assumed that off-road vehicle use would increase from 2013 to 2020 at half the rate of population, or 5.6 percent, because off-road vehicle use is used in such applications as landscaping at City buildings and street medians.

Energy use for stormwater drainage pumping would not change with population, but depends on precipitation levels during the year. Because of the uncertainty in predicting weather several years in advance, stormwater drainage pumping demands in 2020 are assumed to be the average of 2013 and 2005 levels, where 2013 and 2005 were drought and wet years, respectively. This is equivalent to a 26 percent increase from 2013 stormwater drainage energy use.

Applying these growth assumptions and using 2020 emission factors, the City's "business-as-usual" (BAU) emissions in 2020 would be 58,448 $MTCO_2e$, or 59,358 $MTCO_2e$ with off-road fleet emissions, a 2 percent decrease between 2013 and 2020. This estimate assumes that all electric utilities serving the City meet the Renewable Portfolio Standard (RPS) of 33 percent power from renewable sources. Post-2020 forecasts through 2050 assume 1 percent annual growth in emissions from City operations. Forecasts are shown in relation to the local and state targets in Figure 7. The forecasted growth assumptions by sector are summarized below in Table 4.



[1] *The blue line represents actual GHG emissions from City internal operations in 2005 and 2013. Beyond 2013, the blue line represents the Business-As-Usual (BAU) forecast, taking into account population growth and specific growth in City departments. The gray and yellow lines represent the City's original and recommended GHG targets, respectively. Recommended targets (yellow) are based on the City's progress exceeding the original 2020 targets (gray) in 2013, in addition to adopted General Plan goals for ongoing post-2020 reductions.*

Source: City of Sacramento 2015, Department of Finance 2015; data compiled by Ascent Environmental, Inc. in 2015.

Figure 7 City of Sacramento Internal Operations GHG Emissions Targets and BAU Forecasts

Table 4 City of Sacramento Internal Operations Business-As-Usual GHG Emissions Forecast for 2020

	2013 ($MTCO_2e$)	BAU 2020 ($MTCO_2e$)	Explanation of 2020 BAU Forecast
Building Energy	15,011	14,678	Fire Stations 14 and 15 will be expanded by 18,665 sqft. Assumes minimum 2013 Title 24 standards. No net new buildings will be constructed. Assumes 33% RPS in 2020.
Water Management	12,043	10,843	See below
Water Supply Conveyance	*9,559*	*8,079*	*2014 water demand dropped by 19 percent from 2013. Growth to 2020 assumed to be proportional to 10.54% population growth from 2014. Assumes 33% RPS in 2020.*
Wastewater Conveyance	*754*	*671*	*2014 water demand dropped by 19 percent from 2013. Growth to 2020 assumed to be proportional to 10.54% population growth from 2014. Assumes 33% RPS in 2020.*
Stormwater Drainage	*1,730*	*2,094*	*Average of 2005 and 2013 energy usage, which roughly represent wet and drought years, respectively. Assumes 33% RPS in 2020.*
Vehicle Fleet	14,081	15,671	11.29% population growth from 2013 levels applied to total vehicle fleet usage. No net new vehicles added to fleet.
Streetlight and Traffic Signals	4,870	5,187	11.29% population growth from 2013 levels applied. Assumes no change in technology.
Waste-in-Place	13,750	12,068	Assumes natural decay in un-decomposed organic material in the landfill and that the 28th Street landfill will remain closed, using EPA's LandGem Model v. 3.02 to estimate reduction.
Total	59,755	58,448	
Off-Road Fleet	*862*	*910*	*Assume 5.6% growth from 2013, based on half of the population growth rate as off-road vehicles are used at both City-buildings and public facilities.*
Total with Off-Road Fleet	*60,617*	*59,358*	

Notes: Population growth based on estimates from the Department of Finance and the City of Sacramento 2035 General Plan. Water forecasts were based on population growth estimates from 2014 instead of from 2013, due to new information showing significant decreases in water use and likely captures effect of drought response.

sqft = square feet
EPA = U.S. Environmental Protection Agency
RPS = Renewable Portfolio Standard

Source: City of Sacramento 2015, Department of Finance 2015, **Waste**-in-place emissions compiled by Ascent Environmental, Inc. in 2015 based on modeling using U.S. Environmental Protection Agency's (EPA) Landfill Gas Emissions (LandGem) Model (version 3.02).

GAP ANALYSIS

As shown in Table 4 and Figure 7, the 2020 forecast of GHG emissions under a BAU scenario would result in a 2 percent decrease from 2013 to 2020. In comparison to the 2005 baseline, the 2020 BAU scenario would equate to a reduction of 26 percent below 2005 GHG emissions levels. Under this BAU scenario, internal operations are anticipated to exceed the adopted General Plan target of a 22 percent reduction by 2020. Achievement of the 22 percent reduction target reflects required improvements in the renewable power supply and sustained efficiencies in the water management sector. To achieve the full reduction potential of 33 percent below 2005 levels by 2020, emissions from the City's internal operations would need to be reduced 7,104 $MTCO_2e$ below 2013 levels to 52,651 $MTCO_2e$ per year by 2020.

If the City achieves the vehicle fleet reduction target of 75 percent below 2005 vehicle fleet emissions levels by 2020 as called for by 2035 General Plan Policy U 6.1.3, such a reduction alone could result in a 37 percent reduction below 2005 levels by 2020. Alternatively, if the City achieved the 25 percent reduction target from 2005 building energy usage by 2020 (including water management) in advance of the 2035 General Plan Policy U 6.1.4 for 2030, this reduction alone could bring the City's GHG emissions to 26 percent below 2005 levels by 2020. If both vehicle fleet and building-water energy targets are achieved in 2020, without assistance from any other sectors, City internal operation emissions could theoretically be reduced to 48,003 $MTCO_2e$, or 39 percent below 2005 emissions. However, reductions are likely to occur in multiple sectors that could help the City achieve its 2020 goal in the event that the either of the City's vehicle fleet and building energy targets are not met.

CHAPTER 4: GHG REDUCTION STRATEGIES

4.1 ACTION PLAN SUMMARY

To achieve the additional emissions reductions needed to achieve the 2020 reduction target and meet the sector-specific targets for vehicle fleet and building energy sectors identified in the 2035 General Plan, the City has identified eleven new and continuing actions for municipal operations. Actions focus on the City's buildings and facilities, water management sector, vehicle fleet, and streetlights and signals. These new and continuing actions would complement the emissions reductions achieved by systems or permanent reductions resulting from past actions, as described by the 2010 IO CAP (see Appendix B). Collectively, City actions have the potential to reduce 2020 emissions by 41 percent below 2005 levels to 46,733 $MTCO_2e$ per year, exceeding the City's internal operations goal of 52,651 $MTCO_2e$ per year by 2020 (33 percent below 2005 levels by 2020).

Estimated emissions reductions from the new and continuing actions account for applicable future growth in City services by 2020, and changes in future emission factors for electricity generation. Each action is analyzed for the potential future avoided emissions from the 2020 BAU scenario. In this IO CAP, the combined effect of avoided future emissions attributable to new actions are subtracted from the forecasted 2020 BAU scenario. The new net 2020 GHG emissions level is then used to determine progress towards sector-specific goals and overall reduction targets.

The following summarizes GHG reductions from the 2020 BAU scenario that can be achieved through actions in this CAP for the following sectors:

- **Building Energy and Water Management:** Significant reductions can be achieved by implementing energy efficiency and conservation measures in the City's existing buildings and planned expansions, as well as in water management activities. The measures would reduce facility energy use by 28,765 MWh and 394,589 therms per year from 2005 levels. This translates to a combined energy reduction of 138,680 million BTU (MMBTU), a 30 percent reduction from 2005 energy use. Thus, building energy and water management actions proposed in the IO CAP Update will help the City exceed the 2035 General Plan's building energy goals of reducing 2005 energy use by 25 percent by 2030, ten years early (2035 General Plan Policy U 6.1.4). Combined with low-carbon electricity resources from SMUD's achievement of 2020 RPS targets, these measures help reduce 2,598 $MTCO_2e$ per year from the 2020 BAU scenario.

- **Streetlights and Signals:** Continuing a long-standing commitment to improve energy efficiency in the City's traffic signal systems and City streetlights, the strategies result in approximately 1,655 $MTCO_2e$ in GHG savings from the 2020 BAU scenario, a reduction of 1,338 $MTCO_2e$ below 2013 levels for this sector.

- **Vehicle Fleet and Fuels:** Building upon the City's Sustainable Fleet policies already in effect, continued improvements in fleet vehicle efficiency, alternative fuels and infrastructure, and operational and behavioral changes to reduce fuel usage and vehicle miles traveled are identified for this sector, reducing GHG emissions by 7,120 $MTCO_2e$ from the 2020 BAU scenario, or 5,872 $MTCO_2e$ from the 2013 inventory. This is equivalent to 63 percent below 2005 levels for this sector, which means the proposed actions in this sector would not be sufficient to reduce 2005 vehicle fleet emissions by 75 percent, as targeted by 2035 General Plan Policy U 6.1.3. Vehicle fleet actions would result in the largest GHG reductions across all sectors of the City's internal operations, accounting for 43 percent of the reductions associated with the implementation of this IO CAP.

- **Off-Road Fleet:** No reductions have been proposed for the City's off-road fleet from 2013 levels. Off-road fleet includes construction vehicles and landscaping equipment. Off-road fleet emissions were not included in the 2005 GHG inventory.

- **Waste-in-Place:** The City has not proposed any new reductions from waste-in-place emissions. The 28th Street Landfill is the only source of waste-in-place emissions from City operations. The City previously had methane capture systems in place since its permanent closure in 1997. The City replaced methane capture with methane flaring in 2010. Reductions from annual methane flaring have been accounted for in the 2013 inventory and no further reductions are anticipated or planned. However, methane emissions from the landfill will continue to decrease over time because of the natural decline in anaerobic activity since the landfill's closure. More information is in Appendix D.

- **Urban Forestry:** The City's commitment to maintaining and expanding urban forestry can help reduce emissions by establishing carbon sequestration opportunity, and by providing potential reductions in building cooling costs with increased shade for buildings. Only accounting for carbon sequestration potentials, expansion of the City's urban forest between 2013 and 2020 could reduce CO_2 from the atmosphere by 105 $MTCO_2$ in 2020. Energy reductions from tree shading are estimated to reduce another 316 $MTCO_2e$ per year in 2020, for a total reduction of 422 $MTCO_2e$. However, because urban forestry effects were not included in the 2013 or 2005 inventories, these reductions are presented separately.

Table 5 and Figure 8 summarize total GHG emission reductions by sector, including reductions resulting from either City actions or external forces. The City has potential to achieve a 41 percent reduction below 2005 GHG emissions levels by 2020. Due to early progress from 2005 to 2013, the City has already achieved a 22 percent reduction, with potential to realize a full 41 percent reduction by 2020.

Table 5 GHG Reductions from City Action Strategies: 2005 to 2020, by Emissions Sector

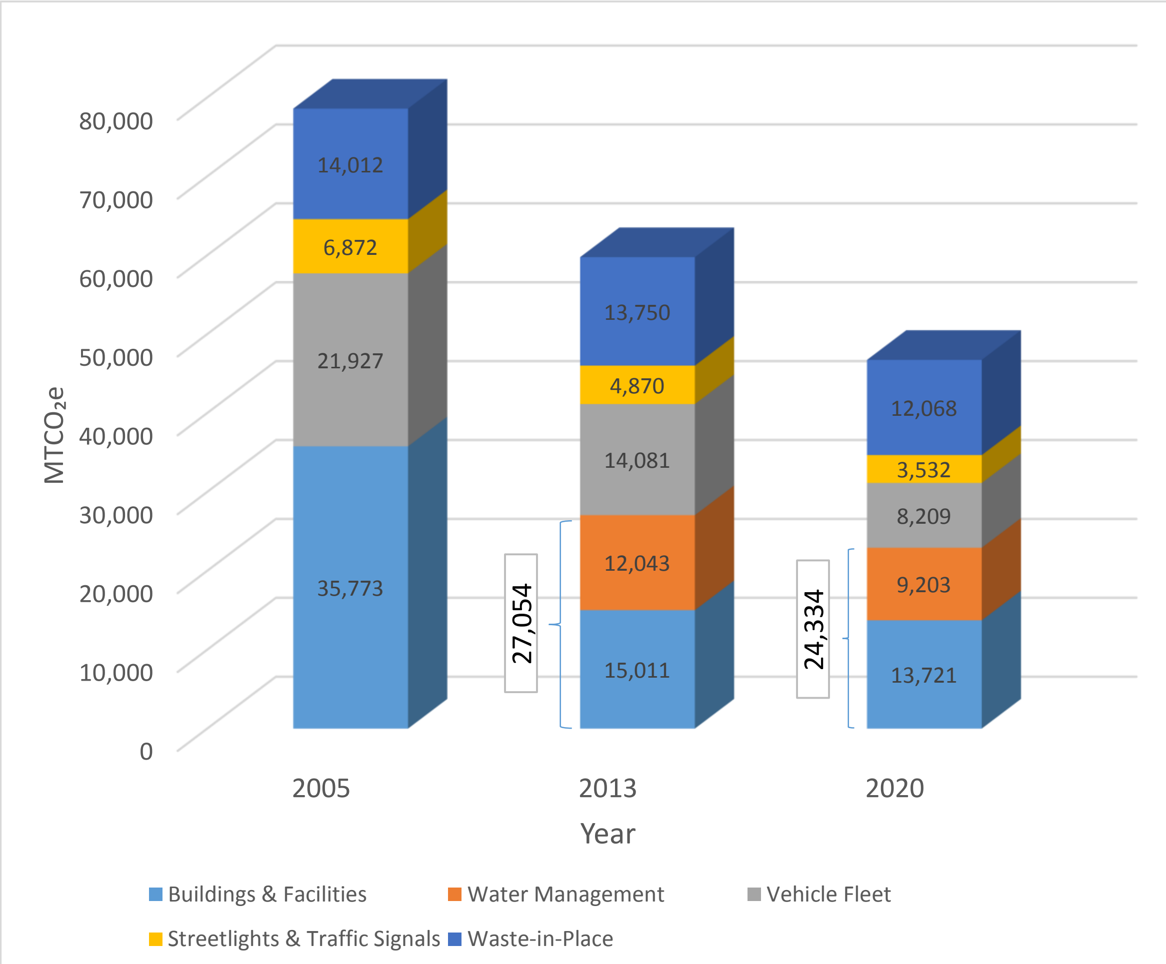
	GHG Emissions Levels ($MTCO_2e$)			Reductions 2005 to 2020		Reductions 2013 to 2020	
Sectors	2005 GHG Baseline Inventory	2013 GHG Inventory Update	2020 Emissions With City Action Strategies/Other	Difference ($MTCO_2e$)	% Change	Difference ($MTCO_2e$)	% Change
Buildings & Facilities	35,773	15,011	13,721	-12,849	-36%	-1,290	-9%
Water Management[a]		12,043	9,203			-2,840	-24%
Vehicle Fleet	21,927	14,081	8,209	-13,718	-63%	-5,872	-42%
Streetlights & Traffic Signals	6,872	4,870	3,532	-3,340	-49%	-1,338	-27%
Waste-in-Place	14,012	13,750	12,068	-1,944	-14%	-1,682	-12%
Total	**78,584**	**59,755**	**46,733**	**-31,851**	**-41%**	**-13,022**	**-22%**

Notes:

a. The water management sector includes energy consumption associated with water conveyance, wastewater conveyance, and sewer and drainage system operations.

NA = not applicable

Source: Sacramento County 2009, 2013 and 2020 data compiled by Ascent Environmental, Inc. in 2015



** Note: For 2005, water management emissions were included in the building & facility sector.*
Source: Sacramento County 2009; 2013 and 2020 data compiled by Ascent Environmental, Inc. in 2015

Figure 8 GHG Reductions from City Action Strategies: 2005 to 2020, by Sector

Table 6 Detailed GHG Savings from City Action Strategies from 2020 BAU Scenario, by Sector

2016 IO CAP ID	Project or Program	New or Revision of Existing	GHG Savings from 2020 BAU		
			Electricity (kWh)	Natural Gas (therms)	GHG ($MTCO_2e$)
Building Energy Sector (BE)					
BE-1	Energy Savers Campaign - "Lights & Equip Off" Policy	Continuation of Existing Action	NA	NA	NA
BE-2	Green Building Policy for New City Buildings	Revision of Existing Action	58,322	43	14
BE-3	Energy Efficiency Retrofits	Revision of Existing Action	3,537,616	12,310	942
	Convention Center Lighting Retrofit		*333,389*	*0*	*81*
	Swimming Pool VFDs		*522,795*	*0*	*127*
	Hart Senior Center HVAC Replacement		*16,708*	*1,610*	*15*
	Panatoni HVAC replacement		*81,445*	*10,700*	*91*
	Kinney Police Station LED retrofit		*83,279*	*0*	*20*
	Miscellaneous Retrofits		*2,500,000*	*0*	*608*
SUBTOTAL: Buildings Energy			**3,595,938**	**12,352**	**957**

Table 6	Detailed GHG Savings from City Action Strategies from 2020 BAU Scenario, by Sector				
2016 IO CAP ID	Project or Program	New or Revision of Existing	GHG Savings from 2020 BAU		
			Electricity (kWh)	Natural Gas (therms)	GHG ($MTCO_2e$)
Water Management Sector (WT)					
WT-1	Pumping efficiency & system optimization	Revision of Existing Action	6,746,066	0	1,641
	Stormwater Drainage		*602,512*	*0*	*147*
	Water Supply and Wastewater Conveyance (Includes reductions from WT-2 to WT-4)		*6,142,554*	*0*	*1,494*
WT-2	Low-Maintenance Landscaping (Included in WT-1)	Revision of Existing Action	*83,560*	*0*	*20*
WT-3	Watering Reductions in City Parks (Included in WT-1)	Revision of Existing Action	*320,383*	*0*	*78*
WT-4	Long-term Water Saving Strategies and Drought-Response (Included in WT-1)	New Action	*2,671,777*	*0*	*650*
SUBTOTAL: Water Management			**6,745,066**	**0**	**1,641**
Streetlights and Signals Sector (SS)					
SS-1	Streetlight LED Program	Revision of Existing Action	6,563,354	0	1,596
SS-2	Traffic Signals LED Program	Revision of Existing Action	241,725	0	59
SUBTOTAL: Streetlights & Signals			**6,805,079**		**1,655**
Vehicle Fleet Sector (VF)					
VF-1	Fleet Efficiency and Electric Fleet Pledge	Continuation and Revision of Existing Action	NA[a]	NA[a]	597
VF-2	Alternative Fuels: Renewable Natural Gas	Revision of Existing Action	NA[a]	NA[a]	6,523
SUBTOTAL: Vehicle Fleet					**7,120**
Urban Forest Sector (UO)					
UO-1	Expanding the Urban Forest	Continuation of Existing Action	243,378	6,932	422
	Tree Shading		*243,378*	*6,932*	*105*
	Annual Carbon Sequestration		-	-	*316*
SUBTOTAL: Urban Forest			**243,378**	**6,932**	**422**
TOTAL (Excluding Urban Forest)			**17,146,082**	**12,352**	**11,372**
TOTAL (Including Urban Forest)			**17,389,460**	**19,285**	**11,794**

Notes:
NA = not applicable
VFD = Variable Frequency Drive
HVAC = heating, ventilation, and air conditioning
LED = light-emitting diode

[a] Emissions savings are because of reductions in fuel use.

Source: Ascent Environmental 2015

4.2 ACTIONS UNDER IMPLEMENTATION OF RENEWABLE PORTFOLIO STANDARDS

In addition to actions that the City implements, local utilities that generate and distribute electrical power also play an important role in reducing GHG emissions in the Sacramento region. SMUD provides service to City facilities in Sacramento County, while Pacific Gas & Electric Company (PG&E) provides service to the few City facilities outside Sacramento County. The State of California has mandated that by 2020 the share of renewable energy used to generate power, commonly referred to as a utility's "renewable portfolio," for all investor-owned utilities, electric service providers, and community choice aggregators shall be increased to 33 percent of total electricity generation. GHG emission factors for electrical power are therefore expected to decrease over time for both SMUD and PG&E.

In the 2020 BAU scenario, the City is expected to purchase approximately 103,640 MWh. From 2005 to 2020, SMUD's electricity emission factor is anticipated to decline from 0.279 $MTCO_2$ per MWh to 0.242 $MTCO_2$ per MWh, a 13 percent reduction. Applying the difference in emission factors to the BAU electricity use, the RPS standard would account for approximately 3,882 $MTCO_2e$ in savings (absent any actions).

Table 7 below summarizes the combined effect of both City and SMUD actions by 2020. SMUD actions in achieving the 33 percent RPS goal only accounts for 5 percent of the estimated reduction from 2005 levels. The City's current actions through 2013 and the implementation of additional actions through 2020 account for the remaining 28 percent reduction from 2005 levels.

Table 7 Summary of Total Combined GHG Reductions from IO CAP Actions and State RPS

	GHG Emissions ($MTCO_2e$)	Percent Change from 2005
Total Baseline GHG Emissions in 2005	78,584	0%
2020 Reductions SMUD Renewable Portfolio (33% by 2020)	-3,882	-5%
2020 Reductions from 2016 IO CAP GHG Actions	-22,112	-28%
Total Reductions by 2020, 2005-2020	-25,994	-33%

Notes:
RPS = Renewable Portfolio Standard
SMUD = Sacramento Municipal Utility District

Source: Data compiled by Ascent Environmental, Inc. in 2015

4.3 DETAILED ANALYSIS OF GHG REDUCTION STRATEGIES

The 2010 IO CAP identified GHG reduction strategies that were either implemented or were expected to be implemented between 2005 and 2020. The City implemented many of these actions by 2013. As part of this IO CAP Update, the City identified additional GHG reduction strategies that have been implemented since 2013 or that will be implemented before 2020. These new actions are presented in addition to the reductions already achieved by 2013, as benchmarked by the 2013 GHG inventory.

4.3.1 Past Accomplishments that Reduced GHGs (2005-2013)

Identifying past or existing emissions reduction efforts is an important step to understand the success and effectiveness of efforts to date. Reviewing past actions may help provide guidance for future efforts. Some programs or projects that occurred before 2013 are described in this section because they illustrate past achievements or provide context for implementing ongoing or improved efforts. It is important to note that past achievements are not credited towards reductions from the 2013 inventory, as the credit of such actions would already be reflected in the 2013 baseline.

Some notable past accomplishments include the installation and operation of solar photovoltaic (PV) panels on City facilities, energy efficiency retrofits at existing buildings, and information technology improvements that together saved the City over 12,500 MWh per year, or enough to power 1,145 homes per year (EIA 2015). However, some programs or projects that involve gradual phasing over time are described as ongoing projects and credited for increased emissions reductions beyond 2013. These on-going programs include replacement of streetlights with LED technology and continued improvements in pumping efficiency at water management facilities.

Previous GHG reductions achieved between 2005 and 2013 are detailed in Appendix B. As noted previously, the City's past actions have helped reduce emissions by 18,829 $MTCO_2e$, or 24 percent, since 2005.

4.3.2 Recent or Planned Actions to Reduce GHG Emissions (2013-2020)

Since 2013, the City has continued to implement programs and projects that save energy and reduce GHG emissions, building upon past successes. These are noted in each sector where appropriate and are counted towards meeting the City's 2020 targets. The City also continues to implement new ideas and approaches not identified in the 2010 IO CAP that can be implemented before 2020 to reduce energy and GHG emissions, both for its own operations and for the broader community. At the planning level, new policies were approved recently as part of the 2035 General Plan (adopted in May 2014).

New policies not previously included in the 2010 IO CAP include several building and facility efficiency upgrades, drought-response water shortage actions, and increased purchase of renewable natural gas (RNG) supply for vehicle fleets. Some continuing measures include the final completion of LED conversion for streetlights, improving the pumping efficiency for water management facilities, and additional watering reductions at City parks. The new and continuing measures are analyzed with respect to anticipated population growth, which is assumed to affect some aspects of City services. More information on growth assumptions for GHG emissions forecasts is available in Section 3.2.

4.4 METHODS AND KEY ASSUMPTIONS

Key methods, sources, and assumptions to calculate reductions for the IO CAP Update follow.

Annual Reductions from the 2020 BAU Scenario

- To account for future growth in the midst of the City's CAP actions, estimated annual reductions in GHG emissions for each action are identified in terms of reductions from the forecasted 2020 BAU scenario for the applicable sector.

GHG Emission Factors

- Electricity
  - CO_2, CH_4, and N_2O emission factors per kWh of electricity consumed were based on the following sources.

- SMUD (CO_2 only)
  - In 2013 and 2014, SMUD achieved 30.0 percent renewable portfolio and emitted 0.253 $MTCO_2$ per MWh (SMUD 2014, SMUD 2013). This was used to estimate a non-renewable emission factor and calculate the emission factor in 2020, assuming achievement of the 33 percent RPS goal. In 2020, electricity generation from SMUD could generate 0.242 $MTCO_2$ per MWh.
- PG&E (CO_2 only)
  - In 2013, PG&E achieved 23.8 percent renewable portfolio and emitted 0.076 $MTCO_2$ per MWh (PG&E 2013a, 2013b). This was used to estimate a non-renewable emission factor and calculate the emission factor in 2020 assuming PG&E achieves the 33 percent RPS goal. In 2020, electricity generation from PG&E could generate 0.067 $MTCO_2$ per MWh.
- eGRID 2010 (CH_4 and N_2O)
  - CH_4 and N_2O emission factors are available for the California region from the EPA's eGrid 2010 report, updated in February 2014 (EPA 2014). Assuming that the CH_4 and N_2O emission factors reflected the SMUD's renewable portfolio in 2013 and would achieve 33 percent renewables by 2020, 2020 CH_4 and N_2O emission factors would be 12.4 and 2.6 g per MWh, respectively.

- Natural Gas
  - CO_2, CH_4, and N_2O emission factors per MMBTU of natural gas consumed were available from Table 12.1 of the 2014 Climate Registry Emission Factors report (The Climate Registry 2014). The Climate Registry reports a U.S. weighted average emission factors of 53.02 kg CO_2, 5 g CH_4, and 0.1 g N_2O per MMBTU of natural gas combusted.
- Transportation Fuels
  - Gasoline and diesel vehicle emissions were calculated using mileage based emission factors from ARB's Emission Factor Model (EMFAC) 2014 database. Emission factors vary by model year and vehicle type.
  - CNG, LNG, propane, hybrid gasoline, and E85 vehicle emissions were calculated using fuel-based emission factors from the 2014 Climate Registry (Climate Registry 2014).
  - Electric vehicle (EV) energy use was calculated by estimating the electricity use derived from applicable EV efficiencies from EPA's fuel economy database (EPA 2015) and known vehicle mileage. SMUD 2020 emission factors were then applied to calculate emissions.
- Solid Waste
  - EPA's LandGem Model Version 3.02 was used to estimate the decay in fugitive landfill emission from 2013 to 2020.

Quantitative vs. Qualitative: Many of the measures were quantified in terms of their expected effectiveness in reducing GHG emissions; however, several actions are supportive of other actions, or lack sufficient data to reasonably estimate the effectiveness of a particular program or project. Such measures are shown as a general strategy and included in this 2016 IO CAP Update for ongoing monitoring and implementation.

Double-Counting: Methods minimize the potential for double-counting GHG emission reductions wherever possible. Several action strategies were calculated independent of other actions, while others were modeled against one another.

4.5 BUILDING ENERGY

The City has an extensive history of working to substantially reduce energy use and associated GHG emissions from buildings and facilities. Between 2005 and 2013, the City applied several energy conservation measures, which resulted in a savings of over 13,000 MWh per year and 55,000 therms per year from 2005 levels. These energy savings contributed to a reduction of approximately 3,000 $MTCO_2e$ from 2005 levels. However, as noted before, these reductions cannot be counted towards meeting the 2020 target because they occurred before 2013 and are already reflected in the 2013 benchmark.

Actions BE-1 through BE-3 would reduce City's energy use by an additional 3,596 MWh and 12,352 therms from 2013 levels by 2020, equivalent to an overall reduction of GHG emissions for this sector by 36 percent. Along with the actions presented in WT-1 through WT-4, the City's energy use would be reduced by 30 percent from 2005 levels, consistent with the target in General Plan Policy U 6.1.4., as shown in Table 8 below. Due to the anticipated expansion of renewable energy sources through the RPS, this 30 percent reduction in energy use will correspond to a 36 percent reduction in GHG emissions for the sector.

Table 8 Estimated Change in Energy Use at City Facilities, 2005 to 2020, with CAP Actions

Energy Use	2005	2020	Difference from 2005 to 2020	% Change from 2005 to 2020
Building + Water Energy (MWh)	100,737	71,971	-28,766	-29%
Building Energy (therms)	1,184,133	789,544	-394,589	-33%
Total Energy (MMBTU)	462,141	324,530	-137,612	-30%

Note:
MMBTU = million British thermal units

Source: Sacramento County 2009, 2020 Data compiled by Ascent Environmental, Inc. in 2015

Building energy actions are further described below. These actions focus on continued energy efficiency retrofits and sustainable building design.

BE-1: Energy Savers Campaign - "Lights & Equip Off" Policy (Continuing Action)

OVERVIEW

A City policy adopted in 2009 directs City staff to turn off all lights and computers when not in use. Lighting and computer use can account for 40 to 50 percent of a building's energy consumption. Many lights and computers in City buildings are left on overnight. By simply turning off lights, computers, fax machines, printers, copiers, or other office equipment at the close of business, significant energy and GHG savings could be achieved at no cost.

While there is specific information available about equipment energy use in the City's buildings and facilities, it is difficult to estimate the potential success of behavioral changes over time related to a variety of different types of lighting and equipment. Some facilities are already equipped with timers and/or occupancy sensors to optimize lighting performance, while others are manually controlled. Nevertheless, the fact that just under half of a typical building's energy use comes from lighting and office equipment, underscoring the potential for significant energy savings.

GHG REDUCTION ANALYSIS

As discussed further in Appendix B, GHG reductions from the City's building energy GHG reduction actions before 2013 accounted for less than half of the actual reductions realized between 2005 and 2013 (3,083 out of 8,719 $MTCO_2e$). The effect of "Lights and Equip Off" policy was not quantified as part of these actions and, thus, could have contributed to the additional reductions. Although this measure could have likely contributed to past reductions in energy use, no monitoring program has been in place or is proposed to measure the effectiveness of this measure. Despite an inability to isolate the energy reductions from this measure, the City continues to encourage behavioral efforts to conserve energy use and costs. The City plans to continue to implement this measure.

FEASIBILITY AND IMPLEMENTATION

The Department of Public Works (DPW) will be the lead staff for this program, working in cooperation with the Office of the City Manager and managers of City buildings. Staff could explore creation of an education or incentive program to encourage conservation behaviors.

BE-2: Green Building Policy for New City Buildings (Continuing Action)

OVERVIEW

"Green buildings" are designed, constructed and operated according to a whole-systems approach to achieve efficient use of energy, reduce consumption of water and raw materials, and avoid or reduce waste. Green building techniques also use other techniques that improve overall sustainability of the built environment. The concept of Green Building represents a growing paradigm shift in the design and construction industry in the movement towards sustainability. Through the efforts of the U.S. Green Building Council,[6] Build It Green,[7] and other organizations, efforts are underway to standardize green building techniques through the adoption of certification standards such as the Leadership in Energy and Environmental Design (LEED) rating system for new and existing commercial and institutional buildings, and Build It Green's GreenPoint Rating system for new and existing residential homes.

In 2004, the City Council adopted a resolution establishing goals for all new and remodeled City facilities to meet a minimum LEED Silver standard. Since the policy was adopted, six new city facilities were designed and constructed between 2005 and 2010, all of which achieved LEED Silver or Gold certification by the US Green Building Council. All six have also exceeded California Title 24 Building Energy Efficiency Standards by at least 20 percent or more. The City received the Green California Leadership Award in 2011 for these certifications.

The City's 2035 General Plan Land Use Policy LU 8.1.5 reiterates the City's ongoing commitment that new or renovated City-owned buildings are energy efficient and meet, as appropriate, LEED Silver or equivalent standards.

GHG REDUCTION ANALYSIS

The City plans to rebuild and expand two existing fire stations by 2020: Fire Stations 14 and 15. Reductions for these buildings are modeled on the recently constructed Fire Station 43, constructed in 2010 to LEED Silver standards. Fire Stations 14 and 15 will be replaced with larger fire station facilities, accommodating the City's growth in services. Assuming that these new fire stations would consume energy at the same energy intensity ratio as the newly built Fire Station 43, Table 9 below shows anticipated building energy performance resulting from the City's Green Building Policy. In total, this measure is anticipated to result in savings of 14 $MTCO_2e$ by 2020.

[6] More information about USGBC and LEED can be found at http://www.usgbc.org/
[7] More information about Build It Green can be found at http://www.builditgreen.org/

Table 9	Future Annual Energy Savings from Green Building Policy for New Buildings				
Location	Sqft	kWh/year	Kwh/sqft/year	therms/ year	therms/sqft/year
Existing					
Fire Station 43 (LEED Silver)	14,732	202,866	14	2,059	0.01
Fire Station 14	2,684	30,400	11	1,116	0.04
Fire Station 15	2,651	35,145	13	805	0.02
New (Using Title 24 Standards)					
Fire Station 14	12,000	194,406	16	143	0.01
Fire Station 15	12,000	194,406	16	143	0.01
New (Using 2011 LEED Silver Standards)					
Fire Station 14	12,000	165,245	14	122	0.01
Fire Station 15	12,000	165,245	14	122	0.01
Avoided Energy Use in 2020					
Fire Station 14	0	29,161	2.43	21	0.00
Fire Station 15	0	29,161	2.43	21	0.00
Net Change in Energy Use from 2013					
Fire Station 14	9,316	134,845	2.44	-994	-0.03
Fire Station 15	9,349	130,100	0.51	-683	-0.01

Notes:

Calculation assumes that Fire Station 43 achieved energy efficiency rates 15 percent better than concurrent Title 24 standards.

Sqft = square feet
LEED = Leadership in Energy & Environmental Design

Source: Data compiled by Ascent Environmental, Inc. in 2015

Note that, despite increased building energy efficiency, GHG emissions generated by these new fire stations would still be greater than 2013 levels because of the increased square footage of the facilities. With respect to the specific planned fire stations, the green building program would result in an avoided emissions of 14 $MTCO_2e$ per year by 2020, but would increase emissions by 53 $MTCO_2e$ per year over 2013 levels due to the increased building size.

FEASIBILITY AND IMPLEMENTATION

The City has demonstrated its ability to implement a minimum of LEED Silver standards in seven different City-owned buildings built since 2009 – the North Natomas Library, Valley Hi Library, George Sim Community Center Expansion, Oak Park Community Center Expansion, Robbie Waters Pocket Library, and Fire Station 43.

The City's Department of Public Works is the lead implementing Department for this action strategy. The new facilities constructed between 2009 and 2015 were funded through the City's Capital Improvement Program, the City's Community Reinvestment Capital Improvement Program (CRCIP), and/or development impact fees. At the time of writing in 2015, full funding for Fire Stations 14 and 15 still needed to be determined.

BE-3: Energy Efficiency Retrofits Program for Existing Facilities (Continuing Action)

OVERVIEW

The City's Energy Efficiency Retrofits program for City facilities is designed to provide better facility systems performance with higher efficiencies, resulting in reduced energy costs and maximizing return on investment. The current and future program builds on past success and partnerships with SMUD in greening the City's facilities. By identifying cost-effective improvements to existing facilities in heating/cooling, lighting, pumping systems, and other facility components, the City can both reduce energy usage and GHG emissions in a cost-effective manner.

Building upon past achievements, the City identified several recent actions and new opportunities to improve energy efficiency at existing buildings. These past and future actions include:

- **Convention Center Lighting Retrofit:** Since the end of 2013, the City has replaced metal halides with LEDs, replaced 1st generation T8s with 4th generation fixtures, and replaced incandescent screw-ins with LED screw-ins.

- **Swimming Pool Variable Frequency Drives (VFD):** Since 2014, the City will have installed variable frequency drives at 10 city-owned pools.

- **Hart Senior Center Heating, Ventilation, and Air Conditioning (HVAC) Replacement:** Since July 2013, the City has completed the retrofit of the existing single zone packaged rooftop HVAC system to a new Variable Refrigerant Flow heat pump system. In addition, the City has performed a total replacement of the old built-up roof with a new single-ply membrane roof.

- **Panattoni HVAC replacement:** Since 2013, the City has completed the retrofit of the existing dual duct Variable Air Volume HVAC system to a new variable refrigerant flow heat pump system.

- **Kinney Police Station LED retrofit:** The City is currently retrofitting the Kinney Police Station to convert existing traditional lighting systems to LED.

- **Additional Energy Efficiency Retrofits on Existing City Facilities:** The City estimates that by 2020, additional energy efficiency upgrades at existing facilities can save 2,500,000 kWh per year in addition to upgrades already noted above.

Electricity and natural gas savings resulting from these efforts are presented in Table 10.

GHG REDUCTION ANALYSIS

Based on the realized and anticipated future energy savings, energy efficiency retrofits at existing City buildings would reduce forecasted 2020 building energy emissions by 942 $MTCO_2e$. Savings achieved by each of the upgrade identified in the list above are summarized in Table 10 below.

Table 10 Facility Energy Efficiency Retrofit Program: Summary of Annual Project Energy Savings in 2020 from the BAU Scenario

Project Title	Avoided Electricity in 2020 (kWh)	Avoided Natural Gas in 2020 (therms)	Avoided GHG in 2020 ($MTCO_2e$)
Convention Center Lighting Retrofit	333,389	0	81
Swimming Pool VFDs	522,795	0	127
Hart Senior Center HVAC Replacement	16,708	1,610	15
Panatoni HVAC replacement	81,445	10,700	91
Kinney Police Station LED retrofit	83,279	0	20
Additional Energy Efficiency Retrofits on Existing City facilities	2,500,000	0	608
Total Savings	3,537,616	12,310	942

Notes:
VFD = Variable Frequency Drive
HVAC = heating, ventilation, and air conditioning
LED = light-emitting diode

Source: Data compiled by Ascent Environmental, Inc. in 2015

FEASIBILITY AND IMPLEMENTATION

DPW, working in partnership with other City Departments, continues to strive towards improving energy efficiency at City buildings and facilities. The Department is investigating other funding options to continue improvements, including state and federal grant programs. Since 2013, DPW has already completed nearly one-third of the anticipated energy reductions to be realized by 2020, demonstrating the capacity to continue the additional energy retrofit efforts.

4.6 WATER AND WASTEWATER MANAGEMENT

The City of Sacramento is uncommon among local governments in that it also provides water delivery services to residents and businesses within the city, in addition to stormwater management and sewer collection services. Water use is correlated with electricity needed to power pumps and lifts for water and wastewater transport. Pumping for stormwater drainage varies year to year depending on the level of precipitation the area receives.

According to the 2013 municipal GHG inventory, water management accounted for 44 percent of combined energy use for building and water energy use. In 2020, water demands from residents and businesses are anticipated to grow with population, but stormwater drainage pumping would depend on annual precipitation. The recent drought has substantially lowered energy demand attributable to stormwater drainage pumping in 2013, declining by 35 percent from 10,406 MWh in 2005 to 6,809 MWh in 2013. Annual precipitation trends in 2005 were substantially wetter year on average than 2013, at 22.11 inches/year in 2005 versus 4.65 inches/year in 2013 (Weather Underground 2015).This analysis assumes that 2020 BAU energy demands would reflect the average of 2005 and 2013 at 8,607 MWh per year.

The City has identified areas where energy used for water management can be reduced through improving the pumping and conveyance efficiency for water and wastewater delivery, including reducing water demands from City operations that would in turn reduce the amount of water or wastewater delivery needed. Most of the following efforts are revisions of past actions to increase efficiency gains or increase water reduction efforts. The City anticipates that water reduction policies and community-wide drought-response cutbacks would lower BAU water demands and subsequent demands on City pumps, resulting in steady levels of annual water demand in 2020 despite anticipated population growth.

WT-1: Water, Wastewater, and Drainage Pumping Efficiency and System Optimization (Revised Action)

OVERVIEW

Since the late 1990s, the City's Department of Utilities (DOU) has been continually seeking new options and technologies to improve the energy and operational efficiencies of the City's water delivery system. Most of these actions have included upgrades to more efficient motors and pumps, but also include pumping logistics. In 2013, the City commissioned an "Energy Management Operations Study" to identify additional improvements that the City could conduct in the water delivery sector by 2020. This report, written by energy consultants Black and Veatch for the City of Sacramento, provided different recommendations for storm drainage management and water and wastewater conveyance. These strategies are analyzed for GHG reductions below.

Stormwater Drainage

According to the Black and Veatch report, implementing an alternate control strategy that allows the level in wet wells to increase during summer months and periods of low rainfall would reduce energy needed to provide hydraulic lift in drainage facilities. The report estimates that this alternate control strategy can reduce energy use for drainage pumping by between 4 and 10 percent. (City of Sacramento 2013a: ES-4). This assumes no change in stormwater drainage needs from the baseline year.

Water and Wastewater Conveyance

Based on the 2013 Black and Veatch Report, selecting more efficient pumps or pump combinations could result in increases of 6 to 8 percent in energy efficiency, without pump asset changes. Black and Veatch estimates a nominal 6 percent reduction in energy use to move the same volume of water. If more production is shifted from the Sacramento Regional Wastewater Treatment Plant to the Fairbairn Water Treatment Plant Expansion Project, approximately an 11 percent energy reduction could be achieved (City of Sacramento 2013a: ES-7).

GHG REDUCTION ANALYSIS

To quantify the GHG reductions from the recommended water management improvements, it was assumed that the City would achieve the median percent reduction in energy use as estimated by the Black and Veatch report by 2020. The reduction in energy use would lead to a reduction in upstream electricity generation emissions, based on SMUD emission factors with full RPS attainment. In addition, water reduction measures external to this action would also reduce the volume of water pumped. The effect of other water reduction measures is discounted from this measure to avoid double counting.

Stormwater Drainage

Full implementation of this action is anticipated to reduce stormwater drainage energy use by 7 percent from forecasted 2020 energy use. Forecasted energy use in 2020 reflects an approximate average precipitation year that reflects averaging stormwater drainage energy use from 2005 and 2013, as described above. Table 11 below shows the energy reductions anticipated from improvements in stormwater drainage efficiency and operation. As shown below, stormwater drainage energy use could be reduced by 603 MWh from the BAU scenario in 2020. This translates to a reduction of 147 $MTCO_2e$. See additional details in Appendix C.

Table 11 Calculation of Energy Reductions from Stormwater Drainage Improvements (WT-1)

	Value	Units	Source
2005 Energy Use for Drainage Pumping	10,406	MWh	City records
2013 Energy Use for Drainage Pumping	6,809	MWh	City records
2020 Annual BAU energy use from Stormwater Pumping	8,607	MWh	Calculated (Average of 2005 and 2013)
Black and Veatch Minimum Energy Reduction	4%	percent	City of Sacramento 2013a:ES-4
Black and Veatch Maximum Energy Reduction	10%	percent	City of Sacramento 2013a:ES-4
Black and Veatch Median Energy Reduction	7%	percent	Calculated
Reduction from 2020 BAU Stormwater Drainage	603	MWh	Calculated
2020 Energy Use for Stormwater Drainage under WT-1	8,005	MWh	Calculated

Source: City of Sacramento 2013a, data compiled by Ascent Environmental, Inc. in 2015

Water and Wastewater Conveyance

Full implementation of this action is anticipated to reduce water and wastewater conveyance energy intensity by 9 percent from the City's 2013 electricity use in kWh per million gallons (MG). In 2013, water and wastewater conveyance had energy intensities of 968 and 384 kWh per MG, respectively. With the recommended improvements to the pumps as reported in the Black and Veatch report, these energy intensities could be reduced to 886 kWh per MG for water conveyance and 351 kWh per MG for wastewater conveyance.

Under the implementation of other water measures included in this CAP, future 2020 water demands on pumping would be lower than forecasted under the BAU scenario due to water conservation by the City and community (see Actions WT-2, WT-3, and WT-4). These water conservation actions would result in a reduction of 3,211 MG in annual water conveyance demand and 1,059 MG in annual wastewater conveyance demand from the forecasted BAU scenario. Table 12 below shows the quantification of the anticipated energy reductions associated with improving water and wastewater conveyance efficiencies as recommended in the Black & Veatch report (City of Sacramento 2013a). It is assumed that the proposed energy efficiency improvements have the same effect on both water and wastewater conveyance activities.

Table 12 Improvement in Water and Wastewater Conveyance Energy Intensities (WT-1)

	Value	Units	Source
2013 Water Energy Intensity	968	kWh/MG	Calculated
2013 Wastewater Energy Intensity	384	kWh/MG	Calculated
Black & Veatch Min Energy Reduction	6%	percent	City of Sacramento 2013a:ES-7
Black & Veatch Max Energy Reduction	11%	percent	City of Sacramento 2013a:ES-7
Black & Veatch Median Energy Reduction	9%	percent	Calculated
New 2020 water conveyance energy intensity under WT-1	886	kWh/MG	Calculated using median reduction
New 2020 wastewater conveyance energy intensity under WT-1	351	kWh/MG	Calculated using median reduction

Source: City of Sacramento 2013a, data compiled by Ascent Environmental, Inc. in 2015

Table 13 shows the reduced water and wastewater demands anticipated in 2020 with the implementation of other water measures in this CAP.

Table 13 Water Supply and Wastewater Conveyance Volumetric and Energy Savings under CAP Implementation			
Water Savings	Water Supply (MG)	Wastewater (MG)	Total (MG)
BAU 2020 Demand for Conveyance	34,298	11,103	45,401
Water Savings from: WT-2: Low-Maintenance Landscaping	-94	0	-94
Water Savings from: WT-3: Watering Reduction in City Parks	-373	0	-373
Water Savings from: WT-4: Long-term Water Savings Strategies and Drought Response	-2,744	-1,059	-3,803
Total Savings	-3,211	-1,059	-4,270
2020 Demand after CAP actions	31,087	10,044	41,131
Energy Savings	Water Supply (MWh)	Wastewater (MWh)	Total (MWh)
2013 Energy Use for Conveyance	37,614	2,968	40,582
2020 BAU Energy Use with 2013 energy intensities	33,214	2,758	35,972
2020 New Energy Use with New energy intensities	27,545	2,283	29,828
Difference from 2020 BAU	5,669	475	6,144
Difference from 2013	10,069	685	10,754

Note:
BAU = business-as-usual
MG = million gallons
CAP = climate action plan
MWh = megawatt-hours

Source: City of Sacramento 2013a, data compiled by Ascent Environmental, Inc. in 2015

Application of the new water intensities to the revised forecast of water and wastewater conveyance demands result in electricity savings of 6,144 MWh from the BAU scenario. Cumulatively, water and wastewater actions result in savings of 1,641 $MTCO_2e$ in 2020. Note that energy savings presented in actions WT-2 through 5 are subsets of these savings, but presented separately for informational purposes. The purpose of separately reporting credit for supportive actions is to recognize the importance of the City's water conservation efforts. See additional details in Appendix C.

FEASIBILITY AND IMPLEMENTATION

The City has already implemented numerous successful energy efficiency improvements to its water system, with ongoing annual energy savings and GHG reductions anticipated through 2020. In addition, the 2013 Black & Veatch report identifies additional project opportunities. DOU will continue to monitor the feasibility of additional future improvements.

WT-2: Low-Maintenance Landscaping (Revised Action)

OVERVIEW

City departments are continuing to explore ways to incorporate sustainable or low-maintenance landscaping to reduce the demand for water used to irrigate City landscapes. These landscapes include City-maintained trees, lawns, and ornamental turf around City buildings and streetscapes. Streetscapes include vegetation and landscaping along street medians, sidewalks, and other thoroughfare features. This measure does not include landscaping at parks, which is included separately under WT-3. In addition to past landscape conversions identified in the IO CAP Update, the City also plans to do the following:

- Reduce irrigation for ornamental turf,
- Remove vegetative ornamental turf, and
- Remove water demand permanently, where appropriate, at City-owned building landscaping and streetscapes.

As of March 2016, in response to severe drought conditions, the City discontinued the watering of ornamental turf area in the 490 acres of streetscapes maintained by the City throughout the community. The exact acreage of turf area within the total streetscape surface area affected is unknown. Based on the current drought, the City does not anticipate replanting turf in the 490 acres of streetscapes, resulting in the potential for permanent water reductions from this strategy.

GHG REDUCTION ANALYSIS

A permanent reduction in watering for 490 acres of streetscapes would result in a savings of 94 MG of water per year by 2020. This assumes that the City would have used 0.19 MG of water per acre per year for irrigation, based on the City's water use at City parks in 2014 (see WT-3). Applying the new water energy intensity through the implementation of action WT-1, this would result in a savings of 83,560 kWh per year or 20 $MTCO_2e$ in 2020 from the BAU scenario. These savings are reflected in the cumulative savings in WT-1.

FEASIBILITY AND IMPLEMENTATION

The City has already discontinued watering of 490 acres of streetscapes. Additional reductions in watering are possible, but would need to consider ramifications associated with maintaining old-growth trees or other long-term community impacts. Watering reductions would also result in monetary savings in water consumption; however, other considerations include the City's future planning goals to maintain the quality of landscaping throughout Sacramento's neighborhoods. The City continues to seek opportunities for water conservation while protecting the urban canopy.

WT-3: Watering Reductions in City Parks

OVERVIEW

In addition to converting landscapes to low-water use features and plantings, the City has also reduced water use at City parks through operational changes, such as controlled irrigation schedules and weather sensitive irrigation systems. In 2010, DPR reduced water use by changing its watering schedule from 5 to 3 days per week, with watering occurring only during evening hours to reduce evaporation. In 2013, the City has achieved further efficiencies in the watering schedule in response to the on-going drought. The City estimates that by 2020, 900 park acres will have centralized weather sensitive irrigation systems installed that can reduce water needs by 15 percent.

The City currently operates 3,200 acres of parkland and has achieved sizable reductions in water use to date, as further described below. The City anticipates building on these early accomplishments for sustained decreases in overall water use, even with the construction of new parks facilities.

GHG REDUCTION ANALYSIS

In 2014, the City reduced water usage at parks by 37 percent, or 362 MG. Under a 2020 BAU scenario, water usage would equal 2014 levels. New park acreage in 2020 is anticipated to contribute an additional 7 MG by 2020, resulting in total reductions of 623 MG per year. Under WT-3, the City anticipates an average 18 percent reduction in City park water usage year-over-year from 2013 to 2020. This would result in annual park water usage of 254 MG per year for existing parks, or 261 MG with the inclusion of new anticipated park acreage in 2020. In total, this measure would result in a net reduction of 362 MG from the BAU scenario.

Using the water energy intensities calculated from WT-1, watering reduction at City parks would save 320 annual MWh, or 78 $MTCO_2e$, by 2020. These savings are reflected in the cumulative savings in WT-1.

FEASIBILITY AND IMPLEMENTATION

In 2014, the City achieved dramatic reductions in water consumption at parks in the span of just one year. Sustained reductions in water use at parks would depend on available technology as well as a detailed plan by the Department of Parks and Recreation (DPR). Given that water rates that DOU charges is anticipated to continue increasing increase in the future, DPR and other departments will have a strong incentive to conserve water.

WT-4: Long-Term Water Saving and Drought-Response (New)

OVERVIEW

The City Council adopted a Water Conservation Plan (WCP) in 2013 which identifies over 20 community-wide water conservation actions. The intent of the WCP is to ensure compliance with requirements established by Senate Bill (SB) X7-7 to reduce urban per capita water consumption 20 percent by the year 2020. As demonstrated in the WCP, to attain this level of reduction, the City of Sacramento must achieve water use of 223 gallons per capita per day (GPCD) by 2020. These water conservation actions, listed in Appendix E, are primarily focused on reducing water consumption by the City's residential and commercial water customers. Yet water conservation also plays an important role in reducing the need for energy consumption related to water production and conveyance. One of these conservation actions is implementation of the advanced metering infrastructure (AMI) and leak detection program, which would promote water conservation by switching customers from flat rate to usage-based billing and reducing water waste. This strategy yields the benefit of avoided capital and environmental costs associated with the development of new water diversion and treatment infrastructure. The WCP estimates that these measures, in addition to changes in the future plumbing code, can reduce community-wide water usage by up to 12 percent or 5,199 MG[8] from the BAU scenario and meet the 223 GPCD goal in the WCP by 2020 (Program C of the WCP) (City of Sacramento 2013b).

These water savings, however, were calculated independent of real life fluctuations in water demand. In 2014, the City experienced a 19 and 12 percent reduction in city-wide water and wastewater conveyance demand from 2013 levels, respectively. It is not immediately clear how much of this reduction is attributable to City conservation efforts or the community's own conservation efforts in the midst of the severe drought California is currently experiencing. Additionally, due to uncertainties with duration of the drought and historical responses to drought, the City anticipates that pre-drought water demands will not return by 2020, even with population growth. Lacking further empirical methods or data, it is anticipated that under the combined effect of WCP actions, community-wide drought response, and population growth, the City would experience a net zero change in water use between 2014 and 2020.

GHG REDUCTION ANALYSIS

Compared to the 2020 BAU scenario, long-term water savings strategies and community-wide drought response would save 2,744 MG per year in water supply demand and 1,059 MG per year in wastewater conveyance. Using the water efficiencies calculated from WT-1, watering reduction actions at City parks would save 2,671 MWh, or 650 $MTCO_2e$, per year by 2020. These savings are reflected in the cumulative savings in WT-1.

FEASIBILITY AND IMPLEMENTATION

The City can continue to encourage residents and businesses to reduce consumption as the drought continues; yet, actual drought response is achieved in partnership with the community. The feasibility of the

8 Based on the reduction potential from the application of the ongoing or new plumbing code and the WCP's proposed Program C. The 12 percent reduction was applied to actual City water usage rates in 2014 (instead of the WCP's currently outdated 2015 estimates).

actions is analyzed in the WCP implementation plan. The 2013 WCP estimates that implementation of Program C in the WCP will cost $3.94 million in 2020 (City of Sacramento 2013b: Table 8-1).

4.7 STREETLIGHTS AND TRAFFIC SIGNALS

The DPW operates and maintains the City's streetlights and traffic signals in the public right-of-way. In 2013, there were approximately 34,000 streetlights and over 600 signalized intersections, which used approximately 16,791 MWh and 2,372 MWh of electricity, respectively. Together, streetlights and traffic signals resulted in 4,267 $MTCO_2e$ in 2013.

SS-1: Streetlight LED Program (Continuing Action)

OVERVIEW

The City of Sacramento began a pilot project in 2010 to convert existing metal halide and other traditional incandescent streetlights to light-emitting diode (LED) technology. The pilot proved successful, resulting in conversion of 1,000 streetlight fixtures and annual savings of 3,240 MWh or 823 $MTCO_2e$ by 2013. The City plans to convert 100 percent of all City streetlights to LED by 2020, including any future streetlights associated with new development.

GHG REDUCTION ANALYSIS

By 2020, the number of streetlights operating within the City may grow proportionally with the City's population. Without the streetlight LED program, the City could continue to operate at 2013 efficiencies, potentially resulting in an 11 percent increase in energy use and a 7 percent increase in emissions.[9] Based on results from the LED pilot project, replacement of traditional incandescent streetlights with LED technology would save approximately 180 kWh per streetlight per year, assuming LED streetlights use 323 kWh per year. Assuming that the number of streetlights will increase by 11 percent to 33,576 in 2020 and assuming no changes in the distribution in streetlight styles (e.g., cobra head, mast arm lights), a 100-percent LED streetlight inventory in the City would avoid the use of 6,563 MWh and emissions of 1,596 $MTCO_2e$ per year in 2020 compared to the 2020 BAU forecast. See Table 14 and Appendix C for more details.

Table 14 Calculation of LED Streetlight Energy and Emission Savings (SS-1)

	Value	Unit	$MTCO_2e$	Source
Number of streetlights in 2013 (3% LED)	33,764	Fixtures	NA	City records
Number of streetlights in 2020	37,576	Fixtures	NA	City records
LED energy use per streetlight	323	kWh/light	NA	Calculated from 2013 inventory
Streetlight energy use in 2013 (3% LED)	16,791	MWh	4,084	City records
BAU streetlight energy use in 2020 (3% LED)	18,687	MWh	4,545	Assumes 11% population growth
LED streetlight energy use in 2020 (100% LED)	12,123	MWh	2,949	Calculated
Energy savings from BAU	6,563	MWh	1,596	Calculated
Energy savings from 2013	4,668	MWh	1,135	Calculated

Notes:
NA = not applicable
LED = light-emitting diode
Source: Data compiled by Ascent Environmental, Inc. in 2015

9 Because of the anticipated effect of the state's RPS goals.

FEASIBILITY AND IMPLEMENTATION

The streetlight LED pilot project was funded by a $100,000 program allocation through the City's Energy Efficiency & Conservation Block Grant (EECBG) and was implemented with in-kind technical assistance from SMUD of approximately $20,000 on energy performance monitoring. In 2013, SMUD rates were approximately $0.13 per kWh, which means that the City saved nearly $420,000 in the same year, recouping far more than the cost of the pilot project itself. The City anticipates completion of replacements of remaining LEDs. Implementation costs are unknown at this time. DPW is tasked with managing this effort.

SS-2: Traffic Signal LED Program (Continuing Action)

OVERVIEW

Since 1996, the City has actively worked to replace the majority of incandescent traffic signal fixtures with LED fixtures. Each LED fixture is approximately 50% more efficient than an incandescent fixture. Additionally, LED fixtures have an average lifespan of approximately seven years, five years longer than the two-year lifespan for incandescents, reducing signal maintenance & replacement costs.

As of late 2009, approximately 85 percent of traffic signals were already converted to LED fixtures. The 2010 IO CAP projected an annual reduction of 1,807 MWh between 2005 and 2015. In 2013, LED traffic signals saved 1,625 MWh, or 413 $MTCO_2e$, from 2005 levels.

GHG REDUCTION ANALYSIS

By 2020, the number of traffic signals operating within the City may grow proportionally with the City's population, similar to anticipated growth in streetlights. Without the traffic signal LED program, the City could continue to operate at 2013 efficiencies, potentially resulting in an 11 percent increase in energy use and 7 percent increase in emissions by 2020.[10] By the end of 2015, the City completed conversion of 100 percent of the City's traffic signals to LED technology. Assuming that the annual savings from 2005 traffic signal energy usage was achieved by 2015, traffic signals are estimated to use 2,189 MWh per year in 2015. Applying population growth factors to 2020 and assuming new signals will also be LED, future energy use and emissions from traffic signals is expected to be 2,398 MWh per year by 2020. This would result in avoided energy use and emissions of 241 MWh and 59 $MTCO_2e$ per year in 2020 from a BAU forecast. See Table 15 and Appendix C for more details.

Table 15 LED Traffic Signal Energy and Emission Savings in 2020 (SS-2)

	kWh	$MTCO_2e$	Source
LED signal energy use in 2013	2,372,353	603	City records
LED signal energy use in 2015 (100% LED)	2,189,009	532	Calculated assuming achievement of predicted savings in 2010 IO CAP
BAU signal energy use in 2020	2,640,193	642	Based on population growth from 2013
LED signal energy use in 2020 (100% LED)	2,398,469	583	Based on population growth from 2015
Savings from BAU	241,725	59	Calculated
Savings from 2013	-26,116	19	Calculated

Note:
NA = not applicable LED = light-emitting diode

Source: Data compiled by Ascent Environmental, Inc. in 2015

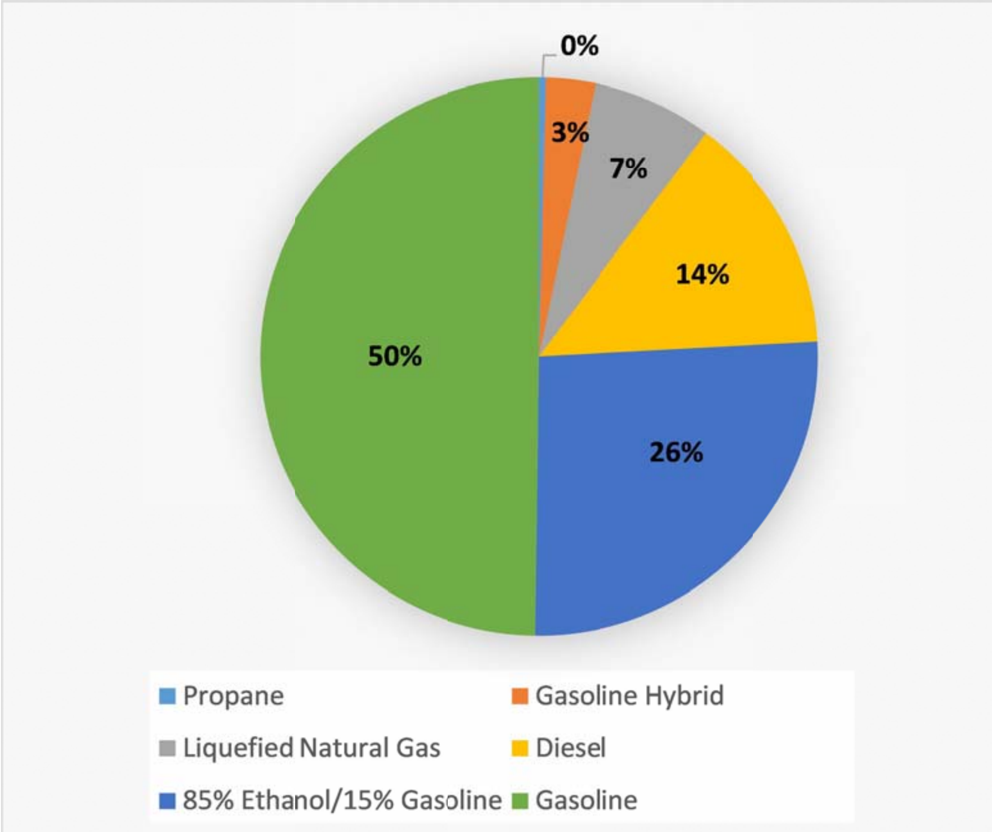
[10] The lower increase in emissions is because of the anticipated effect of the state's RPS goals (see above).

FEASIBILITY AND IMPLEMENTATION

LED replacements in traffic signals have proven to be highly cost-effective with significant energy savings. The DPW will continue to implement the traffic signal LED replacement program. Completion of the LED replacement program is estimated to cost around $500,000. Major funding sources for the LED replacement program include gas tax, major streets fund, and SMUD's LED rebate program. The progress and success of the City's traffic signal LED program thus far demonstrates the feasibility and cost benefits of continued installation of LED signals as the City grows.

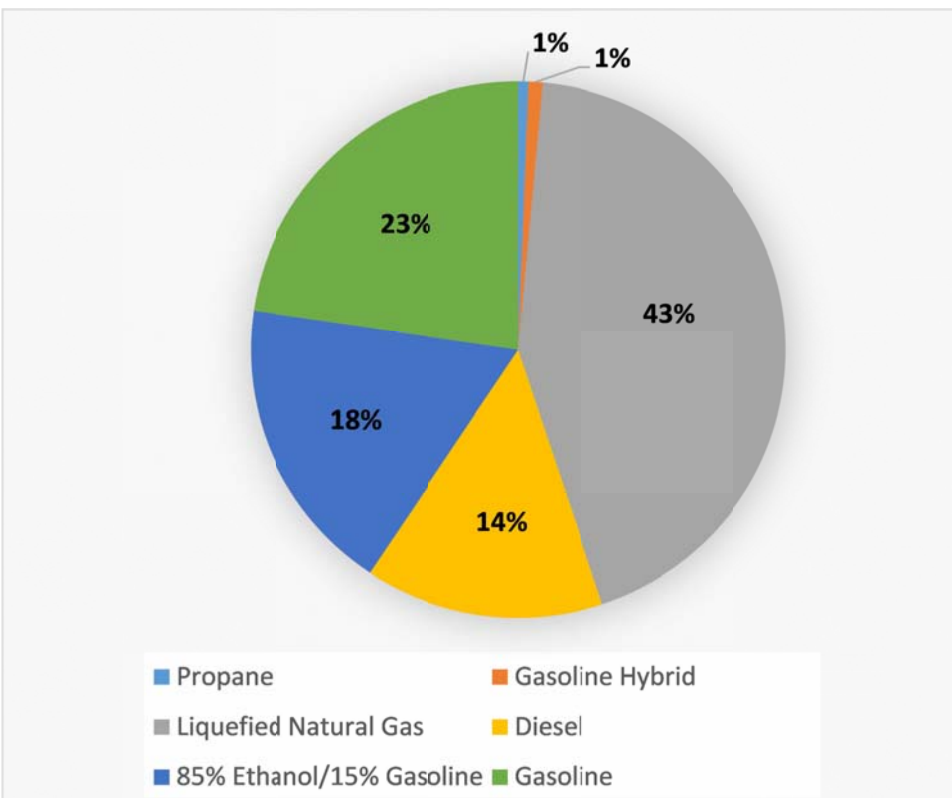
4.8 VEHICLE FLEET

The City's fleet in 2013 included 1,819 vehicles of various fuel types. Most of these vehicles provide direct services to the community, such as waste and recycling pick up, police, fire, and animal control services. A small proportion of the fleet is used to run the City's internal business operations. Figures 9 and 10 below identify the total vehicle fleet mileage and emissions in 2013 by fuel type. Emissions from vehicles vary by vehicle fuel efficiency and frequency of operations. ARB provides emission factors per mile based on vehicle type and model year, drawing on results from laboratory testing. Thus, using a mileage-based approach to calculate GHG emissions is more accurate than volumetric fuel consumption-based emissions estimates. Note that although some electric vehicles were part of the vehicle fleet, their mileage and emissions are negligible and not included in the following figures.



Source: Data compiled by Ascent Environmental, Inc. in 2015

Figure 9 Vehicle Fleet Mileage in 2013 by Fuel Type



Source: Data compiled by Ascent Environmental, Inc. in 2015

Figure 10 Vehicle Fleet Emissions in 2013 by Fuel Type

In comparing the two figures above, although gasoline vehicles represent the highest share (50 percent) of vehicle fleet activity in terms of total miles traveled, LNG vehicles cause the majority of vehicle fleet emissions. LNG is mostly used in heavy-duty solid waste collection vehicles that are generally less efficient than the gasoline and E85 vehicles, which mostly fuel light-duty vehicles. Between 2005 and 2013, 29 percent of new vehicles purchased were alternative fueled vehicles, mostly E85. The City also implemented a variety of programs within that time that resulted in substantial GHG emissions reductions, including fleet telemetrics, adjustments to the solid waste collection schedule, containerization of green waste collection, and a transition to in-region waste disposal. These actions allowed the City to reduce GHG emissions from the vehicle fleet sector by 3,313 $MTCO_2e$, 36 percent below 2005 levels in 2013. See Appendix B for more details and a list of completed actions that are either on-going or have permanent emissions reductions.

Actions for the vehicle fleet sector are described below, with potential to avoid 7,120 $MTCO_2e$ per year by 2020 from the BAU scenario. This would result in annual emissions of 8,209 $MTCO_2e$ per year from vehicle fleet emissions, which is a 63 percent reduction from 2005 levels in this sector. However, even with an expanded version of VF-2, which would eliminate all carbon emissions from the LNG fleet, strategies for this sector would reduce vehicle fleet emissions down to 67 percent below 2005 levels, short of the City's vehicle fleet target (75 percent below 2005 levels). Yet these actions would result in the largest GHG reductions across all sectors of the City's internal operations, accounting for 43 percent of the reductions associated with the implementation of this IO CAP.

VF-1: Overall Fleet Efficiency and the Electric Fleet Pledge (Revised Action)

OVERVIEW

As part of the City's Sustainable Fleet Policy, the City continues to improve fleet vehicle efficiency as part of the City's ongoing replacement program. Vehicle purchases are based upon established vehicle standards that emphasize the greatest fuel economy and lowest emissions in each vehicle's respective class. As national vehicle efficiency standards increase over time, such as the Corporate Average Fuel Economy (CAFE) standards, replacement of older fleet vehicles with newer, more efficient vehicles will naturally increase the fleet's overall efficiency.

Also, as part of the replacement program, the City plans to become a partner with the West Coast Electric Fleets (WCEF) pledge (WCEF 2015). The WCEF pledge aligns public and private efforts to increase purchases of electric vehicles for public and private fleets. Its main goal is to expand the use of zero emission vehicles, to represent "10 percent of new vehicle purchases in public and private fleets by 2016." To achieve this, WCEF encourages fleets to take a range of pledges from evaluating ZEVs as part of fleet purchases to committing to procuring at least 10 percent of all new fleet vehicle purchases by 2016. Currently, the City has identified 31 sedans in the City's existing fleet that are candidates for ZEV replacement by 2020.

Between 2013 and 2020, the City anticipates that a total of 1,098 vehicles of the current fleet, or 60 percent, would be replaced with newer vehicles. By 2020, approximately 31 existing gasoline vehicles would be replaced with electric vehicles and 72 of the oldest diesel solid waste vehicles would be replaced with CNG vehicles. The E85 vehicle fleet will be transitioned to gasoline vehicle replacements of the same type, due to the lower availability of suitable E85 vehicles, which are most commonly used in police applications. The remainder of fleet vehicles would be replaced with newer, more efficient models of the same vehicle type.

GHG REDUCTION ANALYSIS

It is assumed that only the oldest 1,098 vehicles, excluding LNG and propane vehicles, would be replaced by 2020. LNG and propane tend to be used on heavy duty vehicles, which have a longer life-span and lower likely variability in emissions factors by model year. Avoided emissions are calculated by comparing an average 2017 model year of the replaced vehicle to the emissions generated with the previous model year's efficiency and then summing the total avoided emissions across all replaced vehicles.

The calculations for the City's 2013 GHG emissions inventory for the vehicle fleet sector relied on a list of current on-road vehicles in the fleet along with their model year, vehicle type, mileage, and fuel use. This list was used to identify the 1,098 of the oldest vehicles by model year, ranging from 1970 to 2008. These vehicles were assumed to be replaced with 2017 model year vehicles of the same type, fuel, and mileage. Except for the LNG fleet, vehicle mileages for both BAU and VF-1 scenarios assumed an 11-percent increase in mileage by 2020 from 2013 levels, consistent with the City's population growth. Emission factors for all model years, types, and fuels were available from EMFAC 2014. More details are available in Appendix B.

The net effect of the replacement of older vehicles with new models, vehicles that use cleaner fuels, and offsets from some electric vehicles is estimated to result in avoided emissions of 1,309 $MTCO_2e$ from BAU 2020 vehicle fleet emissions. Table 16 below summarizes how this action affects each fuel compared to the BAU scenario and 2013 vehicle fleet inventory. See additional details in Appendix C.

Table 16	Fleet Emissions Savings (VF-1)				
Vehicle Fuel	2013 ($MTCO_2e$)	BAU 2020[a] ($MTCO_2e$)	2020 with VF-1 ($MTCO_2e$)	Difference from 2013 ($MTCO_2e$)	Difference from 2020 BAU ($MTCO_2e$)
Diesel	2,036	2,266	2,181	145	-85
Gasoline	3,193	3,553	3,093	-100	-460
Gasoline Hybrid	120	133	133	13	0
E85 Flex Fuel	2,531	2,817	2,313	-218	-504
LNG	6,114	8,570	6,786	672	-1,784
CNG	0	0	968	968	968
Propane	87	96	96	10	0
Electric	2	2	12	10	10
Total	**14,081**	**17,438**	**15,035**	**954**	**-2,403**

Notes:
NA = not applicable
LNG = Liquefied Natural Gas
CNG = Compressed Natural Gas
E85 = 85% ethanol, 15% gasoline flex-fuel

[a] Based on an 11 percent growth rate except for LNG vehicles. BAU LNG emissions based on addition of 43 new vehicles, assuming average solid waste vehicle mileage.

Source: Data provided by Ascent Environmental, Inc. in 2015

FEASIBILITY AND IMPLEMENTATION

New technology can dramatically reduce fuel consumption, with considerable variations in costs based on technology. While initial upfront costs maybe higher for some alternative fuel vehicles, life-cycle costs may actually be lower due to reduced maintenance and potential for lower fuel costs. Additionally, many gasoline hybrids and electric vehicles have improved in terms of cost efficiency over the years, with a greater market penetration rate, considerably lowering up-front costs. The City has been conservative in the number of electric vehicles it has been willing to commit to purchasing by 2020, and older vehicles are assumed to be replaced with the average new model. This approach would not incur the explicitly higher costs associated with deliberate replacement of older vehicles with advanced technology.

VF-2: Alternative Fuels: Renewable Natural Gas (Revised Action)

OVERVIEW

The City has a significant opportunity in reducing emissions from the vehicle fleet by switching to RNG for the City's CNG and LNG fleet. RNG is sourced from methane gas captured from decomposition of organic waste sources such as landfills and agricultural waste, and is available both as LNG and CNG. Because of these renewable sources, emissions resulting from RNG would add "net zero" carbon emissions into the atmosphere, meaning that no new carbon emissions would be attributed to the combustion of RNG.

In September 2013, the City signed a contract with Clean Energy Fuels to purchase up to $3,000,000 worth of renewable LNG through mid-2016. The City plans to pursue similar renewable LNG contracts through 2020. However, the City anticipates an eventual transition away from LNG and towards CNG because of safety and cost reasons. CNG vehicles are safer to refuel than LNG because of the higher temperature limits for CNG. CNG also generally costs less per gallon of gasoline equivalent (GGE) than LNG. In 2015, the cost of CNG and LNG to the City was $0.71 and $1.21 per GGE, respectively.

Currently, the City is pursuing an $800,000 renewable CNG contract to provide up to $400,000 per year worth of CNG. At the current cost of CNG, the City would be able to purchase up to 1.13 million GGE of CNG during the entire contract period. This action assumes that the renewable CNG contract will be active in 2020 and be able to supply all of the City's CNG needs that year. The City is also planning to replace 72 of the oldest diesel solid waste vehicles with CNG-powered vehicles by 2020.

GHG REDUCTION ANALYSIS

Purchases of renewable LNG and CNG will directly offset future non-renewable fuel needs of the City's vehicle fleet. Assuming that the City will continue the current renewable LNG contract through 2020, the City could allot approximately $1,000,000 per year for the purchase of renewable LNG. At current LNG prices, this could allow the purchase of 826,446 GGE of renewable LNG in 2020, or 87 percent of the City's potential LNG demand in 2020, based on BAU forecasts. Likewise, an allotment of $800,000 per year for renewable CNG would allow the City the purchase of up to 563,380 GGE of renewable CNG, assuming 2013 prices.

By 2020, the City plans to replace 72 diesel waste collection vehicles with CNG vehicles. Using the City's 2013 vehicle inventory, BAU forecasts, and renewable CNG plans, approximately 119,200 gallons of projected diesel use in 2020 would be replaced with 135,411 GGE of renewable CNG, the energy equivalent of the replaced diesel fuel. The renewable CNG available under the $800,000 per year contract would be more than sufficient to offset the estimated CNG demand in 2020.

Combined, the displacement of non-renewable fuels with renewable LNG and CNG along with the replacement of the 72 solid waste diesel vehicles would displace 6,523 $MTCO_2e$. Calculation assumptions can be found in Appendix C.

FEASIBILITY AND IMPLEMENTATION

The extension of the potential renewable CNG and LNG contracts through 2020 would depend on the final approval and start date of the contract and the availability of RNG into the future. CNG and LNG vehicles do not require any special additional equipment to use RNG because it is formulated to be chemically identical to petroleum-based CNG and LNG fuels. Thus, the additional financial burden to the City would be minimal.

Meeting the Vehicle Fleet Target (General Plan Policy U 6.1.3)

The combined effect of VF-1 and VF-2 can limit future 2020 vehicle fleet emissions to 8,209 $MTCO_2e$, which is 63 percent below 2005 vehicle fleet emissions. This falls short of the vehicle fleet emissions goal by 2020 per General Plan policy U 6.1.3: to reduce emissions to 75 percent below 2005 levels in this sector. If VF-2 is expanded such that 100 percent of LNG vehicles in 2020 are able to use RNG, vehicle fleet emissions in 2020 could be reduced to 7,299 $MTCO_2e$, or 67 percent below 2005 vehicle fleet emissions. The City would need to reduce another 1,817 $MTCO_2e$ from the vehicle fleet sector by 2020 to meet the 75 percent goal.

Additional options to reduce fleet emissions would need to be explored to be consistent with the General Plan targets. Recommended options for further consideration include converting additional gasoline and diesel vehicles to CNG, as feasible, and using RNG as the fuel source. Another option is to continue to encourage drivers and operators to improve driving habits and reduce vehicle miles traveled (VMT) through the current fleet telemetrics program. Finally, expanding Action VF-1 to increase the number of electric vehicles, hybrids, or other models that are considerably more efficient than typical models could also contribute to moving the City closer to the vehicle fleet sector target.

4.9 URBAN FORESTRY

Through photosynthesis, trees transform CO_2 in the atmosphere into wood, leaves, bark, and other plant material. Over the lifetime of a tree, several tons of CO_2 can be sequestered (McPherson and Simpson 1998). Trees also provide shading and reduce ambient air temperatures under their canopy. When tree canopies shade buildings, they reduce the energy needed to cool buildings, reducing GHG emissions associated with electricity generation. Although younger trees may not yet be tall enough to provide significant shade to adjacent buildings, consistent maintenance can lead to tree growth that can eventually provide shading for buildings.

UF-1: Expanding the Urban Forest (Continuing Action)

OVERVIEW

While trees are a relatively expensive way to reduce GHG emissions, they provide important co-benefits that contribute to community-wide sustainability and, therefore, warrant investment, including:

- Reducing the impact of global warming and the urban heat island effect by providing shade and transpiring water vapor,
- Improving air quality by removing toxic air contaminants,
- Increasing groundwater supplies by storing rainwater in their root zones,
- Protecting water quality from “pollutant washout” during storms and decrease soil erosion, and
- Providing aesthetic and visual benefits that improve quality of life and raise property values.

The City plans to continue an annual net tree planting rate of 200 per year. This takes into account annual removals or losses and existing constraints because of drought and watering restrictions. The City estimates planting approximately 1,000 trees annually, an amount that would be offset by approximately 800 annual removals due to losses from storms, disease, or other reasons.

GHG REDUCTION ANALYSIS

Between 2013 and 2020, a net increase of 1,400 trees would be added to the City’s urban forest under this action. The U.S. Forest Service’s (USFS) Tree Carbon Calculator was used to estimate the annual sequestration potential of the lost and planted trees. The newly planted trees are anticipated to be an equal mix of common tree species already existing in Sacramento (i.e., *acer saccharinum, pistacia chinensis, celtis sinensis, and quercus ilex*), based on available species data in the USFS model. Each newly planted tree is assumed to be 5-years old at the time of planting, and it is assumed that any removed trees are replaced with the same species. Because of a variety of reasons for removal, a combination of young and mature trees, with an average age 25 years, could be removed.

The estimates are shown in Table 17 below with additional assumptions available in Appendix C.

Table 17 GHG Reductions from Sequestration and Shading from Urban Forest in 2020 (UF-1)

Scenario	Energy reductions		Reduced GHG from Energy Reductions ($MTCO_2e$/year)	Annual CO_2 Sequestration ($MTCO_2e$/year)	Total Annual CO_2e reduced in 2020 ($MTCO_2e$/year)
	Cooling kWh/year	Heating therms/year			
2020 (planted trees)	297,199	8,337	128	372,711	501
2020 (removed trees)	-53,821	-1,405	-22	-56,417	-798
2020 (net effect)	243,378	6,932	105	316,294	422

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using U.S. Forest Service's Tree Carbon Calculator version 1.2.

Because this action has cumulative effects related to continual sequestration from trees planted in the past, carbon sequestered and offset GHG emissions from energy savings is expected to compound over time. By 2020, it is anticipated that trees planted and removed since 2013 would result in a net annual reduction of 422 $MTCO_2e$ in 2020.

FEASIBILITY AND IMPLEMENTATION

The City's Urban Forest Services Division has resources to plant, water, and provide care for approximately 1,000 trees annually, depending on funding priorities. The number of trees planted beyond replacement depends on how many trees are lost to storms and other factors in a given year, leaving a balance of approximately 200 trees planted annually (beyond typical replacement value). Increasing the volume of the urban forest would require additional funding for tree maintenance.

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CHAPTER 6: APPENDICES

Appendix A: Sacramento 2035 General Plan Internal Operations GHG Reduction Strategies

Appendix B: 2013 GHG Emission Inventory and Existing GHG Reduction Measures Assessment

Appendix C: Calculation of CAP Emissions Reductions

Appendix D: Waste-in-Place Forecasts

Appendix E: 2013 Water Conservation Plan Actions

APPENDIX A: SACRAMENTO 2035 GENERAL PLAN INTERNAL OPERATIONS GHG REDUCTION STRATEGIES

Utilities Element

U 5.1.5 - Residential and Commercial Waste Disposal. The City shall continue to provide curbside trash and recycling collection service to single-family residential dwellings and offer collection service to commercial and multi-family residential development.

U 5.1.9 Electronic Waste Recycling. The City shall continue to coordinate with businesses that recycle electronic waste (e.g., batteries, fluorescent lamps, compact-fluorescent (CFL) bulbs) and the California Product Stewardship Council to provide convenient collection/drop off locations for city residents.

U 5.1.11 City Recycling. The City shall serve as a role model to businesses and institutions regarding purchasing decisions that minimize the generation of solid waste in addition to encouraging all City staff to recycle at City facilities.

U 5.1.16 Waste for Energy Generation. The City shall continue to use waste (e.g., methane emissions from landfills) for energy generation, and shall support efforts to remove organic waste from landfills and produce renewable energy from organic waste using technology such as gasification or anaerobic digestion.

U 5.1.17 Local Recycled Materials Market. The City shall continue to provide incentives to encourage the development of a local market for recycled materials.

U 5.1.18 Disposable, Toxic, or Non-Renewable Products. The City shall reduce the use of disposable, toxic, or nonrenewable products in City operations.

U 6.1.2 Peak Electric Load of City Facilities. The City shall reduce the peak electric load for City facilities by 10 percent by 2015 compared to the baseline year of 2004, through energy efficiency, shifting the timing of energy demands, and conservation measures.

U 6.1.3 City Fleet Fuel Consumption. The City shall reduce its fleet's fuel GHG emissions by 75 percent by 2020 compared to the baseline year of 2005, and City operations shall be substantially fossil free (e.g., electricity, motor fuels).

U 6.1.4 Energy Efficiency of City Facilities. The City shall improve energy efficiency of City facilities to consume 25 percent less energy by 2030 compared to the baseline year of 2005.

U 6.1.5 Energy Consumption per Capita. The City shall encourage residents and businesses to consume 25 percent less energy by 2030 compared to the baseline year of 2005.

U 7.1.8 City Operations/Public Services. The City shall continue to use telecommunications to enhance the performance of internal City operations and the delivery of public services.

Land Use

LU 8.1.5 LEED Standard for City-Owned Buildings. The City shall ensure that new or renovated City-owned buildings are energy efficient and meet, as appropriate, LEED (Leadership in Energy and Environmental Design) Silver or equivalent standard.

Public Health and Safety Element

PHS 2.1.9 Advances in Technology. The City shall invest in, and incorporate, future technological advances that enhance the City's ability to deliver emergency medical response, fire-rescue, and fire prevention services more efficiently and cost-effectively.

Environmental Resources Element

ER 3.1.2 Manage and Enhance the City's Tree Canopy. The City shall continue to plant new trees, ensure new developments have sufficient right-of-way width for tree plantings, manage and care for all publicly owned trees, and work to retain healthy trees. The City shall monitor, evaluate and report, by community plan area and city wide, on the entire tree canopy in order to maintain and enhance trees throughout the City and to identify opportunities for new plantings.

ER 3.1.3 Trees of Significance. The City shall require the retention of City trees and Heritage Trees by promoting stewardship of such trees and ensuring that the design of development projects provides for the retention of these trees wherever possible. Where tree removal cannot be avoided, the City shall require tree replacement or appropriate remediation.

ER 3.1.5 Solar Access. The City shall promote plantings and tree placement recognizing solar access for alternative energy systems may be limited.

ER 3.1.6 Urban Heat Island Effects. The City shall continue to promote planting shade trees with substantial canopies, and require, where feasible, site design that uses trees to shade rooftops, parking facilities, streets, and other facilities to minimize heat island effects.

ER 3.1.7 Shade Tree Planting Program. The City shall continue to provide shade trees along street frontages within the city.

ER 6.1.6 Municipal Greenhouse Gas Reductions. The City shall maintain and implement its Phase 1 Climate Action Plan to reduce municipal GHG emissions by 22 percent below 2005 baseline level by 2020, and strive to reduce municipal emissions by 49 percent and 83 percent by 2035 and 2050, respectively.

ER 6.1.11 Reduced Emissions for City Operations. The City shall promote reduced idling, trip reduction, routing for efficiency, and the use of public transportation, carpooling, and alternate modes of transportation for City operations.

ER 6.1.12 Fleet Operations. The City shall continue to purchase low-emission vehicles for the City's fleet and to use available clean fuel sources for trucks and heavy equipment.

ER 6.1.14 Preference for Reduced-Emission Equipment. The City shall give preference to contractors using reduced-emission equipment for City construction projects and contracts for services (e.g., garbage collection), as well as businesses that practice sustainable operations. (SO/JP)

Programs

Program 8. The City shall work with local organizations and residents to continue park and street tree planting and tree replacement programs with a goal of adding 1,000 new trees annually.

> Implements Which Policy(ies): ER 3.1.2; ER 3.1.3; ER 3.1.7
> Responsible Department(s): Department of Public Works
> Supporting Department(s): N/A
> Timing: Ongoing

Program 25. The City shall enroll all applicable municipal facilities in Demand Response Programs and promote onsite energy generation and/or storage to help reduce peak energy demands and offset energy costs.

> Implements Which Policy(ies): U 6.1.2; U 6.1.4
> Responsible Department(s): Community Development Department
> Supporting Department(s): N/A
> Timing: Ongoing

APPENDIX B: 2013 GHG EMISSIONS INVENTORY AND EXISTING GREENHOUSE GAS REDUCTION MEASURES ASSESSMENT

Memo

455 Capitol Mall, Suite 300
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Date: April 6, 2015

To: Yvette Rincon, Sustainability Program Manager, City of Sacramento

From: Erik de Kok and Brenda Hom, Ascent Environmental

Subject: City of Sacramento Internal Operations Climate Action Plan Update

Final Draft Technical Memorandum #1: 2013 Greenhouse Gas Emissions Inventory and Existing Greenhouse Gas Reduction Measures Assessment

INTRODUCTION

In February 2010, pursuant to both State and local policies related to sustainability, the City of Sacramento (City) released its first Internal Operations Climate Action Plan (IO CAP) as part of Phase 1 of the City's overall Climate Action Plan. The 2010 IO CAP examined the City's internal government operations and identified strategies to reduce greenhouse gas (GHG) emissions in a cost effective manner for municipal buildings; vehicle fleet; streetlights and signals; parks maintenance; water, sewer, and drainage pumping; and other facilities and operations that are within the City's immediate control. Nearly 5 years later, the City is now updating the IO CAP to evaluate the progress toward achieving its sustainability and GHG reduction goals for internal operations.

In accordance with the recommended California Air Resources Board (ARB) guidance for local government agencies, the City's GHG reduction target is to reduce emissions from internal operations to at least 15 percent below 2005 levels by 2020. In 2005, the City's internal operations emissions were 78,584 metric tons of carbon dioxide equivalents (MT CO_2e)[1], as benchmarked in the *2005 Sacramento County GHG Inventory* (ICF Jones & Stokes 2009). A 15 percent reduction would mean a reduction of 11,788 MT CO_2e in annual emissions by 2020.

This initial phase of the IO CAP Update is focused on comparing the City's GHG emissions inventories between 2005 and 2013; identifying differences in the inventory data sources, emissions estimation methods, and emissions factors; along with an assessment of the performance of emissions reductions measures presented in the 2010 IO CAP towards achieving the City's 2020 target. As currently estimated, annual emissions in 2013 from City internal operations were reduced by 19,486 MT CO_2e from 2005 levels, a 25 percent reduction that already exceeds the 2020 target seven years early[2]. The greatest reductions could be attributed to a 36 percent reduction in vehicle fleet emissions between 2005 and 2013. Other sectors, such as building energy (including water management) and streetlights/traffic signals had 26 and 29 percent reductions, respectively, between 2005 and 2013.

[1] Note that this memorandum reports GHG emissions in MT CO2e. Both the 2010 IO CAP and the 2005 Sacramento County GHG inventory only account for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions in their GHG analyses.
[2] As compared between 2005 GHG Inventory sectors. Does not include off-road fleet emissions.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- Section 1 summarizes the updated 2013 GHG emissions inventory for each internal operations sector, including a new separate Water Management sector. Key components include:
  - A summary of overall results;
  - Data sources and methods used; and
  - A comparison of the updated 2013 inventory with the previous 2005 inventory.
- Section 2 includes a quantitative and qualitative assessment of the existing GHG reduction measures in the 2010 IO CAP.

1 2013 GREENHOUSE GAS EMISSIONS INVENTORY UPDATE

SUMMARY OF RESULTS

In 2013, the City's internal operations resulted in an estimated 59,755 MT CO_2e, a 24 percent net decrease from the City's emissions in 2005. Emissions related to internal operations at the City resulted from building energy use, City vehicle fleet, off-road vehicles and equipment, streetlight and traffic signal energy use, water management, and solid waste activities. The 2013 inventory includes two new sectors that were not previously identified or included in the 2005 inventory: water management and off-road vehicle fleet.[3] Table 1 and Figures 1 through 3 present the City's 2013 internal operations GHG inventory by sector alongside comparisons to the previous 2005 inventory.

Table 1 City of Sacramento Internal Operations Greenhouse Gas Inventories (2005 and 2013)

Sectors	2005	2013	Difference	% Reduction from 2005
Buildings & Facilities	35,773	15,011	-8,719	-24%
Water Management[a]		12,043		
Vehicle Fleet	21,927	14,081[c]	-7,846	-36%
Streetlights & Traffic Signals	6,872	4,870	-2,002	-29%
Waste-in-Place	14,012	13,750	-262	-2%
Total	**78,584**	**59,755**	**-17,967**	**-24%**
Off-Road Fleet		*862*	*NA*	*NA*
Total with Off-Road Fleet		*60,617*	*-18,829*	*NA*

[a] The water management sector includes energy consumption associated with water intake, treatment and distribution, and sewer and drainage system operations.

Source: ICF Jones & Stokes 2009, Data compiled by Ascent Environmental, Inc. in 2015

[3] Emissions related to water management were included, but not independently identified, in the 2005 inventory. Conversely, the 2005 inventory did not include emissions from off-road equipment, such as landscaping or off-road construction equipment owned and operated by the City.

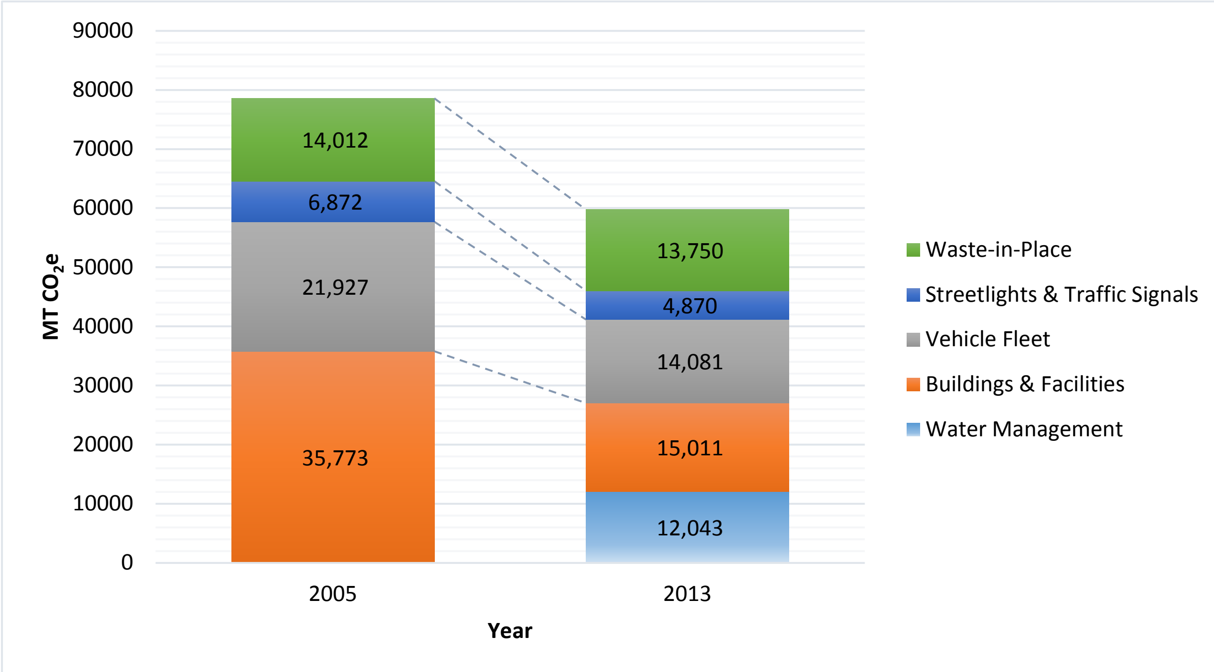
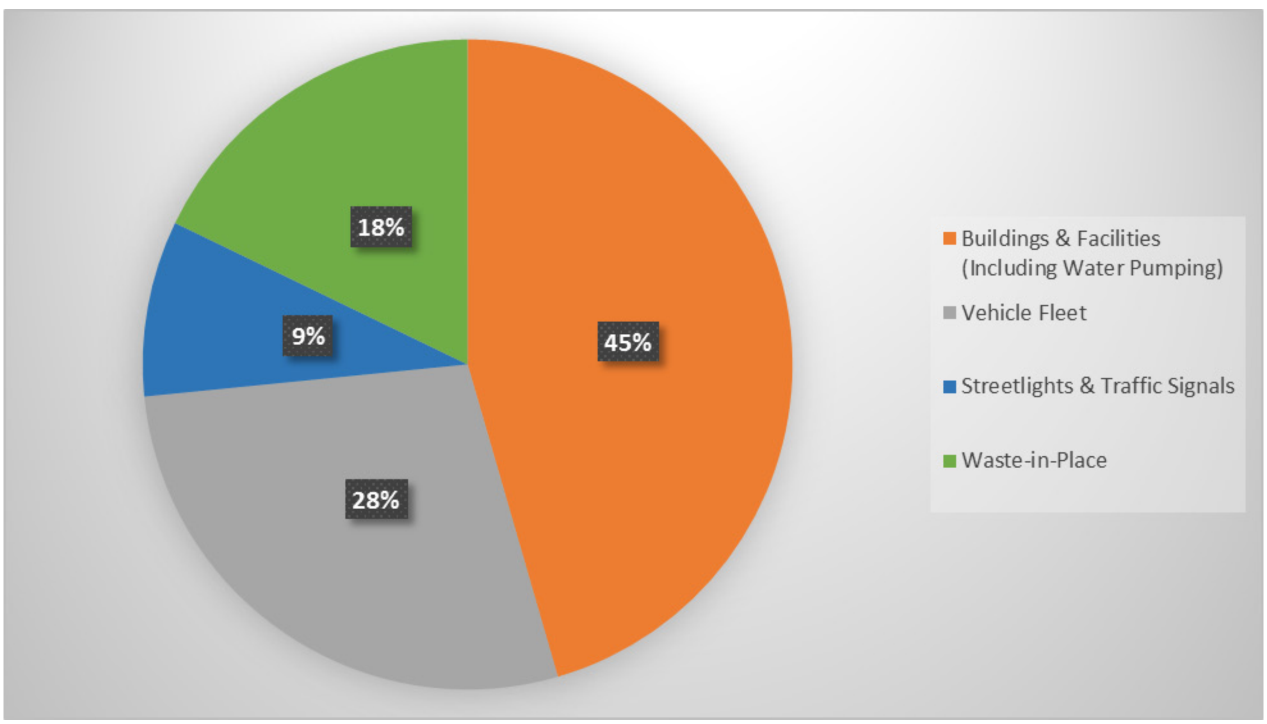


Figure 1 **Comparison between 2005 and 2013 Greenhouse Gas Emissions Inventories**



Source: ICF Jones & Stokes 2009

Figure 2 **City of Sacramento Internal Operations 2005 Greenhouse Gas Emissions Inventory**

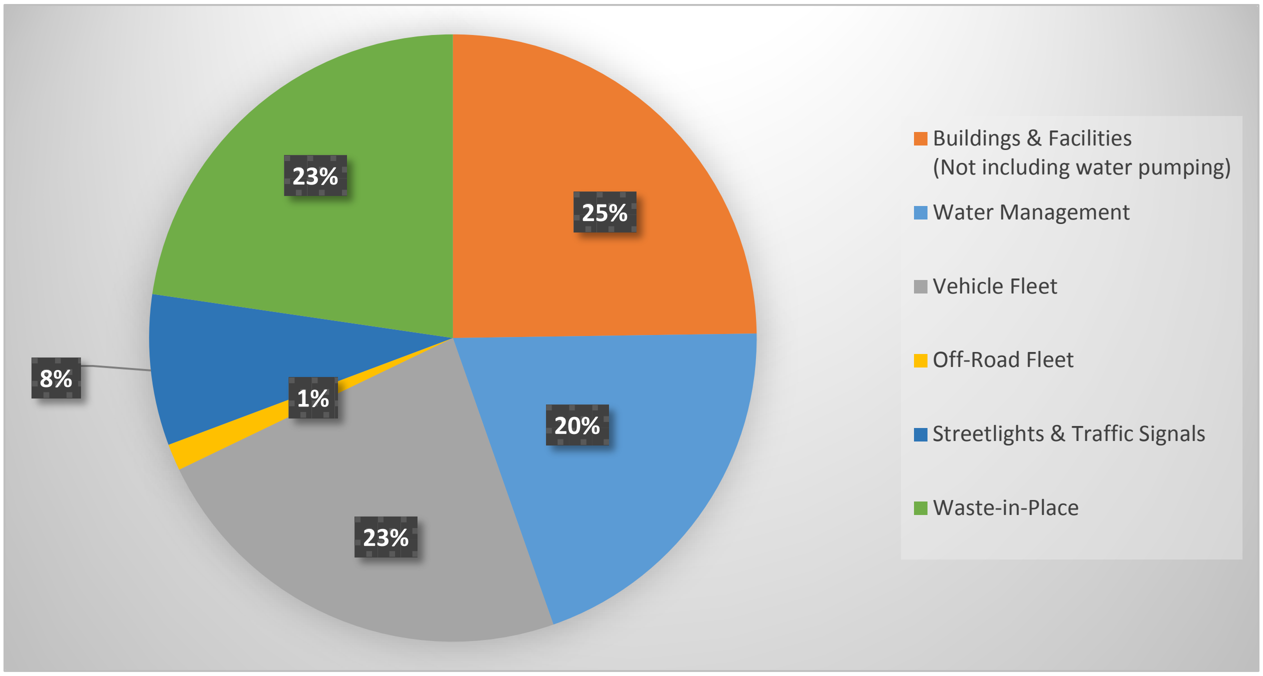


Figure 3 **City of Sacramento Internal Operations 2013 Greenhouse Gas Emissions Inventory**

DATA SOURCES AND METHODS

In addition to incorporating the new Off-Road Fleet and Water Management sectors, the 2013 inventory update includes several changes to the data sources and emission factors used, along with a few minor changes in methods. These differences were necessary in cases where the original data sources used in the 2005 inventory were no longer available or have changed since 2005. New methods were available for estimating GHG emissions from the vehicle fleet and solid waste sectors, which better reflect actual emissions by using more specific emission factors and calculations.

For the 2013 inventory, electricity and natural gas use from buildings, water management, and streetlights and traffic signals were taken exclusively from the City's EnergyCAP database, which currently serves as a repository to track the City's energy purchases. Under the vehicle and off-road fleet sectors, 2013 vehicle mileage, fuel consumption, model year, and fuel types for each individual fleet vehicle were available from the City and could be matched with vehicle and fuel specific emission factors; whereas the 2005 inventory used only fuel consumption data to calculate emissions. The solid waste inventory was updated using equations from the *Local Government Operations Protocol* (LGOP) (Version 1.1), released in June 2010 (ARB et. al. 2010). Between the 2005 and 2013 inventories, the same GHGs (CO_2, CH_4, and N_2O) and global warming potential (GWP) values were used to maintain consistency. Tables 2 and 3 below compare and summarize the differences in data sources, calculation methods, and emission factors by sector and between years.

Global Warming Potentials

GHGs other than CO_2 generally have a stronger insulating effect (greenhouse effect) on the atmosphere than CO_2. This effect is measured in terms of a pollutant's GWP. CO_2 has a GWP factor of 1 while all other GHGs have GWP's relative to their CO_2 equivalents. According to the Second Assessment Report (SAR) from the International Panel on Climate Change (IPCC), CH_4 and N_2O have GWP's of 21 and 310, respectively (IPCC 1996). This means that CH_4 and N_2O would be 21 and 310 times stronger than CO_2, respectively, in their potential to insulate solar radiation within the atmosphere (warm). Newer reports from the IPCC have revised GWP values for CH_4 and N_2O, but using the revised numbers would significantly skew comparisons between GHG inventories (Myhre et.al. 2013). This GHG emissions inventory update uses the original GWP values assumed in the original inventory in order to facilitate a direct comparison between 2005 and 2013.

Additionally, both 2005 and 2013 GHG inventories do not include high GWP pollutants due to their limited occurrence in City operations. The most common high GWP pollutants come from fugitive emissions of electrical power insulators (sulfur hexafluoride) and refrigerants (hydrofluorocarbons). The GWPs and insulative properties of these GHGs range from a few hundred to tens of thousands times greater than CO_2. Although high GWP emissions could occur from City operations, it is assumed that these emissions would be marginal and are not included in the current inventory.

Table 2 City of Sacramento Internal Operations GHG Emissions Inventory: Data Sources by Year and Sector

Sector	2005	2013
Buildings & Facilities	Overall City energy use data from Keith Roberts, which includes water management energy use. Electricity from Streetlights and Traffic Signals were subtracted from this total. Included propane usage, but no diesel usage.	Energy use data by facility from EnergyCAP. Excludes propane use and Library electricity use at Pocket- Greenhaven and North Sacramento-Hagginwoods libraries. . Includes diesel generator usage.
Water Management		Energy use data by water management system type (i.e., water, sewer, or drainage) from EnergyCAP.
Vehicle Fleet	Vehicle fuel use by vehicle type and fuel type. Reported four vehicle types.	Detailed vehicle fleet inventory data by individual vehicle, mileage, fuel consumption, and model year. 14 vehicle types were represented.
Off-Road Fleet	Not included	Off-road data included in 2013 vehicle fleet inventory data provided by City. Includes construction and other off-road equipment.
Streetlights & Traffic Signals	Total energy use from Sacramento Municipal Utility District (SMUD)	Streetlight and traffic signal energy use from EnergyCAP.
Waste-in-Place	Waste-in-Place tonnage	Total CH_4 captured at 28th Street Landfill.

Notes: CH_4 = methane SMUD = Sacramento Municipal Utilities District; TCR = The Climate Registry

Table 3 City of Sacramento Internal Operations GHG Emissions Inventory: Emission Factors and Calculation Methods Summary by Year and Sector

Sector	2005	2013
Buildings & Facilities	SMUD and PG&E 2005 Emissions Factors	SMUD and PG&E 2013 Emission Factors
Water		SMUD 2013 Emissions Factors
Vehicle Fleet	Fuel based emission factors (emissions per gallon)	EMFAC 2011 Emission Factors per vehicle mile for CO_2, EMFAC 2014 Emission Factors per vehicle mile for CH_4, CARB approved methods for N_2O, Climate Registry emission factors for hybrids and non-gasoline/diesel fuels, SMUD 2013 Emission factors for electric vehicles.
Off-Road Fleet	Not included	Fuel based emission factors from The Climate Registry (TCR)
Streetlights & Traffic Signals	SMUD 2005 Emissions Factors	SMUD 2013 Emissions Factors
Waste-in-Place	ARB First Order of Decay (FOD) Model	ICLEI LGOP Equation 9.1 for Comprehensive Landfilled Gas (LFG) Collection Systems
Overall	IPCC SAR GWP values. No high GWPs included.	IPCC SAR GWP values. No high GWPs included.

Notes: CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; ARB = California Air Resources Board; FOD = First Order of Decay; GWP = global warning potential; EMFAC 2011 = California Air Resources Board's emissions factor model (Version 2011); EMFAC 2014 = California Air Resources Board's emissions factor model (Version 2014); ICLEI = International Council for Local Environmental Initiatives; IPCC SAR= Intergovernmental Panel on Climate Change Second Assessment Report; LFG = landfill gas; LGOP = Local Government Operation Protocol; PG&E = Pacific Gas & Electric; SMUD = Sacramento Municipal Utilities District; TCR = The Climate Registry

The approach used to estimate the City's 2013 GHG inventory is consistent with the latest guidance from the ICLEI Local Government Operations protocol (Version 1.1), which was released in June 2010, one year after the publication of the City's 2005 GHG inventory in the *Greenhouse Gas Emissions Inventory for Sacramento County*.

BUILDING AND FACILITIES SECTOR

In 2013, municipal building and facility energy use resulted in 15,011 MT CO_2e, making up the largest percentage of the City's total annual internal operations emissions (25 percent). These emissions include electricity, natural gas, and diesel fuel energy used at City-owned buildings as well as park and recreational facilities that the City owned and operated in 2013. Natural gas was most often used for space heating and water heating. Diesel fuel was used at a City-operated building back-up generator, which is used for short periods for regular testing throughout the year as well as during power outages. The building and facility energy sector consumed 35.2 gigawatt-hours (GWh) of electricity and 800,546 therms of natural gas, and approximately 9,300 gallons[4] of diesel fuel. Electric vehicle charging was also metered in total building electricity consumption, but is subtracted from total building electricity based on the total kilowatt-hours (kWh) of charging estimated under the vehicle fleet sector. All electricity was purchased from the Sacramento Municipal Utility District (SMUD) in 2013 unless the City indicated otherwise.

Approximately 87 percent of building and facility emissions were from the electricity and natural gas consumption at city buildings and libraries[5], contributing a total of 13,010 MT CO_2e in 2013. Parking lot and park and recreation facilities contributed to 12 percent of total emissions, while all other facilities made up less than 2 percent of total emissions from this sector. Additionally, on-site solar photovoltaic cells generated 4.87 megawatt-hours (MWh), of which 4.81 kWh were used on-site and the remaining was returned back to the utility grid. Energy use and emissions by fuel and facility type are presented below in Table 4. Solar energy used on-site was not included in total building energy use because the electricity use shown in Table 4 represents total electricity purchases, not total electricity consumption.

Table 4 City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Building and Facilities Energy Use and GHG Emissions by Facility

Facility	MWh	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Electricity					
Buildings	28,053	7,097	0.36	0.08	7,129
Library[a]	2,550	645	0.03	0.01	648
Parking Lots	2,794	707	0.04	0.01	710
Parks and Recreation	3,842	972	0.05	0.01	976
Parks and Recreation (PG&E)[b]	85	6	0.00	0.00	7
Solid Waste Facilities	29	7	0.00	0.00	7
Other	388	98	0.01	0.00	99
Electric Vehicle Charging	7	2	0.00	0.00	2
Electricity Total	37,734	9,532	0.49	0.10	9,574
Natural Gas					
Buildings	744,132	3,945	37.21	0.74	4,957
Library	41,383	219	2.07	0.04	276
Parking	10,667	57	0.53	0.01	71
Parks and Recreation	2,916	15	0.15	0.00	19
Unknown	2,799	15	0.14	0.00	19
Natural Gas Total	800,546	4,244	40.03	0.80	5,333

4 Actual fuel use not known. Gallons were calculated by dividing total CO_2 emissions by the average emission factor for a gallon of diesel fuel (10.21 kg CO_2/gal), available from The Climate Registry (The Climate Registry 2014). Total CO_2 emissions were estimated using ARB's OFFROAD emission factors based on the equipment type, total hours of generator usage, and the generator horsepower rating. Additional explanation can be found under the vehicle fleet methods discussion further below.

5 Electricity and natural gas are mainly provided by two separate vendors. The City purchases electricity from mainly SMUD and natural gas from PG&E.

Table 4	**City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Building and Facilities Energy Use and GHG Emissions by Facility**				
Facility	MWh	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Diesel					
Generators (Diesel)	200	95.04	-	-	95
Diesel Total	200	95.04	-	-	95.04
Building Energy TOTAL		13,878	40.58	0.91	15,011

Notes: MWh = megawatt-hours; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

PG&E – Pacific Gas & Electric

[a] Library electricity use data are not available the City for Pocket-Greenhaven and North Sacramento- Hagginwood libraries. (Pers. Comm. Anita Lopez)

[b] Camp Sacramento, located in El Dorado County, is the only City owned and operated facility that purchased electricity in 2013 from Pacific Gas and Electric (PG&E).

Source: Data provided by Ascent Environmental, Inc, in 2015 based on modeling using data provided by the City's EnergyCAP database.

Table 5	**City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Building and Facility Emission Factors**	
Emission Factor	Unit	Source
Electricity		
0.313	MT CO_2/MWh	2013 Electric Power System Report for SMUD (TCR Reports 2015)
0.076	MT CO_2/MWh	2013 Electric Power System Report for PG&E (TCR Reports 2015)
28.49	lb CH_4/GWh	EPA eGrid 2010 (2014)
6.03	lb N_2O/GWh	EPA eGrid 2010 (2014)
Natural Gas		
53.02	kg CO_2/MMBtu	2014 Climate Registry Emission Factors. Table 12.1. (TCR 2014)
5	g CH_4/MMBtu	2014 Climate Registry Emission Factors. Table 12.9. (TCR 2014)
0.1	g N_2O/MMBtu	2014 Climate Registry Emission Factors. Table 12.9. (TCR 2014)
Diesel Generator Use		
475[a]	kg CO_2/hr	ARB OFFROAD2007

Notes: MWh = megawatt-hours; GWh = gigawatt-hours; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent; MMBTU = million British thermal units

EPA – U.S. Environmental Protection Agency

OFFROAD2007 – California Air Resources Board's emissions model for off-road vehicles and equipment (Version 2007)

TCR – The Climate Registry

[a] Assumes a 9,999hp generator as a conservative estimate.

Building energy data was available from the City's EnergyCAP database. Diesel generator hours of operation were provided by the City.

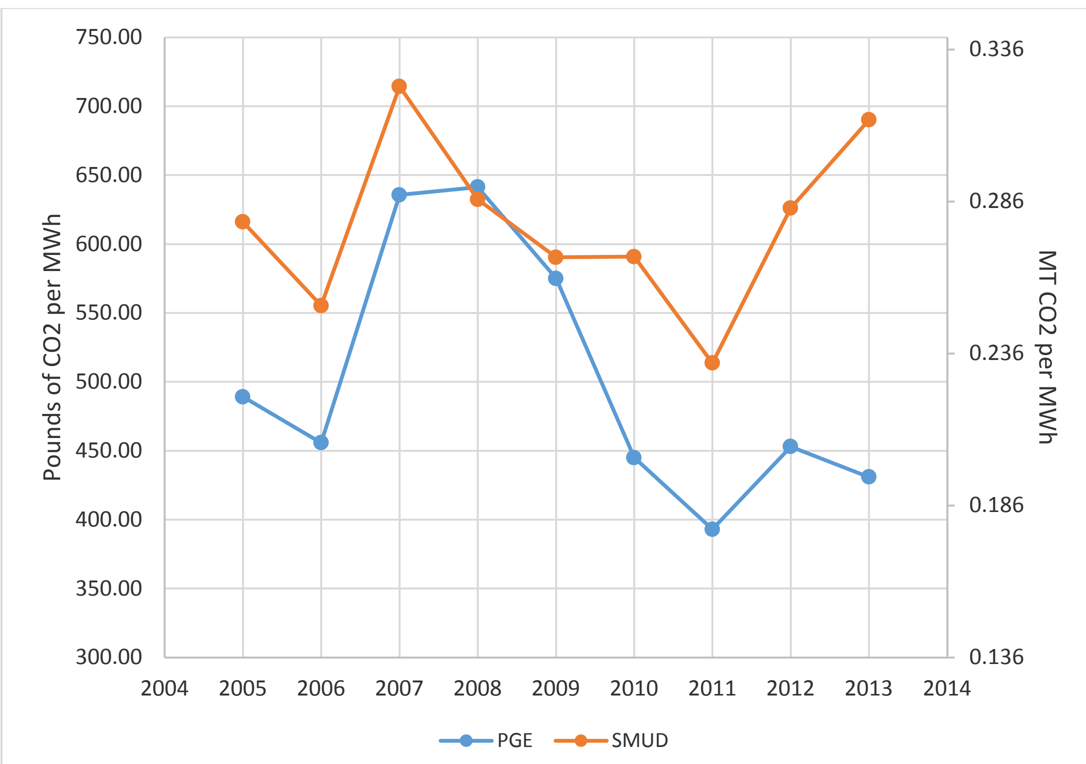
Comparison with the 2005 Inventory

Because total building energy use and water management activity were not separately analyzed in the 2005 inventory, the following presents a comparison of the building energy sector, including water management, between the 2005 and 2013 inventories.

Together, building and facilities energy and water management electricity use decreased from 100.7 to 82.6 GWh between 2005 and 2013, an 18 percent reduction. Building and water management emissions decreased from 35,773 MT CO_2e to 26,397 MT CO_2e, a 26 percent reduction. However, facility-specific electricity consumption data was not available in the 2005 inventory. Without this facility specific data from

2005, it is not possible to identify the facilities or types of facilities that had the greatest decline in building or facility energy use between 2005 and 2013.

Although the decline in building and water energy use resulted in an 18 percent reduction from 2013 to 2005, emissions did not decrease at the same rate. This is mostly due to changes in utility emission factors for electricity. Natural gas emission factors do not change from year to year. In the 2005 inventory, SMUD CO_2 emission factors were 616.07 lb/MWh, or 0.279 MT CO_2/MWh, but in 2013 this factor decreased to 0.253 lb/MWh[6]. Although most utilities aim to expand their renewable energy portfolio to meet or exceed the State's 33 percent Renewable Portfolio Standard (RPS) goal by 2020, GHG emissions from electricity generation has not followed a linear decline on an emissions-per-kWh basis. As shown in Figure 4, SMUD and PG&E emission factors varied in the carbon intensity levels of their electricity generation between 2005 and 2013. SMUD emission factors, in particular, rose sharply between 2011 and 2013, exceeding both 2005 and 2006 emission factors. The on-going drought that began in 2011 has significantly affected the State's hydro power supply, including SMUD hydroelectric sources (Sacramento Bee 2014, SMUD 2014). While unforeseen circumstances, such as the drought, may impact a utility's ability to decrease GHG emissions from electricity generation on a year-to-year bases, both SMUD and PG&E have committed to meet or exceed the State's RPS goal by 2020. Due to these policies and efforts, emission factors should gradually decline over a longer period of time. Additionally, efforts by the City to reduce emissions in the building and water management sectors should not be discouraged by this variability, but should focus on reducing the City's overall energy use and continuing Greenergy purchases from SMUD.



Source: The Climate Registry Reports 2015

Figure 4 SMUD and PG&E CO_2 Emission Factors between 2005 and 2013

WATER MANAGEMENT

The City provides several water-related utility services to residents and businesses in the City in the form of water intake, treatment and distribution; wastewater collection and conveyance; and, storm water drainage.

[6] The City purchases retail electricity from SMUD. This factor represent emissions from retail electricity sales from SMUD in 2013. (TCR Reports 2015)

In 2013, pumping and other activities associated these water-related services (referred to hereafter as the "Water Management" sector) consumed 47.4 GWh of electricity from SMUD, resulting in emissions of 12,043 MT CO_2e (20 percent of the City's total annual emissions). Water management activity represented the second largest sector of emissions in the city after building and facility energy use. Energy use and emissions by water management type are presented below in Table 6.

Table 6 2013 Water Management Sector Energy Use and GHG Emissions by Conveyance Type

Water Management Type	Volume Transported (MG)	MWh	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Water Intake, Treatment and Distribution	38,843	37,614	11,773	0.49	0.10	11,815
Wastewater Collection and Conveyance	7,731	2,968	929	0.04	0.01	932
Storm Water Drainage	10,228	6,809	2,131	0.09	0.02	2,139
Total	**56,801**	**47,391**	**14,833**	**0.61**	**0.13**	**14,886**

Notes: MG = million gallons; MWh = megawatt-hours; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

Source: Data provided by Ascent Environmental, Inc, in 2015 based on modeling using data provided by Terrance Davis from the City of Sacramento (Davis, pers. comms., 2015a, 2015b)

<u>Method</u>

Emissions from electricity consumption from Water Management services in 2013 were also calculated from SMUD CO_2 emission factors and CH_4 and N_2O emission factors from eGrid 2010, presented under the building energy discussion. 2013 electricity consumption was available from the City's EnergyCAP database.

<u>Comparison with the 2005 Inventory</u>

Although not broken out in the 2005 inventory, the City provided Water Management sector activity data and associated energy use data for calendar year 2005. Table 7 shows the comparison between 2005 and 2013 Water Management sector volumes, energy use, and GHG emissions.

Table 7 City of Sacramento Internal Operations GHG Emissions Inventory: Comparison between 2005 and 2013 Water Management Activity and Emissions

Water Management Type	2005			2013		
	Volume (MG)	MWh	CO_2e (MT)	Volume (MG)	MWh	CO_2e (MT)
Water Intake, Treatment and Distribution	44,778	26,432	6,717	38,843	37,614	9,559
Wastewater Collection and Conveyance	12,904	3,381	859	7,731	2,968	754
Storm Water Drainage	43,572	10,406	2,644	10,228	6,809	1,730
Total	**101,255**	**40,219**	**10,220**	**56,801**	**47,391**	**12,043**

Notes: MG = million gallons; MWh = megawatt-hours; MT = metric tons; CO_2e = carbon dioxide equivalent

Source: Data provided by Ascent Environmental, Inc, in 2015 based on modeling using data provided by Terrance Davis and Bill Miller from the City of Sacramento (Davis, pers. comm., 2015c; Miller, pers. comm. 2015)

The City managed nearly half as much water in 2013 compared to 2005. In particular, there were significant reductions in the volume of storm water pumped. This was likely due to the on-going drought that began in 2011. Additionally, water demands began to decline in 2007/2008 due to economic recession and some conservation as a result of the adoption of additional plumbing standards and the 2009 State Model Water Efficient Landscape Ordinance. 2005 was a relatively wet year in comparison to 2013, with 22.17 inches of rain registered as compared to 2.69 in 2013 (WRCC 2013). With less precipitation, the demand for pumping storm water would also decrease.

Energy use for water intake, treatment, and distribution increased by 42 percent even though volumes decreased by 13 percent between 2005 and 2013. Several reasons for the net increase in water energy consumption are possible. First, more treated water may have been pumped for longer distances in 2013 as compared to 2005 to serve a growing and geographically expanding population. In addition, since 2011, the drought may have forced the City to pump more groundwater from further depths than in past years. These weather and hydrological impacts on water management, combined with water-saving actions and a slight decrease in SMUD emission factors between 2005 and 2013, may have caused the overall 20 percent increase in water management-related GHG emissions.

STREETLIGHT AND TRAFFIC SIGNALS

In 2013, operation of streetlight and traffic signals in the City resulted in 4,870 MT CO_2e, making up 8 percent of the City's total annual emissions. SMUD supplied the electricity for all streetlights and traffic signals in the City. Electricity use and emissions by fixture types are presented below in Table 8.

Table 8 City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Streetlight and Traffic Signal Energy Use and GHG Emissions by Fixture Type

Fixture Type	Number of Fixtures	MWh	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Traffic Signal	615[a]	2,372	600	0.03	0.01	603
Cobra Head Streetlight	9,226	7,577	1,917	0.10	0.02	1,925
Post-Top Streetlight	13,034	5,471	1,384	0.07	0.01	1,390
Old Style Ornamentals Streetlight	2,651	1.11	0.28	0.00	0.00	0.28
New Style Ornamentals Streetlight	5,243	2,201	557	0.03	0.01	559
Sac Mast Arm Streetlight	3,607	1,514	383	0.02	0.00	385
Old Sacramento Streetlight	115	27	7	0.00	0.00	7
Total	**34,491**	**19,163**	**4,848**	**0.25**	**0.05**	**4,870**

Notes: MG = million gallons; MWh = megawatt-hours; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

[a] This is the minimum number of signals in the City. There are 614 separate accounts for traffic signals plus one master account for an unknown number of signals.

Source: Data provided by Ascent Environmental, Inc, in 2015 based on modeling using data provided by the City

Method

Electricity consumption by streetlight and traffic signal fixtures were provided by the City (Rincon, pers. comm. 2015). Total electricity consumption is consistent with those reported in EnergyCAP, though EnergyCAP does not report energy consumption by fixture type. Emissions from the electricity consumption of streetlights and traffics signals in 2013 were also calculated from SMUD CO_2 emission factors and CH_4 and N_2O emission factors from EPA's eGrid 2010 report, presented under the building energy discussion. 2013 electricity consumption is available from the City's EnergyCAP database.

Comparison with the 2005 Inventory

There were approximately 5,124 fewer streetlights reported to be in operation in 2013 compared to 2005.The difference is likely due to changes or inconsistencies in record-keeping practices between the two inventory years, which resulted in double-counting of some fixtures. The number of traffic signals increased from 562 to 615, with a net reduction of 5,071 fixtures for both streetlights and signals. This 13 percent reduction in the number of fixtures, along with the City's efforts to convert more streetlights and signals to energy-saving light-emitting diodes (LEDs), likely contributed to the 19 percent reduction in electricity use. Additional differences in electricity emissions factors would explain the 29 percent reduction in overall sector emissions between 2005 and 2013, as shown in Table 1.

VEHICLE FLEET

The City's 2013 vehicle fleet consisted of a variety of vehicle types using both conventional and alternative fuels. Fuel consumption from the vehicle fleet operations resulted in emissions of 14,081 MT CO_2e, making up 23 percent of the City's annual operational emissions. In 2013, the City operated 1,819 on-road vehicles including maintenance trucks, vans, solid waste collection vehicles, police and fire vehicles, and light duty passenger vehicles. In addition, several alternative fueled on-road vehicles were also in use in 2013, including 7 electric vehicles, 40 gasoline-hybrids, and 266 flex fuel vehicles that run on E85 fuel[7]. Table 9 shows the total vehicle miles travelled (VMT), fuel use, and emissions by vehicle fleet type and fuel type in 2013.

Table 9 City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Vehicle Fleet Activity and Emissions by vehicle and fuel type

Vehicle Type	VMT	Fuel Use	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Diesel		Gallons				
Light Duty Vehicles	40,540	3,022	27	0.00	0.00	27
Medium Duty Vehicles	932,818	123,695	483	0.00	0.04	496
Heavy Duty Vehicles	1,167,690	309,950	1,480	0.01	0.10	1,512
Diesel Total	*2,141,048*	*436,667*	*1,991*	*0.01*	*0.14*	*2,036*
Gasoline		Gallons				
Light Duty Vehicles	7,402,106	574,979	3,014	0.13	0.05	3,032
Medium Duty Vehicles	223,191	46,363	144	0.00	0.00	144
Heavy Duty Vehicles	24,260	4,358	17	0.00	0.00	17
Light Duty Hybrids	438,747	13,625	120	-	-	120
Gasoline Total	*8,088,304*	*639,325*	*3,294*	*0.13*	*0.05*	*3,313*
E85 Flex Fuel		Gallons				
Light Duty Vehicles	3,433,217	348,579	2,163	0.17	0.20	2,227
E85 Flex Fuel Total	*4,003,620*	*395,728*	*2,455*	*0.20*	*0.23*	*2,531*
Liquefied Natural Gas (LNG)		Gallons				
Heavy Duty Truck	1,068,772	857,238[a]	6,011	2.10	0.19	6,114
LNG Total	*1,068,772*	*857,238*	*6,011*	*2.10*	*0.19*	*6,114*
Propane		GGE				
Light Duty Vehicles	21,894	1,907	15	0.00	0.00	15
Medium Duty Vehicles	38,422	7,589	59	0.00	0.01	61
Heavy Duty Vehicles	1,723	1,280	10	0.00	0.00	10
Propane Total	*62,039*	*10,776*	*84*	*0.00*	*0.01*	*87*
Electric		kWh				
Light Duty Vehicles	18,964	6,734	2	0.00	0.00	2
Electric Total	*18,964*	*6,734*	*2*	*0.00*	*0.00*	*2*
Total	**15,382,747**		**13,838**	**2.44**	**0.62**	**14,081**

Notes: VMT = vehicle miles travelled; GGE = gasoline gallons equivalents; kWh = kilowatt-hour; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

[a] Assumes fuel consumption is provided in gallons of LNG.

Source: Data provided by Ascent Environmental, Inc, in 2015 based on modeling using data provided by the City's Department of General Services.

[7] E85 = 85 percent ethanol and 15 percent gasoline.

Method

Vehicle fleet data were provided by the City's Department of General Services (Choe, pers. comm., 2014). The data consisted of 2013 annual VMT and fuel consumption for each individual vehicle in the fleet as well as model year, fuel type, and vehicle classification. Unfortunately, the dataset does not have either VMT or fuel consumption available for a handful of individual vehicles. The missing VMT and fuel consumption data are estimated using the fleet average fuel economy for the applicable vehicle category.

For gasoline and diesel vehicles, a combination of fuel-based (e.g. per gallon) and vehicle-based (e.g. per mile) emission factors were used to provide the most accurate estimate of vehicle fleet emissions. ARB's EMFAC2011 web-based model was used to determine CO_2 emissions on a per mile basis. EMFAC2011 provides unique emission factors by vehicle type, fuel type, and model year (MY). For model inputs, calendar year (CY) 2014, Sacramento County, and aggregated speed bins were selected. CY2014 emission factors were used due to the absence of MY2014 vehicles in the CY2013 EMFAC outputs. Emission factors between CY2014 and CY2013 are not expected to vary significantly. ARB's newest model, EMFAC2014, was used to determine CH_4 emission factors, which were not available in EMFAC2011 model outputs. Unfortunately, EMFAC2014 does not yet have CO_2 emission factors for aggregated speed bins, thus could not be used as a source for the CO_2 emission factors. N_2O emissions were calculated using ARB approved methods that assume 4.16 percent of NO_X emissions as equivalent to N_2O emissions for all gasoline vehicles and 0.3316 g N_2O per gallon fuel for all diesel vehicles (CARB 2012). Gasoline hybrid vehicle emissions were calculated using fuel based emission factors for gasoline from The Climate Registry (8.78 kg CO_2/gallon). CH_4 and N_2O emission factors for hybrid gasoline vehicles would likely be lower than for conventional gasoline vehicles, but are not available in published literature, and were thus excluded from the inventory. Hybrid gasoline CH_4 and N_2O emissions, however, are expected to be marginal. Additionally, certain diesel medium duty vehicles and light duty trucks were not represented in EMFAC2011. Emissions from those vehicles were calculated using diesel fuel based emission factors (10.21 kg CO_2/gallon) from The Climate Registry. (TCR 2014).

With respect to alternative fuels, each fuel type was calculated with the emissions factor for the specific fuel type. E85 vehicles were assumed to be fueled with 85 percent ethanol and 15 percent gasoline. CO_2, CH_4, and N_2O emission factors for E100 and gasoline from The Climate Registry were applied to E85 fuel use and miles travelled with the assumed ethanol-to-gasoline ratio. Propane and LNG emission factors were also available from The Climate Registry. Ethanol, propane, and LNG CO_2 emission factors were available in kg CO_2 per gallon, while CH_4 and N_2O emission factors were only available in grams per mile. Total kWh consumed was provided by the City for electric vehicles, the related emissions for which were calculated assuming the same SMUD and eGrid emission factors shown in Table 5.

Comparison with the 2005 Inventory

In 2013, the City's vehicle fleet was ranked the No. 1 Green Fleet in America at the Government Green Fleet Conference in Phoenix, Arizona (Government Fleet Magazine 2013). This ranking was based on seven categories including fleet composition and fuel use and emissions. Between 2005 and 2013, total annual vehicle fleet emissions declined by nearly 36 percent from 21,927 MT CO_2e to 14,081 MT CO_2e. The greatest reduction in vehicle fleet emissions came from the reduction of gasoline fuel consumption, followed by diesel consumption. Annual diesel and gasoline fuel emissions declined by 7,798 and 7,612 MT CO_2e, respectively, while the annual consumption of alternative fuels increased. Twenty-nine percent of total vehicles purchased since 2005 were alternative fueled vehicles. Table 10 compares fuel consumption and emissions by fuel type between 2005 and 2013.

Table 10	City of Sacramento Internal Operations GHG Emissions Inventory: Fuel Consumptions by Fuel Type between 2005 and 2013							
	Fuel Consumption				Emissions (MT CO_2e)			
	Units	2005	2013	Difference	2005	2013	Difference	% Change
Diesel	Gallons	1,213,779	436,667	-777,112	9,745[a]	2,036	-7,710	-79%
Gasoline	Gallons	934,994	639,325	-295,669	11,111	3,313	-7,798	-70%
CNG	SCF	240,102	0	-240,102	1,071	0	-1,071	-100%
LNG	Gallons	0	857,238	857,238	0	6,114	6,114	NA
Purinox	Gallons	12,461	0	-12,461	0[b]	0	0	NA
E85	Gallons	0	395,728	395,728	0	2,531	2,531	NA
Propane	GGE	0	10,776	10,776	0	87	87	NA
Electricity	kWh	-	6,743	6,743	-	2	2	NA
Total					21,927	14,081	-7,848	-36%

Notes: SCF = standard cubic feet; GGE = gasoline gallons equivalents; kWh = kilowatt-hour; MT = metric tons; CO_2e = carbon dioxide equivalent

"-" – None reported

NA – Not Applicable

CNG – compressed natural gas

LNG – liquefied natural gas

E85 – 85% ethanol, 15% gasoline

[a] Includes emissions from ultra-low sulfur diesel

[b] Emissions from Purinox combustion is not estimated in the 2005 Inventory. No publically available data currently exist on the emission factor of Purinox.

Source: Data compiled by Ascent Environmental, Inc .in 2015.

OFF-ROAD FLEET

City operations also include operation of off-road vehicles and equipment, such as construction, off-road cart, and landscaping equipment. The City's off-road fleet emissions were not included in the previous 2005 inventory, and are, therefore, excluded from the 2013 inventory when comparing with the 2005 inventory. However, it is possible that some off-road fleet fuel consumption was characterized in the 2005 vehicle fleet inventory, but that is not known for certain. Nevertheless, off-road fleet operations in 2013 resulted in emissions of 862 MT CO_2e from the consumption of diesel, propane, gasoline, and electricity. Table 11 shows the total fuel use and emissions by off-road fleet category and fuel type in 2013.

Table 11	City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Off-Road Fleet Activity and Emissions by vehicle and fuel type				
Off-Road Fleet Type	Fuel Use	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)
Diesel	Gallons				
Construction Equipment	28,952	295.60	0.02	0.01	298
Off road Equipment	45,945	469.10	0.03	0.01	473
Light Duty Cart	35.10	0.36	0.00	0.00	0.36
Heavy Duty Equipment	283	3	0.00	0.00	3
Diesel Total	*75,215*	*768*	*0.04*	*0.02*	*775*
Gasoline	Gallons				
Construction Equipment	444	0.21	0.00	0.00	0.21
Off road Equipment	324.47	4	0.00	0.00	4
Light Duty Cart	7,454	3	0.00	0.00	3
Medium Duty Equipment	156	65	0.00	0.00	66
Gasoline Total	*8,378*	*74*	*0.00*	*0.00*	*74*

Table 11	City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Off-Road Fleet Activity and Emissions by vehicle and fuel type				
Off-Road Fleet Type	**Fuel Use**	**CO_2 (MT)**	**CH_4 (MT)**	**N_2O (MT)**	**CO_2e (MT)**
Propane	**GGE**				
Construction Equipment	2,096	1.37	0.00	0.00	1.38
Off road Equipment	54	11.72	0.01	0.00	12
Propane Total	*2,150*	*12*	*0.01*	*0.00*	*12*
Electric	**kWh**				
Light Duty Cart	680	0.30	0.00	0.00	0.31
Electric Total	*680*	*0.30*	*0.00*	*0.00*	*0.31*
Total		**854**	**0.05**	**0.02**	**862**

Notes: GGE = gasoline gallons equivalents; kWh = kilowatt-hour; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using data provided by the City's Department of General Services.

Method

All off-road vehicles and equipment were calculated using fuel based emission factors, included in Table , below. While ARB's OFFROAD model has more specific emission factors by off-road vehicles and equipment and fuel types, calculating actual emissions requires equipment horsepower and total hours of use. With only fuel consumption and incomplete mileage data, the fuel-based emission factors from The Climate Registry and SMUD were applied to the off-road fleet fuel consumption.

Table 12	City of Sacramento Internal Operations GHG Emissions Inventory: 2013 Fuel Based Emission Factors used for Off-Road Fleet		
Fuel Type	**CO_2**	**CH_4**	**N_2O**
Diesel	10.21 kg/gal	0.58 g/gal	0.26 g/gal
Gasoline	8.78 kg/gal	0.50 g/gal	0.22 g/gal
Propane (Liquid)	5.59 kg/gal	0.17 g/L	0.028 g/L
Electric	0.313 MT/MWh	28.49 lb/GWh	6.03 lb/GWh

Notes: gal = gallon, GWh = gigawatt-hour; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent

Source: Climate Registry Emission 2014, TCR Reports 2015, EPA 2014.

Comparison with 2005 Inventory

The 2005 GHG inventory did not report emissions from the off-road vehicle fleet. Thus, the change in off-road fleet emissions from 2005 to 2013 is unknown. However, emissions from this sector would only make up about 1 percent of the City's total operational emissions in 2013.

WASTE-IN-PLACE

Emissions from solid waste at the City's internal operations level come from waste-in-place emissions at the City-owned-and-operated 28th Street Landfill. Waste-in-place emissions are the result of anaerobic decomposition of organic material from the existing accumulated waste in a landfill. The anaerobic decomposition occurs at covered landfills where the deposited waste is not exposed to the oxygen in the atmosphere.

The 28th St. Landfill was used to dispose of solid waste generated within the City between 1968 and 1994. Since the 28th Street landfill's permanent closure in 1997, a methane gas recovery system was installed and operated by a third-party contractor that collects and disposes of much of the gas that is generated from the closed landfill. From the early 1990's and 2010, the City sold a portion of the captured landfill gas to

Blue Diamond Almond for their industrial operations, flaring the remaining captured CH_4. However, in 2013, the landfill flared all CH_4 that was captured through its landfill gas (LFG) collection system. Fugitive CH_4 emissions resulting from the LFG collection and flaring in 2013 resulted in an estimated 13,750 MT CO_2e. Approximately 316 million standard cubic feet (MMSCF) of methane emissions were captured and flared in 2013. The IPCC considers any CO_2 emissions from flaring or fugitive emissions to be of biogenic origin and not significant to overall solid waste emissions (IPCC 2006).

<u>Method</u>

Equation 9.1 from the ICLEI LGOP (Version 1.1) was used to calculate GHG emissions from a comprehensive landfill gas collection system. Table 13 shows the inputs and assumptions used for each component of the applied equation.

Table 13 City of Sacramento Internal Operations GHG Emissions Inventory:2013 Waste-in-Place Emissions Calculation and Assumptions

Equation 9.1 Variables	Value	Source
LFG Collected (MMSCF)	316	City of Sacramento
Fraction of CH_4 in LFG (%)	35%	City of Sacramento
Destruction Efficiency (level of flaring)	0.99	City of Sacramento
Collection Efficiency	0.75	LGOP recommended assumption[a]
CH_4 emitted (MT CH_4)	655	
Waste-in-place (MT CO_2e)	**13,750**	

Notes: MMSCF = million standard cubic feet; MT = metric tons; CO_2 = carbon dioxide; CH_4 = methane; CO_2e = carbon dioxide equivalent

LFG – landfill gas

LGOP – Local Government Operations Protocol

[a] No data were available from the City, thus the LGOP recommended assumption was used in-place of a City specific value.

Source: Rincon. pers. comm., 2014, ARB et. al. 2010.

<u>Comparison with 2005 Inventory</u>

Waste-in-place emissions decreased by 2 percent from 2005 to 2013, by 262 MT CO_2e. Not counting the LFG previously sold to Blue Diamond between the early 1990s and 2010, landfill cover and capture methods have not changed significantly between 2005 and 2013. The landfill's methane capture system has been in place since 1994 and still meets all current emissions standards, even in light of the State's Landfill Methane Control Measure that became effective in June 2010 (ARB 2014).

Both the 2005 and 2013 inventories are consistent with the 2008 ICLEI LGOP and 2010 ICLE LGOP, respectively. Although ICLEI recommends using landfill gas measurement data, if available, such data were not available at the time the 2005 inventory was developed. As an alternative, the 2005 inventory calculated the City's 2005 waste-in-place emissions using the ARB's Excel tool based on the IPCC's First Order of Decay (FOD) model, according to the 2008 ICLEI LGOP recommended alternate methods. The FOD model method estimates emissions based on the landfill's waste deposit history. In the 2013 inventory, captured landfill methane volumes at the 28th St. Landfill were available and, thus, waste-in-place emissions were calculated using recommended equations in the 2010 ICLEI LGOP. These equations directly calculate emissions from the known methane capture. Waste-in-place emissions estimated using direct methane capture measurements are considered more accurate than emissions estimated using historical waste deposit data, which makes general assumptions on organic content and decomposition rate of the deposited waste.

2 ASSESSMENT OF EXISTING IO CAP ACTIONS

The 2010 IO CAP identifies 30 individual actions across five strategic areas that would reduce annual GHG emissions from internal City operations. The majority of these actions were implemented between 2010 and 2013, and many are still currently active. In the 2010 IO CAP, the City expected that these actions would reduce 10,075 MT CO_2e per year by 2020. In 2013, these actions avoided annual GHG emissions of approximately 7,726 MT CO_2e from the City's operations and an additional 839 MT CO_2e from outside of the City's GHG inventory. As previously mentioned, the City's annual emissions in 2013 were 19,486 MT CO_2e less than in 2005. The estimated avoided emissions due to the existing IO CAP actions may not fully explain the trends seen in the comparison between the 2005 and 2013 annual GHG emissions inventories for a variety of reasons. These may include, but are not limited to, the following:

- Reductions in the size and scale of City services and operations during the economic recession spanning the years 2008-2012;
- Differences in calculation methods;
- Actions that were determined to be unquantifiable in the IO CAP, but still resulted in GHG emission reductions; and
- Other actions taken by the City between 2010 and 2013 that were not included in the IO CAP.

Table 14 provides a comparison between the original estimated annual energy and GHG emissions reductions for the existing actions in the 2010 IO CAP, and current (2013) energy savings and associated GHG emissions reductions for these existing actions, in order to estimate progress made to date. Additional reporting on the progress and challenges of each existing IO CAP action and comparisons to the previous forecasts are discussed further below.

CHANGES IN METHODS AND ASSUMPTIONS

In order to reflect current (2013) conditions, new data sources, emissions factors, and approaches were used to quantify the progress of existing actions implemented since the 2010 IO CAP. Updates to existing measures were provided through interviews with various City staff. To quantify building electricity and water electricity emissions, new 2013 SMUD emission factors were used, as identified in the inventory discussion above and in Figure 4. The City provided estimated or real activity data updates for many of the IO CAP action strategies. Vehicle fleet fuel savings were estimated using either EMFAC2011 emission factors or fuel based emission factors depending on specific action and the type of data that was received. In addition, new sectors have been added to the discussion, including separating out water strategies, and some strategies have been reorganized under more appropriate sectors although the original numbering has not changed.

Table 14	Assessment of Existing Actions in the City of Sacramento 2010 Internal Operations Climate Action Plan								
Action Strategy ID	Description of Existing Project or Program	2010 IO CAP Estimates			IO CAP Update Estimates (as of 2013)				
		Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Annual GHG Reduction (MT CO_2e)	Year Completed	Implemented between 2010 and 2013?	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	2013 Annual GHG Reduced (MT CO_2e)
Building and Facilities Sector									
1	Thermostat Set-Point Optimization Policy (API #57)	NA	NA	450	On-Going	Yes	Unknown	Unknown	591
2	Energy Savers Campaign - "Lights & Equip Off" Policy (API #57)	NA	NA	unknown	On-Going	Partially	Unknown	Unknown	Unknown
3	North Area Corp Yard - Lighting Reduction Project	136,000	-	28	2009	Yes	136,000	0	35
4	Downtown Plaza Parking Garage - LED Pilot Project	24,810	-	5	2009	Yes	24,810	0	6
5	Convention Center Complex - Lighting Retrofit Projects	241,626	-	50	2010	Yes	241,626	0	61
6	Energy Efficiency Retrofits on existing City facilities	4,738,566	52,029	1,263	On-Going	Yes	3,374,815	Unknown	858
7	Solar PV and Thermal Hot Water on City Facilities	4,998,269	1,100	1,049	2009-2020	Yes	4,864,671	1,102	1,244
8	Green Building Policy for New City Buildings	294,765	1,929	77	2010	Yes	345,153	3,390	111
9	Greenergy and other purchased offsets	NA	NA	262	2009	Unknown	Unknown	Unknown	Unknown
10	"Green IT" Programs & Projects	2,929,629	-	611	Varies	Partially	432,020	-	110
11	Pumping efficiency & system optimization (water, sewage, drainage)	268,000	NA	56	TBD	Yes	268,000	-	68
Subtotal: Buildings & Facilities		*13,363,665*	*55,058*	*3,852*	*NA*	*NA*	*9,687,095*	*4,492*	*3,083*
Streetlights and Signals Sector									
12	Streetlight LED pilot project and citywide replacement program	5,400,000	NA	1,127	On-going	Yes	3,240,456	NA	858
13	Traffic Signals LED Replacement Program	1,807,475	NA	377	On-going	Yes	1,624,970	NA	413
Subtotal: Streetlights & Signals		*7,207,475*	-	*1,504*	*NA*	*NA*	*4,865,426*	*NA*	*1,236*
Vehicle Fleet									
14	Fleet Telemetrics (Zonar) Implementation on all City vehicles	NA	NA	2,104	2014	Yes	NA	NA	NA
15	Fleet Efficiency (3% annual improvement through 2020)	NA	NA	576	2020	Yes	NA	NA	35
16	Alternative Fuels: Low Carbon Fuel Program (vehicles & infrastructure)	NA	NA	654	2020	Yes	NA	NA	990
17	Solid Waste 4/10 Schedule	NA	NA	539	2009	Yes	NA	NA	539
18	Joint use of County North Area Recovery Station (Solid Waste VMT reductions)	NA	NA	268	2010	Yes	NA	NA	106
19	Green Waste Containers citywide (Solid waste VMT & fuel reductions)	NA	NA	429	2020	Yes	NA	NA	1,643
26	Green Landscaping Equipment Pilot Program	NA	NA	NA	TBD	Unknown	Unknown	Unknown	Unknown
27	Explore Waste-to-Energy Opportunities	Unknown	Unknown	Unknown	TBD	Began in 2014	0	0	0

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		Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Annual GHG Reduction (MT CO_2e)	Year Completed	Implemented between 2010 and 2013?	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	2013 Annual GHG Reduced (MT CO_2e)
29	In-region waste disposal (reduce private commercial hauling out-of-region) **(Scope 3)** [a]	NA	NA	1,854	2013	Partially	NA	NA	839 (Scope 3)
Subtotal: Vehicle Fleet		*NA*	*NA*	*4,570*	*NA*	*NA*	*NA*	*NA*	*3,313*
Solid Waste									
20	Expand waste reduction and recycling programs for City facilities (API #57))	Unknown	Unknown	Unknown	TBD	Partially	Unknown	Unknown	Unknown
21	Fugitive methane reductions at 28th Street Landfill.	Unknown	Unknown	Unknown	2013	Yes	Unknown	Unknown	Unknown
Subtotal: Waste		*Unknown*	*Unknown*	*Unknown*	*NA*	*NA*	*Unknown*	*Unknown*	*Unknown*
Water Management									
22	Low-Maintenance Landscaping	52,564	0	64	2010-2020	Partially	4,448	Unknown	1
23	Watering Reductions in City Parks	991,597	0	NA	TBD	Yes	Unknown	Unknown	Unknown
24	Centralized, Weather-Sensitive Irrigation Systems	1,379,640	0	79	2010-2020	Yes	68,502	Unknown	17
25	Interim Water Conservation Plan and Water Efficient Landscaping Ordinance (REVISED TO: Long-term Water Saving Strategies)	NA	NA	Unknown	On-Going	Yes	281,739	Unknown	72
Subtotal: Water Management		*2,423,801*	*0*	*143*	*NA*	*NA*	354,688	-	90
Urban Forest and Other									
28	Expanding the Urban Forest	Unknown	Unknown	6	On-Going	Yes	Unknown	Unknown	67
30	Sustainable Purchasing Policy **(Scope 3)** [a]	NA	NA	NA	TBD	No	Unknown	Unknown	Unknown
Subtotal: Urban Forest and Other		Unknown	Unknown	*6*	NA	NA	Unknown	Unknown	*67*
Total		22,994,941	55,058	10,075	NA	NA	14,907,210	4,492	7,790
Total (with Scope 3 Emissions)		22,994,941	55,058	11,929	NA	NA	14,907,210	4,492	8,629

Notes: kWh = kilowatt-hour; MT = metric tons; CO_2e = carbon dioxide equivalent

"-" – None reported

API – Administrative Policy Instruction

CAP – Climate Action Plan

IO – Internal Operations

NA – Not Applicable

TBD – To be determined

[a] Scope 3 emissions are not counted towards reductions in the inventory.

Source: City of Sacramento 2010, data compiled by Ascent Environmental, Inc. in 2015

BUILDING ENERGY

Building energy actions in 2013 resulted in the reduction of 3,083 MT CO_2e from the building and facilities energy sector. This is 769 MT CO_2e less than what was estimated in the 2010 IO CAP. The greatest reductions in building energy emissions came from the increased reductions in building energy use through energy efficiency and renewable energy actions (Action Strategy 6 and 7).

1. Thermostat Set Point Optimization - "2 Up/2 Down" Policy (Sustainability API #57)

Administrative Policy Instruction (API) #57 requires "Optimization of Facility Temperature Settings" in which summer and winter thermostat set points would be established at 78 degrees and 68 degrees, respectively. However, if the set points are not currently maintained, the API instructs City staff to work towards these set points by increasing the set points 2 degrees in the summer, and reducing them by 2 degrees in the winter ("two up/two down"). According to the policy text, "...by changing the temperature one degree Fahrenheit in a 100,000 square foot building the energy savings would reduce associated power plant carbon dioxide emissions by 45,000 pounds per year."

The 2010 IO CAP stated that many City facilities may not be able to achieve the temperature set point optimization and assumed that this action would affect roughly 1.1 million square feet. Currently, about half (1.25 million square feet) of the City's buildings are applying the thermos stat set point optimization. Using the API estimated emission reduction factors to maintain consistency with the previous analysis[8], the City avoided emissions of 591 MT CO_2e in 2013.

2. Energy Savers Campaign

The API #57 also included a policy directing City staff to turn off all lights and computers when not in use. The 2010 IO CAP did not quantify possible reductions from this action, but predicted significant energy saving potentials because lighting and computer use account for nearly half of a building's energy consumption. In 2009, some facilities were already equipped with timers and/or occupancy sensors to optimize lighting performance, while others were manually controlled. In 2013 and currently, this policy was intended to influence behavioral changes as well as automated changes in computers. Behavioral changes would include remembering to turn off building lights and other equipment when not in use. However, the City commenced an energy efficiency campaign in July 2013 to encourage employees to turn off lights and equipment when not in use. Energy and GHG emissions reductions from this action were not quantified in the 2010 IO CAP due to dependence on individual employee actions. Similarly, no data to quantify GHG emissions reduction from this action was available. Thus, annual GHG reductions associated with the behavioral component of this measure in 2013 could not be determined.

Estimated GHG reductions from automated reductions for City computers and related equipment (e.g., power management) were estimated under the "Green IT" action (see item 10 below).

3. North Area Corporation Yard - Lighting Reduction Project

As in 2009, the North Area Corporation Yard (NACY) continued to have 25 percent of the lights at the facility disconnected. Annual energy savings in 2013 are assumed to be the same as in 2009 at 136,000 kWh per year. However, due to changes in SMUD's electricity emission factors, the annual GHG emissions reduction due to this action was 35 MT CO_2e in 2013.

4. Downtown Plaza Parking Garage - LED Pilot Project (completed in 2009)

In 2009, the City collaborated with SMUD to implement a Light-Emitting Diode (LED) pilot project at the Downtown Central Parking Garage's lower level. This pilot aimed to install 25 bi-level LED fixtures, which were all in operation in 2013. While the 2010 IO CAP estimated an annual savings of 34,400 kWh from the

[8] Actual avoided emissions may vary due to changes in utility emission factors.

operation of these lights, these fixtures had an actual savings of 24,810 kWh in 2013. Thus, after applying current emission factors, this action resulted in a reduction of **6 MT CO_2e** per year.

In 2014, demolition began on the Downtown Plaza Mall and parts of the parking garage to make way for the construction of the proposed Downtown Kings Arena. As part of this demolition, all 25 fixtures were likely removed.

5. Convention Center Complex - Lighting Retrofit Projects

The Convention Center Lighting Retrofit projects were completed by 2010. These included the replacement of inefficient interior lighting as well as retrofit of the LED marquis sign. Annual energy savings in 2013 are assumed to be the same as in 2009 at 241,626 kWh per year. However, due to changes in SMUD's electricity emission factors, the annual avoided emissions due to this action was **61 MT CO_2e** in 2013.

6. Energy Efficiency Retrofits on Existing City Facilities

Of the 19 planned energy efficiency retrofit projects listed in the 2010 IO CAP under Action Strategy 6, approximately 8 were completed and are currently incurring energy savings. At the Pannell Community Center, the boiler retrofit, lighting retrofit, and DDC Controls Optimization were completed with an estimated annual savings of 129,141 kWh. At the Central Library, a boiler replacement, installation of a variable frequency drive, replacement of air handlers, and the installation of a controls optimization resulted in an annual savings of 179,751 kWh[9]. LED lighting retrofits at 8 city garages retrofits resulted in an annual savings of 2,887,923 kWh[10]. Lastly, upgrading the pumps at the Pannell Pool to VFD's saved 178,000 kWh per year. In all, 2013 had a savings of 3,374,815 kWh and avoided **858 MT CO_2e** in annual emissions.

7. Solar PV and Thermal Hot Water on City Facilities

In 2013, solar photovoltaic (PV) panels and thermal systems saved 4,807 MWh and 1,102 therms. In addition, another 58 MWh was generated by the solar PV systems, but returned to SMUD's electricity grid and credited towards the City's account. A total of 4,865 MWh was generated by solar PV systems on City facilities, which is close to the 4,998 MWh of solar generation estimated in the 2010 IO CAP. Thus, in 2013, solar PV and thermal hot water systems avoided **1,244 MT CO_2e**.

8. Green Building Policy for New City Buildings

Between 2005 and 2013, the City had constructed 7 new LEED®-certified buildings. At the time of the 2010 IO CAP, only 6 had been operating. In 2011, the City began operation of the new North Natomas Fire Station #43, which is rated LEED®-Silver. The LEED®-Silver building is assumed to use 25 percent less energy than an equivalent building built under the 2008 Title 24 standards that were in effect in 2011. Assuming that the previously estimated annual savings of the six other LEED® buildings are valid for 2013 and adding in the additional savings from the operation of Fire Station 43, the total annual energy savings was 345,153 kWh and 3,390 therms, resulting in the avoided emissions of **111 MT CO_2e** in 2013.

9. Greenergy and Other Purchased Offsets

SMUD's Greenergy program allows customers to purchase renewable energy credits from the utility grid. In 2009, the City purchased a total of 789,589 kWh of Greenergy blocks. However, in 2013, there was no known active contract to continue annual Greenergy purchases. Therefore, there were **no GHG reductions** from this action in 2013.

10. "Green IT" Programs & Projects

Prior to 2010, the City began a series of programs to help "green" the City's information technology (IT) infrastructure and office equipment. These programs are categorized into five specific Green IT measures. The 2010 IO CAP estimated that these measures would reduce 2.9 million kWh and 611 MT CO_2e per year.

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[9] Note that Library electricity use from the Pocket-Greenhaven and North Sacramento – Hagginwood libraries is not included in the 2013 GHG inventory. Not all changes listed here were identified in Table 7 of the 2010 IO CAP.

[10] It is uncertain of the 8 retrofitted garages were included in the "samples of parking garages" identified in 2010 IO CAP under Action Strategy 6.

However, as shown below, this analysis estimates that these measures resulted in a combined reduction of at least 432,020 kWh at **110 MT CO_2e per year in 2013**. How each measure contributed to the total reduction from the "Green IT" programs and projects is explained below. The shortfall of the 2013 GHG reductions as compared to previous forecasts is mostly due to missing energy savings data for the data center energy efficiency projects and office equipment.

- Data Center Energy Efficiency Projects
  The 2010 IO CAP identifies a series of upgrades and operational changes to the City's data center that occurred since 2005 that would reduce energy use for temperature control and air flow. No additional changes to the data center efficiency projects were added between 2010 and 2013. The savings estimated in the 2010 IO CAP are based on the difference in monthly energy use at the data centers between 2008 and 2009 and extrapolate that to an annual savings of 100,375 kWh per year. However, according to current EnergyCAP data, annual energy use at City data centers ("Computer Services" place name) actually decreased from 1,148 MWh to 1,116 MWh per year. Because EnergyCAP data does not distinguish between applications of energy use, the energy savings attributable to the heating and cooling impacts of this measure are unknown.

- Server Virtualization and Consolidation Project
  This measure aims to reduce the number of on-site servers to reduce energy use. The 2010 IO CAP estimated that 100 regular servers would be reduced to 7 virtualized servers with an annual savings of 276,816 kWh by 2020. By 2013, 31 servers had been removed and virtualized. The City removed 18 servers from the main data center and 15 physical servers from departmental data centers. No data are available on the number of additional virtualized servers used in place of the removed on-site physical servers. Assuming the same replacement ratio (100:7) and energy use per server type, it is estimated that the 31 removed servers resulted in a net reduction of 85,813 kWh and 22 MT CO_2e.

- Storage Management Project
  The IT Department is still exploring ways to improve data storage management options that will result in the ability to avoid adding new storage devices, and possibly replace existing storage units with more energy efficient units. Although the IT department has considered new storage management options starting from 2010, the City has not yet taken formal actions related to storage management since that time.

- Power Management Project
  In 2009 and 2010, roughly 80 percent of all computers and printers were left on overnight. The 2010 IO CAP estimates that installing power management features on all computers would result in the savings of 247 MT CO_2e per year. Currently and in 2013, the City has configured all computer monitors to go to "sleep mode" after 15 minutes of inactivity. However, the power management of printers and computer systems (not including the monitors) is still reliant on manual input from employees. In 2013, the City had approximately 5000 computers. Using the same EnergyStar Computer Power Management Savings calculator used in the 2010 IO CAP, approximately 346,207 kWh and 88 MT CO_2e was saved from the Power Management Project.

- EnergyStar Computing and Office Equipment Replacement Program
  In 2010, the City adopted a Sustainable Purchasing Policy that requires "purchases of appliances and electronics for which Energy Star certification is available when practicable". In 2013, all replaced computers and related equipment were EnergyStar models. No data were available on the actual number of replaced computers and related equipment. Thus, savings from this program could not be quantified.

11. Pumping efficiency & system optimization (water, sewage, drainage)

The 2010 IO CAP evaluated the energy saving from the installation of VFD pumps to increase pumping efficiency for the City's water, sewage, and storm drainage conveyances services. There have been several improvements made at numerous pumping facilities between 2005 and 2010. However, no additional optimizations have been made since 2010. Thus, the energy savings estimated for this Action Strategy in the 2010 IO CAP are assumed to be ongoing, where 267,000 kWh is saved annually from VFD driven pumps. This translates to a savings of **68 MT CO_2e** in 2013.

Although included in the building energy sector in the 2010 IO CAP, this Action Strategy will be categorized under the Water Sector in the IO CAP Update.

STREETLIGHTS AND TRAFFIC SIGNALS

LED streetlight and traffic signal projects resulted in the reduction of **1,236 MT CO_2e** from the streetlights and signals sector in 2013. This is 267 MT CO_2e less than what was estimated in the 2010 IO CAP. The greatest reductions in this sector came from the removal and conversion of streetlight fixtures to LED.

12. Streetlight LED Pilot Project and Citywide Replacement Program

The goal of the streetlight LED pilot project was to demonstrate that LED lighting is more cost-effective and energy efficient than traditional high pressure sodium or incandescent streetlighting fixtures. The 2010 IO CAP estimated an annual savings of 5.4 million kWh, which assumed that all 30,000 streetlights in the City would be converted to LED by 2020 after completion of the pilot program. About 1,000 streetlights out of the 33,764 streetlights in the City in 2013 were converted LED as part of the pilot program. However, the City has not yet converted 100 percent of the streetlight inventory. Although the inventory of streetlights in the City was reportedly lower in 2013 than in 2005 (a difference of 5,124 fixtures), this is likely due to a double count of streetlights in the 2005 inventory. The current count of streetlights is more accurate and the actual number of streetlights may have increased since 2005 due to city growth. However, without an accurate count of 2005 streetlights, the explanation for the change in the city's streetlight inventory cannot be known for sure. The conversion of streetlights to LED fixtures and the reduction in streetlight operation resulted in an annual savings of 3,240 MWh (3.2 million kWh) and **823 MT CO_2e**.

13. Traffic Signals LED Replacement Program

As of late 2009, approximately 85 percent of traffic signals were already converted to LED fixtures. The City's Department of Transportation plans to complete the traffic signal conversion to LEDs by the end of 2015. The 2010 IO CAP projects an annual reduction of 1,807,475 kWh between 2005 and 2015. In 2013, LED traffic signals saved 1,624,970 kWh from 2005 levels, which is consistent with the trends forecasted in the 2010 IO CAP. These saving resulted in the annual reduction of **413 MT CO_2e** in 2013, which is 36 MT CO_2e more saved than previously estimated.

VEHICLE FLEET

Vehicle fleet action strategies resulted in the reduction of **3,313 MT CO_2e** from the on-road and off-road fleet sector in 2013. This is 1,509 MT CO_2e less than the reduction estimated in the 2010 IO CAP. The reason for this large discrepancy can be mostly explained by the lack of data or appropriate methods to calculate the real impacts of Action Strategies 14 and 15, further discussed below. Among the quantified strategies in this update, the greatest reductions in this sector came from the implementation of containerized yard waste collection in Action Strategy 19. Further reductions were also realized in the form of Scope 3 emissions where City actions resulted in reduced demand for third party solid waste transport, as detailed in Action Strategy 29.

14. Fleet Telemetrics Implementation on all City Vehicles

The application of fleet telemetrics to City's fleet management was anticipated to have the greatest potential to reduce fleet GHG emissions in the short term. Fleet telemetrics involves tracking real-time vehicle fleet operation including vehicle location, fuel use, mileage, and idling time. In 2013, 100 percent of the vehicle fleet had some form of fleet telemetrics installed. With the exception of unmarked police department vehicles, police department patrol vehicles, and off-road and construction equipment, vehicles in the City fleet have either Zonar, a Vehicle Identification Box (VIB), or a Remote Vehicle Analytic (RVA) GPS device installed on the vehicle.

This action likely reduces fuel usage through improved fuel efficiencies and reduced VMT resulting from increasing awareness among drivers, operators, and fleet managers of the real-time vehicle and fuel usage. The 2010 IO CAP estimated that the full implementation of the fleet telemetric action strategy would reduce annual fuel consumption by 10 percent from 2009 levels, from 2.45 to 2.20 million gallons of diesel, gasoline, ethanol, and LNG (a difference of 47,464 gallons). In 2013, total fuel consumption from these fuel types was 2.43 million gallons[11], which fell short of the forecasted fuel reduction. Although fleet telemetrics may have contributed in part to some avoided fuel use, other actions such as overall improvement in fleet efficiency (Action Strategy #15), reductions in solid waste truck VMT (Action Strategies #17 and #18), downsizing City operations and staff during the recession, and other changes to the fleet would also have affected fleetwide fuel consumption. Therefore, fuel reductions and subsequent emissions savings caused specifically by the implementation of Action Strategy #14 cannot be quantified. **No GHG reductions** are estimated from this action in 2013.

15. Fleet Efficiency (3 percent annual improvement through 2020)

Under API #57, the City aims to continuously improve fleetwide vehicle efficiency as part of the City's on-going replacement program. The 2010 IO CAP assumed that vehicle efficiency would improve by 3 percent every year from 2010 through 2020, resulting in an annual additional reduction of 18,277 gallons of fuel in addition to what would be saved under Action Strategy #14. Between 2010 and 2013, the City purchased 474 new vehicles[12], which included 151 new E85 vehicles, 141 gasoline vehicles, 9 hybrid gasoline vehicles, and 7 electric vehicles for both on-road and off-road fleets. These new purchases coincided with the removal of over 400 vehicles from the City fleet within the same time period. By comparing the average fuel economies of the replaced vehicles[13] and multiplying the difference to the total mileage of the new vehicles in 2013, efforts to improve fleet efficiency under this Action Strategy resulted in a savings of approximately **713** gallons of diesel and **3,218** gallons of gasoline. This equates to an annual reduction of at least **35 MT CO_2e** in 2013 from the improvement of fleet efficiency.

16. Alternative Fuels: Low Carbon Fuel Program (Vehicles & Infrastructure)

Between 2009 and 2013, the City reduced the number of gasoline and diesel vehicles by 353 units from 89 percent to 77 percent of the on-road fleet, but increased off-road fleet. During the same time, the City purchased 191 new E85 flex fuel vehicles and seven additional gasoline-hybrids. Previously, the 2010 IO CAP only anticipated an additional 75 E85 flex fuel vehicles by 2013. After comparing the emission factors between the 2013 fleet's alternative fueled vehicles to their gasoline or diesel counter parts, the City's alternative fuels program saved **990 MT CO_2e** in 2013.

17. Solid Waste 4/10 Schedule

By 2009, the City fully implemented the "4/10" schedule for solid waste operations to reduce the overall VMT of the solid waste collection vehicles. This was done by changing the workweek from 8 hours per day at five days per week to 10 hours per day at four days per week. This would save one day's worth of travel to and from waste transfer locations every week. There have been no changes to the program between 2009 and 2013, although the vehicles used in the program may have changed. Without further data on the combined effect of the "4/10" schedule and vehicle changes, Action Strategy #17 is assumed to incur the same fuel savings of 65,418 gallons of diesel and LNG as estimated in the 2010 IO CAP. This reduced annual emissions of **539 MT CO_2e** in 2013.

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[11] Includes fuel consumption from both on-road and off-road fleets. The 2010 IO CAP did not distinguish between the two vehicle fleet categories.
[12] 410 on-road and 64 off-road vehicles between model years 2010 and 2014, operating in 2013.
[13] Only compared the difference in fuel use between vehicles of the same fuel type.

18. Joint use of County North Area Recovery Station (Solid Waste VMT reductions)

This action was intended to reduce VMT from the solid waste fleet by decentralizing waste transfer facilities by including the use of the Sacramento County North Area Recovery Station (NARS). The 2010 IO CAP estimates that this action would save approximately 170,000 VMT annually. However, prior to 2012, the city was allowed to deliver 25,000 tons maximum to NARS. Since that time, the City is now allowed to deliver up to 40,000 tons; and, in 2013, the City delivered 35,384 tons of garbage to NARS. Thus, with the increased waste tonnage delivered, the City estimates that only 59,260 VMT have been saved in 2013. This resulted in the subsequent reduction of **106 MT CO_2e** in 2013.

19. Green Waste Containers citywide (Solid waste VMT & fuel reductions)

Since 2004, the Recycling and Solid Waste Division has offered containerized green waste collection to select areas of the City on a voluntary basis in place of solely collecting yard waste from street side deposits (loose-in-street). Containerizing green waste reduces fuel usage due to more efficient collection operations than using the less efficient “Claw” to gather yard waste deposited loose-in-street. This would potentially significant GHG emission reductions over the long term. The measure presented in the 2010 CAP recommended expanding on this practice to the whole city. As of late 2009, approximately 75 percent of residential customers were active participants in the voluntary program. Beginning July 1, 2013 all City residential customers are required to use a containers for yard waste year round.

While containers are made available for yard waste collection year-round, operation of loose-in-the-street leaf collection still exists alongside containerized collection and takes place during November, December and January. Between 2005 and 2013, conversion to containerized collection of green waste resulted in an 86 percent decrease in annual fuel consumption leading to a reduction of 178,765 gallons of diesel, gasoline, and LNG per year[14]. This, in turn, resulted in avoided emissions of **1,643 MT CO_2e**.

26. Green Landscaping Equipment Pilot Program

As of early 2015, the City has not yet conducted the proposed pilot study to explore the feasibility of converting landscape equipment to more fuel efficient or lower-carbon fueled equipment, to reduce GHG emissions and improve air quality. An analysis of the GHG emission reductions from this program will begin one year after the pilot commences, as described in the 2010 IO CAP. **No GHG reductions** are estimated from this action in 2013.

27. Explore Waste-to-Energy Opportunities

Waste-to-Energy (WTE) is the process of creating (or recovering) energy in the form electricity or heat from the incineration of a waste source. In 2010, the City began exploring WTE opportunities by collaborating with outside agencies in the Sacramento region. In 2013, the City established a yearlong sourcing agreement with Atlas Disposal and Clean Energy Fuels to provide renewable natural gas sourced from Atlas’ local anaerobic digester that began in mid-2014. The digester collects food waste from local restaurants and schools. **No GHG reductions** are estimated from this action in 2013.

29. In-region Waste Disposal (Reduce Private Commercial Hauling Out-of-Region)

This action strategy aimed to reduce inter-regional emissions by switching from hauling City waste out-of-state to hauling waste within the Sacramento region. All solid waste collected by the City (both internal operations and communitywide) is transported to landfills in various locations by 3rd party waste haulers. In 2009, approximately 75,000 tons of the City’s municipal solid waste per year was deposited at Lockwood Landfill[15] in Sparks, Nevada. The Lockwood Landfill was the primary location for the disposal of waste by the City through the beginning of 2012. Effective February 22, 2012, City waste now goes to Kiefer Landfill in Sacramento County.

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[14] Previous green waste calculations in the 2010 IO CAP used the wrong emission factor for LNG. Revised estimates show a 662 MT CO_2e reduction in emissions from 2005 to 2009, instead of the previously estimated at 429 MT CO_2e.

[15] Owned and operated by Waste Management, Inc.

Using the same hauling trip rate and distances, but with updated vehicle emission factors[16], the avoidance of out-of-state waste hauling led to a reduction of 470,127 VMT and **839 MT CO_2e** in 2013. GHG reductions from this Action Strategy are considered Scope 3 emissions reductions are not counted towards the City's GHG inventory.

WATER

Action strategies in this sector resulted in the reduction of **90 MT CO_2e** from various water reduction measures in the City in 2013. This annual reduction is 53 MT CO_2e less than the reduction estimated in the 2010 IO CAP for the water sector. The reason for this discrepancy is mainly due the difference in assumed water energy intensities. Other reasons also include the various stages at which the City is at in meeting their water reduction targets.

Water energy intensities used in this analysis are based on City-specific 2013 data. The City's total volume of water conveyed and the electricity used for water conveyance was used to calculate a City-specific water energy intensity: 0.000968 kWh per gallon of delivered water. This is approximately 3.5 times less than the 0.0035 kWh/gal assumed in the previous analysis, which was based on a statewide average available from ICLEI's proprietary Climate and Air Pollution Planning Assistant (CAPPA) tool.

22. Low-Maintenance/Sustainable Landscaping

City departments are continuing to explore ways to incorporate sustainable or low-maintenance landscaping to reduce the demand for water used to irrigate City landscapes. These have included four separate efforts to convert existing landscape or ensure the sustainability of new landscape. The progress of the four efforts since the 2010 IO CAP is summarized below.

- **Convert existing park turf to low water use landscapes**
  The Department of Parks and Recreation (DPR) plans to incrementally reduce the acreage that is currently planted with turf and replace it with low water use plants, drought tolerant turf grass or artificial turf. The 2010 IO CAP estimates an average rate of 25 acres per year. However, between 2010 and 2013 only 3.2 acres have been converted at an average of 1 acre per year.

- **Convert portion of new parks to low water use landscapes**
  DPR has committed all future designs for new parks to include a greater emphasis on drought tolerant plants, natives, and plants that are well adapted to local conditions. The 2010 IO CAP estimates that, of the 200 acres of new parks to be developed between 2010 and 2020, 15 percent would be low-water landscapes – an average of 3 acres of new low-water landscape acres per year. Between 2010 and 2013, 34.6 acres of new parkland was added to the City. Assuming that 15 percent of these parks would be low-water landscapes, only 3.7 acres of low-water use landscapes were actually developed – an average rate of 1.2 acres per year.

- **Convert Old City Cemetery turf to natives**
  By 2010, the City already converted 4 acres of turf in the Old City Cemetery to native plant demonstrations. No additional conversions have been made at this site between 2010 and 2013.

- **Convert 2 artificial sports fields**
  Only one synthetic turf field was completed between 2010 and 2013 – the Hagginwood Synthetic Soccer Field, which measures approximately 74,000 square feet (1.7 acres).

As in the 2010 IO CAP, the current estimates of water reduction are based off the assumption that 652,000 gallons are required to irrigate an acre of land, without any water saving measures applied. Synthetic turf is assumed to displace 100 percent of water required for equivalent natural turf. Low-water land is assumed to

[16] EMFAC 2011 Emission Factor for diesel solid waste collection vehicles

reduce unmitigated water usage by 50 percent. With respect to the upstream energy intensity used for water conveyance, the 2010 IO CAP assumed 0.0035 kWh per gallon as provided by the ICLEI CAPPA tool. The current 2013 update uses 0.968 Watt-hours/gallon, calculated from the City's actual total water conveyance volume and electricity use. The estimated savings for the measures enacted under Action Strategy 22 is summarized below in Table 1. Actions in 2013 are estimated to have resulted in avoided emissions of **1.13 MT CO_2e** per year.

Table 1 City of Sacramento Internal Operations Actions 2013 Update: Converted Park Acres and GHG Reductions from Low Maintenance Landscaping

Climate Action Measure	2010 IO CAP		2013 Update	
	Total Acres to be Converted by 2013	Total Annual GHG Reduction (MT CO_2e)	Total Acres Converted by 2013	Total Annual GHG Reduction (MT CO_2e)
DPR: Convert existing park turf to low water use landscapes	75	5.95[a]	3.2	0.26
DPR: Convert portion of new parks to low water use landscapes	9	26	3.7	0.42
CC&L: Convert Old City Cemetery turf to natives	4	33.5[a]	4	0.32
DPR: 2 artificial sports fields	NA	4.9	1.7	0.14
Total	**88**	**70.3**	**12.6**	**1.13**

Notes: MT = metric tons; CO_2e = carbon dioxide equivalent

CAP – Climate Action Plan

CC&L – Convention, Culture and Leisure Department

DPR – Department of Parks and Recreation

IO – Internal Operations

NA – Not Applicable

[a] The 2010 IO CAP presented a GHG reduction range based on a 40 to 60% reduction in water consumption for low-water use landscapes. The value presented here is a 50percent reduction

Source: City of Sacramento 2010, Data compiled by Ascent Environmental, Inc., in 2015

23. Watering Reductions in City Parks

In addition to converting landscapes to have low-water use features, water use at City parks has also been reduced through operational changes, such as through controlled irrigation schedules. In 2010, DPR reduced water use by changing its watering schedule from 5 to 3 days per week and only in the evening hours to reduce evaporation. In 2013, further reductions in the watering schedule have occurred due to the on-going drought.

The 2010 IO CAP quantified the reductions from this Action Strategy by using the observed water reduction between 2008 and 2009. Although the 2010 IO CAP acknowledged that the emissions reduction due to these watering reduction measures is unknown, year-to-year changes in water use are also greatly affected by weather, such as the on-going drought that began in 2011. Thus, water, energy, and emissions reductions specifically from operational watering measures in City parks is unknown. **No GHG reductions** are estimated from this action in 2013.

24. Centralized, Weather-Sensitive Irrigation Systems

The City is in the process of converting outdated and ineffic*ient sprinkler systems to centralized and weather-sensitive irrigation control systems. Between 2005* and 2010, DPR converted 500 acres at 55 city parks to new, water-conserving central irrigation systems with weather station or sensor-based irrigation control technology. Between 2011 and 2013, the City upgraded 4 additional park irrigation systems, including systems at Lewis Park (3.3 acres), Bertha Henschel Park (2.5 acres), Danny Nunn Park (12.6

acres), and Bill Conlin Park (21.2 acres), watering a total of 39.6 acres. By 2020, DPR estimates that 900 acres of city parks would be watered by such technology.

Between 2011 and 2013, new irrigation control systems were installed at the Arcade Creek and Bing Maloney golf courses. The updated sprinkler system at these courses is estimated to provide water reductions of between 10 and 20 percent. In 2013, water meter devices were also purchased to provide data on ground water data to manage irrigation usage on both courses, as both courses are irrigated with well water.

Additionally, all new parks had central irrigation systems installed. As previously mentioned, the City developed approximately 35 new acres of parkland between 2008 and 2013, consistent with DPR's goal to achieve 200 new acres by 2020. This brings the total acres of City parks with new irrigation systems, exclusive of golf courses, to 535 acres as of 2013.

Assuming that these centralized irrigation control systems would reduce water use by 15 percent, this action strategy is estimated to have reduced water use in 2013 by 70 million gallons. This water reduction would be on top of any water reductions realized from low-water use turf, as describe in Action Strategy 22. This total water reduction is estimated to have reduced 68,502 kWh and **17.4 MT CO_2e**[17] in 2013.

25. Interim Water Conservation Plan and Water Efficient Landscaping Ordinance

A 100-acre foot savings identified in the 2010 CAP was tied directly to specific short-term measures and activities identified in the Interim Conservation Plan. These included performing water audits on 120 city parks. Since 2010, the City's conservation strategy has shifted away from large landscape audits for parks. When City Council adopted the 2012 Water Conservation Plan, it included long-term water savings strategies, which was specifically adopted as Program C in the plan. Program C implementation estimates 25,000 acre-feet of water savings through 2040. This would equate to a reduction of 893 acre-feet per year. Using the City's 2013 water conveyance energy use per gallon[18], the revised annual savings from this action would be 281,739 kWh per year, resulting in a reduction of **72 MT CO_2e** per year in 2013.

SOLID WASTE

Solid waste action strategies resulted may have resulted in some GHG reductions, although these reductions cannot be quantified. This sector contains two action strategies including waste and recycling programs and fugitive methane reductions at the 28th Street Landfill. With respect to the waste and recycle programs, there has not been a tracking system in place to quantify the type and amount of waste that was either avoided or recycled. In addition, no additional fugitive methane reductions are expected because the landfill has been capturing methane with the same or similar systems since before 2005 through 2013.

20. Expand Waste Reduction and Recycling Programs for City Facilities (API #57)) (some Scope 3 emissions)

The goal of this measure is to reduce waste from City facilities and promote sustainable waste management through reducing, recycling, and reusing. However, due to the lack of available data to track progress of these programs, GHG reductions from this action were not quantified. Additionally, many of these programs would also result in Scope 3 emissions reductions as reduced waste generation can result in offsetting upstream production of supply and materials. Qualitative updates to the three focus areas of the City's waste reduction programs are discussed below. **No GHG reductions** are estimated from this action in 2013.

- **Printing, Copying, Storing and Disseminating Documents**

  To reduce paper use, toner use, and energy use, the City considered the API #57 requirements for:

[17] This assumes that well water is the same energy intensity as city supplied water.
[18] Calculated with total water conveyance volumes and energy consumption used in water conveyance from City data for calendar year 2013.

- Double-sided printing
- Double-sided copying
- Printing in draft mode to reduce toner
- Electronic storage of files, in accordance with the City's Records Retention Policy and Electronic Document Management Policy
- Electronic Dissemination of Document through Email, Website, or other means

Between 2010 and 2013, the City applied a system-wide standard for double-sided printing. However, the City has not yet implemented system-wise double-sided copying, printing in draft mode to reduce toner. Additionally, it is the City's current standard practice to store and disseminate files and documents electronically. Many employees have even begun to use computer tablets in place of paper copies to use during meetings or at their desk. No data was available as to the amount of paper, toners, or energy that was saved from these actions. Subsequent emissions reductions that would result from these actions would be considered Scope 3 emission reductions under the ICLEI LGOP and are not credited toward the City's reduction target.

Recycling in City Operations

According to API #57, City employees are required to recycle waste generated from various aspects of City operations, including:

- paper and cardboard,
- plastics,
- glass,
- aluminum/steel/tin cans,
- printer and toner cartridges,
- hazardous waste, such as bleach, paints, insecticides, solvents, oil, grease, batteries, or common e-waste items such as used electronic equipment, batteries.

The City has recycled waste regularly for many years and there have been no significant changes to the City recycling program between 2010 and 2013. Currently, each office or cubicle has a large recycle bin with small side trashcan to promote recycling and reduce waste generation. All hazardous waste is taken care of properly and the City must follow the construction and demolition waste ordinance. Currently, a private waste hauler collects the waste at City facilities as part of their commercial business. The collection routes are not dedicated to just City facilities so it is not feasible to determine the amount of waste City facilities generate to determine any reductions in waste generation due to recycling or other programs. Thus, the GHG emission reduction from recycling in City facilities could not be calculated because the City does not track the level of recycling by City employees and changes in the City's waste generation is unknown.

Bottled Water Purchasing Restriction

API #57 prohibits City staff from using public funds to purchase bottled water in all forms (single-serve or 5 gallon), with some exceptions based on certain circumstances such as for outdoor events where tap water is not readily available, emergencies, and other limited situations. In 2013 and currently, the City continues to enforce this restriction of bottled water purchases. Exceptions include outdoor functions where elderly or children are present. It is not currently known how much bottled water was purchased annually prior to the adoption of API #57, or how much associated waste reduction and Scope 3 emissions would be achieved under this policy.

21. Fugitive methane reductions at 28th Street Landfill

Effective June 17, 2010, the California Air Resources Board is implementing a new landfill gas regulatory control measure that requires owners and operators of existing gas controlled municipal solid waste facilities to operate in an optimal manner (ARB 2014). The control measure ensures the reduction of methane emissions from municipal solid waste landfills by requiring gas collection and control systems on landfills where these systems are not currently required, and establishes statewide performance standards to maximize methane capture efficiencies. In the 2010 IO CAP, which was completed prior to the approval and implementation of ARB's new landfill gas control measure, the impact of the control measure on landfill operations and subsequent GHG emissions was unknown. However, the 28th Street landfill has been covered and capturing landfill gas since 1995.

In 2009, some of the landfill gas was sold to Blue Diamond Almonds to be used as fuel in their industrial operations. Not all of the methane captured was used, however, so some of the gas was flared to reduce fugitive methane emissions from the landfill. In March 2010, the City discontinued sending captured methane to Blue Diamond. Since that time, including 2013, all captured gas has been flared. Any leaked gas due to losses in the recovery system are not included in the captured gas. In the years since the establishment of the landfill control measure, the City has passed all service emissions tests per current ARB standards. In anticipation of more stringent emissions standards, the City plans to install a new flare and blower in 2015.

No significant changes were made to the 28th Street landfill in response to the adoption of ARB landfill regulatory control measure. Therefore, no GHG emissions reductions occurred due to the adoption of the ARB landfill rule and **no GHG reductions** are estimated from this action in 2013.

URBAN FOREST

28. Expanding the Urban Forest

The 2010 IO CAP estimates that 200 trees would be planted annually through 2010 under this action. As part of this update, the City estimates that 1,000 trees were planted annually between 2010 and 2014, exceeding the previously estimated planting rate. However, many of the removed trees either did not survive or were vandalized, resulting in the removal of 2,500 trees between the same period. Thus, between 2010 and 2013, a net increase of 1,125 trees occurred. To calculate the annual CO_2 sequestered by the net addition of trees, the same sequestration potential used in the 2010 IO CAP is assumed – 59.7 kg CO_2/tree[19]. Based on these assumptions and estimates, **67 MT CO_2 per year** was sequestered from the net addition of trees between 2010 and 2013.

OTHER

30. Sustainable Purchasing Policy

The City has not yet adopted a Sustainable Purchasing Policy (SPP). According to the 2010 IO CAP, the SPP would require City staff to procure products and services for the City's operations in a manner that integrates fiscal responsibility, social awareness and community and environmental stewardship. **No GHG reductions** are estimated from this action in 2013.

[19] The 2010 IO CAP used a Sacramento specific study which is still the most characteristic of the City's trees.

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APPENDIX C: CALCULATION OF CAP EMISSIONS REDUCTIONS

SS-1	Streetlights and Signals		LED Streetlights
Information			
Streetlights, including existing and new fixtures, would be 100% LED by 2020.			
			Source
	Number of LED lights in 2013	33,764	City Record
	Number of LED lights in 2020	37,576	Scaled by 11% population growth from 2013
	Energy Use (kWh)	MTCO2e	Source
LED energy use per streetlight (kWh/light)	323	0.078	Calculated from City Record
LED streetlight energy use in 2013	16,791,029	4,084	City Record
BAU streetlight energy use in 2020	18,686,747	4,545	Scaled by 11% population growth from 2013
LED streetlight energy use in 2020	12,123,393	2,949	Assumes 100% of future lights will be LED
Savings from BAU in 2020	6,563,354	1,596	Calculated
Savings from 2013	4,667,636	1,135	Calculated

SS-2	Streetlights and Signals		LED Traffic Signals
Information			
All existing signals are already LED as of 2009. Alll new traffic signals would be LED by 2020.			
	kWh	MTCO2e	Source
LED signal energy use in 2013 (kWh)	2,372,353	603	City Record/Calculated
LED signal energy use in 2015 (kWh)	2,189,009	532	Year of LED replacement program completion
LED signal energy use in 2020 (kWh)	2,398,469	583	Scaled by 10% population growth from 2015
BAU signal energy use in 2020 (kWh)	2,640,193	642	Scaled by 11% population growth from 2013
Savings from BAU in 2020	241,725	59	Calculated
Savings from 2013	-26,116	19	Calculated
To simplify calculations, this assumes that growth in the number of signals does not begin until 2015.			

		Energy reductions		Emission reductions (CO2 equivalents)			CO2 Sequestration	Total CO2 Stored	Above ground biomass
		Cooling	Heating	Cooling	Heating	Cooling + Heating			(dry weight)
Tree Age	Species	(kWh/tree)	(MBtu/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)
5	ACSA1 (Acer saccharinum)	12	0.04	5	2	7	17	29	12
5	PICH (Pistacia chinensis)	21	0.07	8	4	12	9	20	9
5	CESI4 (Celtis sinensis)	35	0.10	14	6	19	117	461	196
5	PLAC (Platanus hybrida)	42	0.12	17	6	23	39	117	50
5	QUIL2 (Quercus ilex)	8	0.03	3	1	4	14	26	11
6	ACSA1 (Acer saccharinum)	18	0.06	7	3	10	27	56	24
6	PICH (Pistacia chinensis)	27	0.08	11	4	15	12	33	14
6	CESI4 (Celtis sinensis)	43	0.13	17	7	24	118	579	246
6	PLAC (Platanus hybrida)	50	0.14	20	7	27	43	159	68
6	QUIL2 (Quercus ilex)	11	0.04	4	2	6	21	47	20
7	ACSA1 (Acer saccharinum)	24	0.08	9	4	14	39	95	40
7	PICH (Pistacia chinensis)	32	0.10	13	5	18	15	47	20
7	CESI4 (Celtis sinensis)	51	0.15	20	8	28	117	696	296
7	PLAC (Platanus hybrida)	56	0.15	22	8	30	45	205	87
7	QUIL2 (Quercus ilex)	16	0.05	6	3	9	29	76	32
8	ACSA1 (Acer saccharinum)	31	0.10	12	5	17	52	146	62
8	PICH (Pistacia chinensis)	38	0.11	15	6	21	17	64	27
8	CESI4 (Celtis sinensis)	60	0.16	24	9	32	116	812	345
8	PLAC (Platanus hybrida)	62	0.17	25	9	34	47	252	107
8	QUIL2 (Quercus ilex)	20	0.06	8	3	11	36	111	47
9	ACSA1 (Acer saccharinum)	39	0.11	15	6	21	65	212	90
9	PICH (Pistacia chinensis)	44	0.13	17	7	24	19	83	35
9	CESI4 (Celtis sinensis)	69	0.18	27	10	37	114	927	394
9	PLAC (Platanus hybrida)	68	0.18	27	10	37	49	301	128
9	QUIL2 (Quercus ilex)	24	0.08	10	4	14	43	154	66
10	ACSA1 (Acer saccharinum)	47	0.13	18	7	26	80	291	124
10	PICH (Pistacia chinensis)	49	0.14	19	7	27	20	103	44
10	CESI4 (Celtis sinensis)	78	0.20	31	10	41	112	1039	442
10	PLAC (Platanus hybrida)	74	0.19	29	10	40	50	350	149
10	QUIL2 (Quercus ilex)	28	0.09	11	5	16	49	204	87
11	ACSA1 (Acer saccharinum)	55	0.15	22	8	30	94	385	164
11	PICH (Pistacia chinensis)	54	0.15	21	8	29	22	125	53
11	CESI4 (Celtis sinensis)	87	0.21	34	11	45	110	1149	488
11	PLAC (Platanus hybrida)	80	0.20	32	11	42	50	401	170
11	QUIL2 (Quercus ilex)	32	0.10	13	5	18	56	260	110
25	ACSA1 (Acer saccharinum)	62	0.17	25	9	34	108	494	210
25	PICH (Pistacia chinensis)	59	0.16	23	9	32	24	149	63
25	CESI4 (Celtis sinensis)	94	0.22	37	12	49	108	1257	534
25	PLAC (Platanus hybrida)	85	0.21	34	11	45	51	451	192
25	QUIL2 (Quercus ilex)	36	0.11	14	6	20	62	322	137

	Annual	Energy reductions		Emission reductions (CO2 equivalents)			CO2 Sequestration	Total CO2 Stored	Above ground biomass
		Cooling	Heating	Cooling	Heating	Cooling + Heating			(dry weight)
	Average per tree planted per year (assume one of each type)	(kWh/tree)	(MBtu/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)
2014	Year 1	24	0	9	4	13	39	131	55
2015	Year 2	53	0	21	8	30	84	305	130
2016	Year 3	89	0	35	14	49	132	529	225
2017	Year 4	131	0	52	21	73	186	806	343
2018	Year 5	180	1	71	28	99	244	1141	485
2019	Year 6	236	1	93	36	129	306	1539	654
2020	Year 7	297	1	118	44	162	373	2003	851
	Average per removed tree per year	67	0	27	9	36	71	534	227

Number of trees planted per year	1000
Number of tree removed per year	800

Scenario	Energy reductions Cooling (kWh/year)	Heating (Mbtu/year)	Heating (therms/year)	Reduced MTCO2e from Energy Reduction	CO2 Sequestration (kg/year)	Total CO2e reduced
2020 (effect from planted trees)	297,199	834	8,337	128	372,711	500.54
2020 (effect from removed trees)	53,821	140	1,405	22	56,417	78.87
2020 (net effect)	243,378	693	6,932	105	316,294	421.67

WT-1 (drainage)	Water	Pumping efficiency & system optimization (drainage)	
Information			
Based on the "ENERGY MANAGEMENT OPERATIONS STUDY" Black and Veatch Report from 2013, implementing an alternate control strategy that allows the level in wet wells to increase during summer months and periods of low rainfall would reduce energy needed to provide hydraulic lift in drainage facilities. The report estimates that this alternate control strategy can reduce energy use for drainage pumping by between 4 and 10 percent. (page ES-4). Assume no growth in drainage demand, despite reductions due to drought-adjusted demand.			
Caveats			
Energy reduction is based on reductions from forecasted 2020 energy use for drainage pumping. Because 2013 is a drought year and rainfall/water supply in 2020 is unknown, the energy reduction estimates are based on the average between 2005 and 2013 energy usage. Another query from Energy CAP would be needed to provide a more even analysis. Due to this caveat, the calculations assume the most conservative reduction.			
	Value	Units	Source
2013 Energy Use for Drainage Pumping	6,809	MWh	Energy CAP
2005 Energy Use for Drainage Pumping	10406	MWh	Energy CAP
2020 Annual BAU energy use	8,607	MWh	Calculated
Black and Veatch Min Energy Reduction	4%	percent	City of Sacramento 2013a:ES-4
Black and Veatch Max Energy Reduction	10%	percent	City of Sacramento 2013a:ES-4
Black and Veatch Median Energy Reduction	7%	percent	Calculated
2020 Energy reduction from BAU	602.51	MWh	Calculated
2020 Energy use with WT-1	**8,004,806**	KWh	Calculated
2020 Energy use with WT-1 (with max reduction)	7,746,587	KWh	Calculated

WT-1 (water and wastewater)	Water	Pumping efficiency & system optimization (water)	
Information			
Based on the "ENERGY MANAGEMENT OPERATIONS STUDY" Black and Veatch Report from 2013, selecting more efficient pumps or pump combinations could result in increases of 6 to 8 percent in energy efficiency, without pump asset changes. B&V estimates a nominal 6 percent reduction in energy use to move the same volume of water. If more production is shifted from SRWTP to EAFWTP, approximately 11 percent energy reduction can be acheived. (Page ES-7) This calculation assumes energy reductions are applicable to both water supply and wastewater conveyance.			
Caveats			
	Value	Units	Source
2013 Water Volume	38,843	million gallons	Energy CAP
Energy Intensity	968	kWh/MG	calculated
2013 Wastewater Volume	11,948	million gallons	Energy CAP
Energy Intensity	248	kWh/MG	calculated
Black and Veatch Min Energy Reduction	6%	percent	City of Sacramento 2013a:ES-7
Black and Veatch Max Energy Reduction	11%	percent	City of Sacramento 2013a:ES-7
Black and Veatch Median Energy Reduction	9%	percent	Calculated
New 2020 water conveyance energy intensity	**886**	**kWh/MG**	**Calculated**
New 2020 wastewater conveyance energy intensity	**227**	**kWh/MG**	**Calculated**
2020 Water Volume (see WT-5)	31,555	million gallons	WT-5
2020 Wastewater Volume	10,044	million gallons	WT-5
Water volume reductions from BAU:	Water Supply (MG)	Wastewater (MG)	Total
WT-2: low-maintenance landscaping	-94	0	-94
WT-3: watering reduction in city parks	-362	0	-362
WT-3: weather sensitive irrigation	-10	0	-10
WT-4: Long-term Water Savings Strategies and Drought Response	-2,744	-1,059	-3,803
Reduced Water Use after Actions WT-2 to WT-4	-3,210	-1,059	-4,269
BAU 2020 Demand	34,298	11,103	45,401
New Water Use in 2020	31,088	10,044	41,132
2013 Energy Use (MWh)	37,614	2,968	40,582
2020 BAU Energy Use (MWh)	33,214	2,758	35,972
2020 New Energy Use (MWh)	27,546	2,283	29,829
Difference from 2020 BAU	5,667	475	6,143
Difference from 2013	10,068	685	10,753
2020 water + wastewater energy use after WT-1	29,829,383	KWh	Calculated
2013 water + wastewater energy use	40,582,356	KWh	Energy CAP
Energy reduction from 2013 after WT-1	10,752,973	KWh	Calculated
Energy reduction from 2020 BAU after WT-1	**6,142,554**	KWh	Calculated

WT-2	Water	Low-Maintenance Landscaping	
Information			
Maintain water reductions from 2013 of watering demands for ornamental turf. (490 acres as of April 2014)			
	Value	Units	Source
Reduced watered acres (acres)	490	acres	City
Annual Reductions from 2013 watering for ornamental turf (MG)	**94**	MG	Calculated from WT-4
2020 water energy reduction (kWh)	**83,560**	KWh	Calculated

WT-3 (Part 1)	Water	Watering Reductions in City Parks		
Information				
City Parks has achieved 37% watering reductions in 2014 from 2013 and anticipates a sustained 15-20% annual reduction from 2013 through 2020. 36 new acres are still planned to be constructed by 2020, but these new acres will result in greater water demands, even if they are lower than what they would have been. No growth is anticipated for city park watering. No growth anticipated for city parks to 2020. Assume wastewater conveyance is unaffected. (accounted for in WT-1). Note that the additional water use for the new parks is assumed to be included in the City's BAU overall increase in water demand with population.				
			2014	**2013-2020**
Percent Reduction from 2013 Water Use at City Parks annually.			37%	18%
Year--->	**2013**	**2014**	**2020**	**2020 (with new acres)**
Annual Park Water Use with WT-3 (no-growth) (MG)	978	616	254	261
BAU Annual Park Water Use (includes addition of 36 new park acres by 2020) (MG)	978	616	616	623
Water Savings from BAU (MG)	0	0	362	362
	Value	Source		
Total Park Acres in 2013 (acres)	3,200	http://portal.cityofsacramento.org/ParksandRec/Parks		
2014 Water Use per Acre (MG/acre)	0.192458	Calculated		
New park acres between 2013 and 2020 (acres)	36	City assumptions		
Water Use at new parks in 2020 (MG)	6.93	Assumes that these have 2014 level of water use per acre		
Annual Additional Water use from 36 new park acres (MG)	7			
NET Annual Park Water Savings from 2020 (MG)	362			
New energy intensity from WT-1 (water) (kwh/MG)	886			
Annual Energy Savings (kWh)	**320,383**			

WT-3 (Part 2)	Water	Centralized, Weather-Sensitive Irrigation Systems in City Parks	
Information			
Between 2005 and 2010, DPR converted 500 acres at 55 city parks to new, water-conserving central irrigation systems with weather station or sensor-based irrigation control technology. Between 2011 and 2013, the City upgraded 4 additional park irrigation systems, including systems at Lewis Park (3.3 acres), Bertha Henschel Park (2.5 acres), Danny Nunn Park (12.6 acres), and Bill Conlin Park (21.2 acres), watering a total of 39.6 acres. By 2020, DPR estimates that 900 acres of city parks would be watered by such technology. Takes into account water use per acre from WT-3 (Part 1).			
Percent of savings from installation of efficient irrigation systems		15%	
	2005-2010	2011-2013	2013-2020
Parkland converted to more efficient irrigation systems (totaling 900 acres) (acres)	500	40	360
Reduced water demand at parks due to WT-3 in 2020 (MG)	69	Using MG/acre from 2014	
Additional annual water reduction from converted parkland (MG)	10.4	360 acres x 0.15	
New energy intensity from WT-1 (water) (kwh/MG)	886		
Additional Energy Savings in 2020 (kWh)	**9,219**		

WT-4	Water	Long-term Water Saving Strategies/Drought Response
Information		
City Council adopted a Water Conservation Plan in 2013 which identifies 20+ actions to ensure compliance with SBX7-7 and a 223 GPCD objective by 2020. These actions, while primarily focused at the City's water customers (residential and commercial users), play a significant role in mitigating the internal operations impacts associated with water production through reducing total City water demand by 2040. This yields the benefit of avoided capital and environmental costs associated with the development of new water diversion and treatment infrastructure.		
City of Sacramento's Department of Utilities provided an estimation of annual savings by 2020 from 2013. The City forecasts an increase in water demand by 2020, which would result in an increase of 11% from 2013 levels. With the applicable long-term water saving strategies, water demand would only increase by 2% from 2013 to 2020 (2013 Water Conservation Plan). With the effect of the drought in recent years that caused a 19% reduction in water supply demand and the annual variability associated with weather, it is further anticipated that water demand would remain unchanged from 2014 levels.		
	Value	Source
2013 City-Wide Water Usage (MG)		
Water Conveyance	38,843	Energy CAP
Wastewater Conveyance	11,948	Energy CAP
2014 City-Wide Water Usage (MG)		
Water Conveyance	31,555	Calculated
Wastewater Conveyance	10,044	Bill Miller (see 8/18/15 email)
Percent reduction from 2013	19%	Terrance Davis (see water savings tab in Consolidated Actions file)
Water reduction from 2013	7,288	Calculated
Water Reductions in WCP (MG)		
2020 - No-Conservation	51,491	Table 3-3 of the 2013 WCP (converted from AF to MG)
2020 - from Program C and Plumbing Code	45,149	Table 7-2 of the 2013 WCP (converted from AF to MG)
Percent reduction from no conservation	12%	
BAU 2020 Water Use (MG)		
Water Conveyance	34,298	Based on population growth from 2014
Wastewater Conveyance	11,103	Based on population growth from 2013
2020 Water Use with WCP only (MG)		
Water Conveyance	30,074	Does not take into account community drought-response
Wastewater Conveyance	9,735	Does not take into account community drought-response
Anticipated 2020 City-Wide Water Usage (based on drought response and conservation plans) (M		
Water Conveyance	31,555	
Wastewater Conveyance	10,044	
Difference from BAU (MG)		
Water Conveyance	2,744	
Wastewater Conveyance	1,059	
Total	3,803	
Energy Savings from BAU due to WT-4 (kWh)		
Water Conveyance	2,431,065	
Wastewater Conveyance	240,712	
Total	2,671,777	

VF-1	Vehicle Fleet	Fleet Efficiency and West Coast Electric Fleet Pledge	
Information			
-According to the City, 1098 vehicles and equipment will be replaced between 2013 and 2020.			
With replacement of 1098 vehicles by 2020.			
2013 Vehicle Inventory	1,819		
Number of vehicles replaced by 2020	1,098		
Passenger Cars to be replaced with electric	31		
Diesel solid waste vehicles replaced with CNG	72		
Vehicles replaced with more efficient versions of the same vehicle	995		
Percent of 2020 Vehicle Inventory with newer MPGs	55%		
Percent of 2020 Vehicle Inventory with original MPGs or with new fuel type	45%		
	CO2e (MT)	Assumptions	
2020 BAU Vehicle Fleet Emissions without CNG	15,671	No CNG vehicle replacements of diesel solid waste	
2020 Vehicle Fleet Emissions (including Electric Fleet Pledge and replaced vehicles) (Includes non-renewable CNG vehicles)	15,074	1098 of the oldest on-road vehicles replaced with MY 2017 vehicles. 72 Diesel solid waste vehicle would be replaced with CNG. Assume same annual mileage as 2013.	
Annual Emission Reduction from VF-1	**597**		

VF-2	Vehicle Fleet		Alternative Fuels: Renewable Natural Gas

Information

Background:

-According to the City, the City co-signed a purchase contract with the County to purchase up to $3,000,000 dollars worth of renewable LNG over three years growing at at $100,000 per year, starting at the end of 2013 and ending in 2016 or until the contract is no longer available for use through extension or termination. The City plans to continue this contract into the future, pursuing the contract after expiration. However, further into the future, the City is aiming to transition from LNG to CNG due to safety and cost reasons.

-The City is pursuing a new contract to obtain $400,000 per year for renewable CNG for a 2 year contract, totally $800,000 for the term. Under this measure, it is assumed that the contract will continue out to 2020.

-The City is also anticipating replacing 72 diesel solid waste vehicle to the fleet between FY16 and FY20 with CNG vehicles.

-The City is planning to extend the Renewable LNG contract into the future.

Method:

-Assume that CNG vehicles use an average amount of fuel per year, based on the City's average CNG waste vehicles in 2013

-Estimate the total cost of CNG needed to be purchased in 2020 assuming all CNG vehicles use RNG.

-Assume that 3 year contract will be extended at current growth rate of an additional $100k per year.

-Assume emissions from all RNG use is zero.

Forecasted CNG demand	**Value**	**Unit**	**Source**
Solid Waste Diesel Use estimated in 2013 for 72 Diesel Solid Waste Vehicles	121,674	GGE	Inventory
Solid Waste LNG Use estimated in 2013	857,238	GGE	Inventory
CNG Use estimated in 2020	135,411	GGE	Inventory scaled by population growth
LNG Use estimated in 2020	954,021	GGE	Inventory scaled by population growth
Renewable CNG Purchase Contract Constraints for City	**Value**	**Unit**	**Source**
Price of CNG (2013)	$ 0.71	$/GGE	City of Sacramento
2 year contract	$ 800,000	dollars	RNG Contract
Year 1	$ 400,000	dollars	RNG Contract
Year 2	$ 400,000	dollars	RNG Contract
Year "X" (2020)	$ 400,000	dollars	Assumed CNG contract will continue into 2020
Renewable LNG Purchase Contract Constraints for City	**Value**	**Unit**	**Source**
Price of LNG (2013)	$ 1.21	$/GGE	City of Sacramento
3 year contract total Maximum	$ 3,000,000	dollars	RNG Contract
Year 1 (2014)	$ 900,000	dollars	RNG Contract
Year 2 (2015)	$ 1,000,000	dollars	RNG Contract
Year 3 (2016)	$ 1,100,000	dollars	RNG Contract
Year "7" (2020)	$ 1,000,000	dollars	Calculated, assuming contract rate will continue through 2020.
Forecasted RNG use and Emission Reduction	**Value**	**Unit**	**Source**
Renewable CNG			
Price of CNG (2020)	$ 0.71	dollars/GGE	Assuming same as current price
Available Renewable CNG to use in 2020	563,380	GGE	Total value divided by price
Total Non-Renewable CNG use in 2020	-	GGE	Remaining Fuel Demand not met by Renewable Fuel
Total Renewable CNG use in 2020	135,411	GGE	Calculation
Percent RCNG	100%	percent	Calculation
Non-Renewable CNG emissions in 2020	-	MT CO2e	Based on available renewable CNG.
Theoretical displaced CNG emissions in 2020 due to Renewable CNG	**971**	MT CO2e	Based on growth-adjusted fuel use of oldest 72 solid waste diesel vehicles in 2013 inventory.
Displaced Diesel emissions in 2020 due to Renewable CNG	**629**	MT CO2e	Based on growth-adjusted fuel use of oldest 72 solid waste diesel vehicles in 2013 inventory.
Renewable LNG			
Price of LNG (2020)	$ 1.21	dollars/GGE	Assuming same as current price
Available Renewable LNG to use in 2020	826,446	GGE	Total value divided by price
Total Non-Renewable LNG use in 2020	127,574	GGE	Remaining Fuel Demand not met by Renewable Fuel
Total Renewable LNG use in 2020	826,446	GGE	Calculation
Percent RLNG	87%	percent	Calculation
Non-Renewable LNG emissions in 2020	910	MT CO2e	Based on available renewable LNG and growth-adjusted LNG demand in 2020.
Displaced LNG emissions in 2020 due to Renewable LNG	**5,894**	MT CO2e	Based on available renewable LNG and growth-adjusted LNG demand in 2020.
Total Displaced CNG and LNG emissions in 2020	**6,523**	**MT CO2e**	**Calculation**

APPENDIX D: WASTE-IN-PLACE FORECASTS

Waste-in-Place Forecasts		
Information		
28th Street Landfill opened in 1968 and closed in 1997. City reported that, in 2013, 318,546,689 scfm (9020237.7248 m3) of methane was captured. Goal is to determine the amount of methane that would be captured in 2020 because of decay.		
Method: Use EPA LandGem Model V. 3.02. Place a dummy value for the year 2021 (or any year beyond 2020). Place dummy formulae under "Input Units" in the User Inputs tab, between 1968 and 1997, such that the total for these years add up to the dummy value. Go to the Methane tab and select the calculated methane emissions for the year 2013 (Cell J68). Use the "What-if" function of excel to force the 2013 methane emissions to equal 9020237.7248 m3 by changing the dummy value in the User Inputs tab. Calculate fugitive methane emissions from estimated 2020 methane emissions from LandGem.		
	Value	**Source**
2013 Collected LFG (m3)	9,020,238	City (Doug Huston)
2020 Collected LFG (m3)	7,841,818	Calculated from LandGem
2020 Collected LFG (mmSCF)	276.93	Calculated
m3/mmSCF	28316.84659	
Calculate Fugitive Methane Gas		
Based on Equation 9.1 in the ICLEI LGOP Chapter 9.		
LFG Collected (MMSCF)	277	
CH4%	35%	
DE (level of flaring)	0.99	
CE	0.75	
OX	0.1	
Unit Conversion	19.125	
GWP for CH4	21	
CH4 emitted (MTCH4)	575	
CH4 emitted (MTCO2e)	12,068	
Total Fugitive Emissions in 2020	12,068	

APPENDIX E: 2013 WATER CONSERVATION PLAN ACTIONS

6. COMPARISON OF INDIVIDUAL CONSERVATION MEASURES

6.1 Conservation Measures Evaluated

The following table presents the measure descriptions that were analyzed for the efforts of the WCP.

Table 6-1: Measure Description and Selection

DSS Model Measure Number	Focus Area	DOU Lead/ Partner	Conservation Measure	Measure Description	Key Commitments to CUWCC or Other Agencies
1	Water Waste	CO/DS/CE	**Investigate Customer Potential Leaks and Water Waste Ordinance Enforcement**	Continue to enforce water waste ordinance with required customer leak repairs. Effort is based on calls through customer complaints (through City call 3-1-1 system). Additionally, customers are notified through Computerized Maintenance Management System (CMMS) with automated written letters generated to customers with continuous flowing meters as flagged by the AMI Leak Report. Water Conservation Office follows-up with customers with potential leaks, first as a desktop review to see if potential leak is resolved. If continuous flow is still present, CO staff performs a Field Leak Investigation.	Existing CUWCC Foundational BMP 1.1
2	Water Loss	O&M	**Water Loss Control Program**	Continue to implement AWWA Manual M36 Methodology. (1) Use System Audit to track annually Infrastructure Leakage Index (ILI) Progress. Goal to lower the (ILI) and non-revenue water every year by pre-determined amount based on cost-effectiveness. (2) Analyze and Address Apparent Losses (i.e. data for billing system errors, and address meter testing and repair/replacement to insure more accurate meter reads and revenue collection). (3) Covers current efforts to address Real Losses (i.e. find and repair leaks in the distribution system to reduce real water loss and take other actions. Specific goals and methods are in progress by DOU - a program to implement best practices is ongoing (i.e., installation of data loggers and proactive leak detection, accelerated meter replacement and will be done over time). Leak repairs would be handled by existing crews.	CUWCC Foundational BMP 1.2 - Assume combine with other Water Loss measures
3	Metering	O&M	**AMI System with Meter Retrofits and Conservation Benefits**	Continue with approved AMI system installation. The AMI web portal that is being developed by City of Sac indicates to the customer and Utility where and how their water is used thereby facilitating water use reduction and helps customers identify leaks. Require that new customers with AMI capability review hourly consumption data when taking advantage of City incentives (i.e. online bill pay, rebate incentives).	Supporting CUWCC Foundational BMP 1.3.
4	Pricing	IPM	**Conservation Pricing**	Currently City has volumetric uniform rate for all new customers and one year after customer has a meter retrofit. Future Water Rate Study is planned. Seek a rate structure that would be more equitable among metered users than uniform volumetric rate. Goal is to complete study by 2014 and to implement a new tiered pricing structure designed and in place by 2016.	CUWCC Foundational BMP 1.4. Pending Rate Study conclusions
5	Education & Conservation General Administration	PI/ CO/RWA	**Public Information, Regional Outreach, Media Campaign**	Public education is necessary to raise awareness of conservation measures available to customers. Coordinate with the RWA Be Water Smart Regional Outreach Programs and use various methods to teach customers about efficiency measures. Include speakers to community groups, educational material, conservation website, radio, TV spots, demonstration gardens, etc. Refine and develop media messages, social marketing plan that will use public input to assist in changing attitudes. This measure also includes the Program Management and Administration needed by the Public Information Officer and Conservation Office staff.	Existing CUWCC Foundational BMP 1.1 & BMP 2

Table 6-1 (Continued)

DSS Model Measure Number	Focus Area	DOU Lead/ Partner	Conservation Measure	Measure Description	Key Commitments to CUWCC or Other Agencies
6	Single Family Residential Surveys	CO/RWA	**Single Family Residential Audits (Surveys)**	Continue conventional indoor and outdoor water surveys for existing single-family residential customers. Normally those with high water use are targeted and provided customized water saving information, tips and tools. Outdoor water surveys for existing single family residential customers (4 units or more). Target those with high water use and provide a customized report to owner.	CUWCC BMP 3.1 & 3.2
7	Multi-family Residential Surveys	CO/RWA	**Multi-family Residential Audits (Surveys)**	Continue conventional indoor and outdoor water surveys for existing multi-family properties. Normally those with high water use are targeted and provided customized water saving information, tips and tools. Outdoor water surveys for existing multifamily residential customers (less than 4 units). Target those with high water use and provide a customized report to owner.	CUWCC BMP 3.1 & 3.2
8-Int	SF Residential Incentives - Indoor	CO/ SMUD/ SRCSD	**Residential High Efficiency Washer Rebate Intensive**	Continue to provide a SF rebate for the installation of a high efficiency washer (HEW). Rebate amounts have been $100 (www.sparesacwater.org). Program will be short lived as it is intended to be a market transformation measure and eventually would be stopped as efficient units reach saturation.	CUWCC BMP 3.3. Assume Keeping Existing Partnership with SMUD
9	Multi-family, Commercial and Institutional - Incentives	CO/ RWA /SMUD /SRCSD	**Commercial High Efficiency Washer Rebate Intensive**	Provide an incentive to MF and CI customers for the installation of a high efficiency washer (HEW).Program will be short lived as it is intended to be a market transformation measure and eventually would be stopped as efficient units reach saturation.	Supports CUWCC BMP 4
10-Int	Residential Incentives - Indoor	CO/ RWA/ SRCSD	**Residential High Efficiency Toilet (HET) Rebates**	Continue to provide a rebate for the high efficiency toilet (HET). HET's are defined as any toilet flushing at 1.28 gpf or less and include dual flush technology. Rebate amounts have been $100 (www.sparesacwater.org). Move to lower flush volume of 0.8 gpf after new AB 715 law goes into effect in 2014.	CUWCC BMP 3.4. Prop 84 funding for DACs.
11-Int	Commercial and Institutional - Surveys	CO/ RWA /SMUD /SRCSD	**CII Surveys and Top 100 Users Program**	All CII customers would be offered a free water survey that would evaluate ways for the business to save water and money. The CII surveys would be for large accounts (accounts that use more than a significant amount of water per day) such as hotels, restaurants, stores and schools. Will need to prioritize and staff properly. Emphasis will be on supporting the high water users including monitoring the high water users (e.g., Cal State University campus, U.C. Medical Center, etc.).	Supports new CUWCC BMP 4 that requires savings be met. Need supporting surveys.
12-Int	Commercial and Institutional - Incentives	CO/ RWA /SMUD /SRCSD	**CII Rebates to Replace Inefficient Equipment Intensive**	Provide an incentive for a standard list of water efficient equipment or on a case by case basis. Included would be icemakers, water-cooled ice machines, steamers, washers, efficient dishwashers, replace once through cooling, and add conductivity meters on cooling towers. Pattern after Southern Nevada Water Authority, East Bay MUD or Seattle Water Department programs.	Supports CUWCC BMP 4
13	Commercial and Institutional - Incentives	CO/RWA/ SRCSD	**Promote Restaurant Spray Nozzles**	Provide lower than a 1.6 gpm spray nozzles for the rinse and clean operation in restaurants and other commercial kitchens. Thousands have been replaced in California going door to door, very cost-effective because saves hot water. Contact the Food Science Technology Center for more information: http://www.fishnick.com/	New State Title 20 Regs. Very cost effective. Assume included.
14-Int	Commercial and Institutional - Incentives	CO/RWA/ SRCSD	**Commercial High Efficiency Toilet (HET) Rebates**	Continue to provide an incentive for the high efficiency toilet (HET). HET's are defined as any toilet flushing at 1.28 gpf or less and include dual flush technology. Historically, rebate amounts have been $150 (www.sparesacwater.org)	CUWCC BMP 3.4. New State Law AB 715 after 2014.

Table 6-1 (Continued)

DSS Model Measure Number	Focus Area	DOU Lead/ Partner	Conservation Measure	Measure Description	Key Commitments to CUWCC or Other Agencies
15	Commercial and Institutional - Incentives	CO/RWA/ SRCSD	**High Efficiency Urinal Rebate (<0.25 gallon)**	Continue to provide a rebate for high efficiency or waterless urinals to existing high use CII customers (such as restaurants). (www.sparesacwater.org)	Supports CUWCC BMP 4
17	Large Dedicated Irrigation Only - Surveys	CO/RWA/ SSQP	**Irrigation Water Surveys**	All public and private irrigators of landscapes would be eligible for free landscape water surveys upon request. Normally those with high water use would be targeted and provided a customized report. Assume 10 percent of large turf areas are surveyed per year.	CUWCC BMP 5.
18	Large Dedicated Irrigation Only - Budgets	CO/RWA/ SSQP	**Irrigation Water Budgets**	Irrigators of landscapes with separate irrigation account (meter) use would receive a monthly or bi-monthly irrigation water use budget.	CUWCC BMP 5 and Pending Prop 84
20	Residential Incentives - Outdoor	CO/RWA/ SSQP	**Residential Financial Incentives for Irrigation and Landscape Upgrades**	For SF customers with landscape, provide a Smart Landscape Rebate Program with incentives towards the purchase and installation of selected types of irrigation equipment upgrade excluding smart controllers (see below). Planned to include rotation nozzles, drip conversion, water wise plants and mulch.	Pending Prop 84 funding support.
21	Large Accounts Irrigation - Incentives	CO/RWA/ SSQP	**Financial Incentives for Irrigation and Landscape Upgrades**	For MF, CII, and IRR customers with large landscapes (i.e. greater than 1 acre), continue to provide a Smart Landscape Rebate Program with rebates towards the purchase and installation of selected types of irrigation equipment upgrade excluding smart controllers (see below). Planned to include rotation nozzles, drip conversion, water wise plants and mulch.	CUWCC BMP 5
24	Residential Incentives - Outdoor	CO/RWA/ SSQP	**Residential Financial Incentives for Smart Controllers**	Provides for SF customers with an incentive to install smart controllers. Also includes training support. Assume administered together with Smart Landscape Rebates program (above).	Pending Prop 84 funding support.
25	Commercial Incentives - Outdoor	CO/RWA/ SSQP	**Commercial Financial Incentives for Smart Controllers**	Provides for larger landscape MF, CI and IRR customers with an incentive to install smart controllers. Assume administered together with Smart Landscape Rebates program (above).	Pending Prop 84 funding support.
27	Residential and Non-Residential Irrigation for New Development	DS/CE	**Enforce new Landscape and Irrigation Requirements and Ordinance**	Enforce City's Water Efficient Landscape Design Standards and Ordinance. Standards specify that development projects subject to design review be landscaped according to River Friendly principals, with appropriate turf ratios, plant selection, efficient irrigation systems and smart irrigation controllers.	Existing. Assume Included.

Notes:

DOU Lead: CO = Conservation Office, FO = Field Operations, PI = Public Information, IPM = Integrated Planning & Business Operations, DS = Development Services, CE = Code Enforcement

Customer Categories: SF – Single Family, MF – Multi-family, CII – Commercial, Industrial and Institutional, All – All of the Above, System – Utility's Distribution System, IRR - Dedicated Irrigation Meter; DOU - City of Sacramento Dept. of Utilities

Partnerships: RWA = Regional Water Authority, SMUD = Sacramento Municipal Utility District, SRCSD = Sacramento Regional Sanitation District, SSQP = Sacramento Stormwater Quality Partnership

6.2 Perspectives on Benefits and Costs

The determination of the economic feasibility of water conservation programs involves comparing the costs of the programs to the benefits provided through avoided costs for building additional infrastructure and/or operating expenses, such as chemical and energy that is not required when less volume of water is treated. This analysis was performed using the DSS Model (see Section 3 and Appendix A for further description). The DSS Model calculates savings at the