Winters Climate Action Plan Development Board Meeting

Thursday, April 16, 2020
6:30 p.m.

Zoom meeting ID: 964099847
Join by phone: +1(669) 900-6833
Join by computer or smart device: https://zoom.us/j/964099847

AGENDA

Members of the CAP Development Board

x Ken Britten
x Gar House
x Kelly Linville
x Jennifer Urquhart
x Sam Warren
x Alternate: Shawn Yarnes

John W. Donlevy, Jr., City Manager
Ethan Walsh, City Attorney
Tracy Jensen, City Clerk

Equity and Inclusion

PLEASE NOTE – The numerical order of items on this agenda is for convenience of reference. Items may be taken out of order upon request of the Chair or board members. Public comment time may be limited and speakers will be asked to state their name.

Roll Call

Pledge of Allegiance

Recap: Brief review of previous meeting

PUBLIC COMMENTS

At this time, any member of the public may address the Board on matters, which are not listed on this agenda. Residents should reserve their comments for matter listed on this agenda at the time the item is considered by the Board. An exception is made for members of the public for whom it would create a hardship to stay until their item is heard. Those individuals may address the item after the public has spoken on issues that are not listed on the agenda. Presentations may be limited to accommodate all speakers within the time available. Public comments may also be continued to later in the meeting should the time allotted for public comment expire.

DISCUSSION QUESTION

What communities do you feel are left out of the discussion? Do you have ideas on how to reach them?

PRESENTATIONS

1. Julia Cohen - Overview of YRC *Resiliency Planning Toolbox*
2. Regional greenhouse gas (GHG) inventory results; breakdown by sector

BOARD DISCUSSION ITEMS

1. Board officer nominations and voting.
2. Establish frequency of upcoming meetings and future meeting times.
3. Identify avenues of community engagement, groups and neighborhoods to target, communication strategies and messaging.

NEXT MEETING TOPIC

Land use, Transportation and Circulation Planning

BOARD ACTION ITEMS

1. Ethics Training for Local Officials Resource -Members must complete by 05/15/2020: http://www.fppc.ca.gov/learn/public-officials-and-employees-rules-/ethics-training.html
2. Read Draft CAP: *Mobility (pgs 14-21),* read *City of Winters Climate Action Plan Strategy Report.*

ADJOURNMENT

I declare under penalty of perjury that the foregoing agenda for the April 16, 2020 regular meeting of the Winters Climate Action Plan Development Board was posted on April 13 2020 at the City of Winters website at www.cityofwinters.org. The agenda was made available to the public during normal business hours and board members were notified via e-mail of its' availability.

NEXT MEETING TOPIC

Land Use, Transportation, and Circulation Planning

Christopher Flores

Christopher Flores, Climate Fellow

Questions about this agenda – Please call the City Clerk's Office (530) 794-6702.

General Notes: Meeting facilities are accessible to persons with disabilities. To arrange aid or services to modify or accommodate persons with disability to participate in a public meeting, contact the City Clerk.

The board does not transcribe its proceedings. Anyone who desires a verbatim record of this meeting should arrange for attendance by a court reporter or for other acceptable means of recordation. Such arrangements will be at the sole expense of the individual requesting the recordation.

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View on the internet: http://www.cityofwinters.org/climate-action-plan

Any attachments to the agenda that are not available online may be viewed at the City Clerk's Office or locations where the hard copy packet is available.

Climate Action Plan Development Board agenda packets are available for review or copying at the following locations:

City Hall – Finance Office - 318 First Street

EQUITY AND INCLUSION
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Winters Climate Action Plan Development Board Meeting
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Jueves, dieciséis de abril de 2020

CITY OF WINTERS
california
Est. 1875

Zoom tips:

- Everyone is muted *except* for CAP Development Board Members
- If you wish to speak on a topic, please use the “raise hand” function on zoom or type a question in the chat box
- Please keep comments concise

EQUITY AND INCLUSION
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Roll call · Pledge of Allegiance

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Public Comments · Discussion Question

WHAT COMMUNITIES DO YOU FEEL ARE LEFT OUT OF THE DISCUSSION? DO YOU HAVE IDEAS ON HOW TO REACH THEM? ¿QUIÉNES SON LOS COMUNIDADES QUE NO ESTAN INCLUIDOS EN ESTE DISCUSCIÓN? ¿TIENE IDEAS COMO SE LOS INVOLUCRAR?

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AUBURN-GRASS-VALLEY

PG&E power shutoffs 'a serious worry' for people with powered medical devices

For people who rely on electricity to power medical or mobility devices, a PG&E Public Safety Power Shutdown can threaten their health and safety.

"We need the food that we lost." Low-income families still reeling from blackouts

Tossing a fridge full of food means hunger for Californians on tight budgets. Even food banks lost supplies during outages.

PG&E's power shutoff in California shows the inequities of climate risks

More than 800,000 customers could lose power as California's largest utility tries to avoid igniting another wildfire.

By Umair Irfan | Updated Oct 10, 2019, 2:16pm EDT

YRC RESILIENCY PLANNING TOOLBOX

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Presentations - YRC Resiliency Planning Toolbox ·
Regional GHG Inventory Results

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Yolo Resiliency Collaborative

- Members include jurisdictions, agencies & organizations throughout Yolo County

- Goal: increase capacity of agencies and jurisdictions to adapt to climate change

- The toolbox helps streamline the adaptation process & fosters cooperation;
  No one can adapt alone ---> collaborative process

- Additionally, helps agencies comply with SB 379

Content from toolbox to potentially include in Winters draft CAP - other suggestions or language to be included?

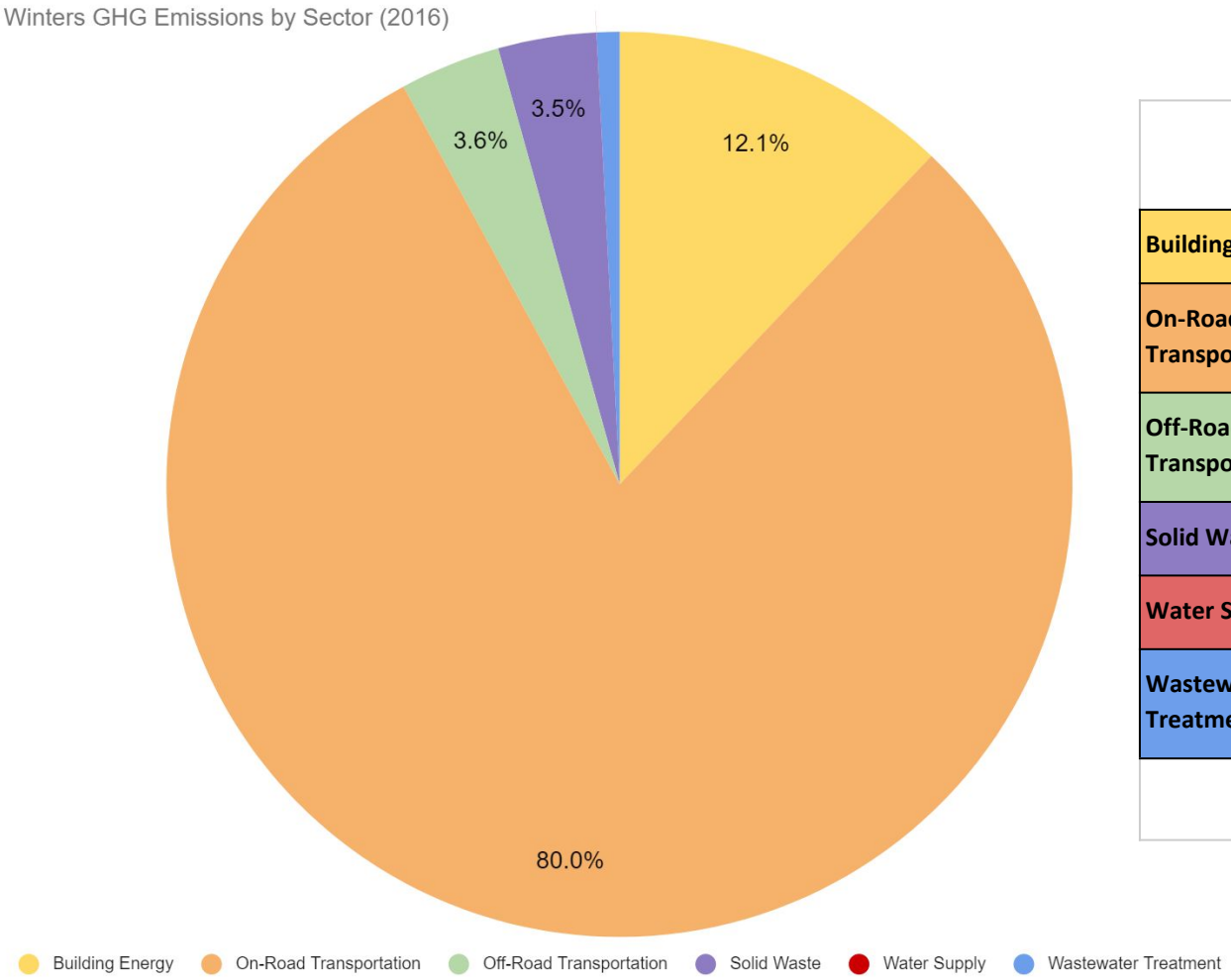
- Hold workshops during hours and at locations convenient for community members, provide childcare and food, and provide translation services (*People and community, pg. 30* ➡ *Community Engagement*)

- Translate City of Winters outreach materials, public resources, and public documents into all languages spoken by over 5% of the population. (*People and community, pg. 31* ➡ *Community Engagement*)

- Use census and neighborhood level data to determine which communities are most vulnerable to heat, then focus urban greening projects in these communities (*Urban greening, pg. 44* ➡ *Urban Forest*)

From YRC Toolbox ➡ Draft CAP

https://docs.google.com/spreadsheets/d/1U7Mw9cLZ1kSeBoHfN7G2FiONcnQsLLkG/edit#gid=814477429



	MT CO2e	CO2e Percent of Annual Total Emissions
Building Energy	8,236	**12.1%**
On-Road Transportation	54,550	**80.0%**
Off-Road Transportation	2,451	**3.6%**
Solid Waste	2,392	**3.5%**
Water Supply	2	**0.0%**
Wastewater Treatment	557	**0.8%**
	68,189	100.0%

BOARD DISCUSSION ITEMS

1. Board officer nominations and voting.
2. Establish frequency of upcoming meetings and future meeting times.
3. Identify avenues of community engagement, groups and neighborhoods to target, communication strategies and messaging.

NEXT MEETING TOPIC

Land use, Transportation and Circulation Planning

BOARD ACTION ITEMS

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2. Read Draft CAP: *Mobility (pgs 14-21),* read *City of Winters Climate Action Plan Strategy Report.*

City of Winters Greenhouse Gas Emissions Inventory - 2016

Emissions Sector	2016 GHG Emissions			
	Activity	Units	MT CO2e	CO2e Percent of Annual
Building Energy			**8,236**	**12.1%**
Commercial - Electricity	10,897	kWh	1,455	2.1%
Commercial - Natural Gas	15,350	MMBtu	817	1.2%
Commercial Subtotal			**2,272**	3.3%
Residential - Electricity	15,610	kWh	2,084	3.1%
Residential - Natural Gas	72,904	MMBtu	3,880	5.7%
Residential Subtotal			**5,964**	8.7%
On-Road Transportation	**212,245**	**VMT/day**	**54,550**	**80.0%**
Off-Road Transportation			**2,451**	**3.6%**
Solid Waste	**5,343**	**Tons**	**2,392**	**3.5%**
Waste-in-Place		Tons	0	0.0%
Waste Generation	5,343	Tons	2,392	3.5%
Water Supply	**115**	**acre-ft/year**	**2**	**0.00%**
Wastewater Treatment		**GPD**	**557**	**0.8%**
Total CO2e/yr			**68,189**	

	MT CO2e	CO2e Percent of Annual Total Emissions
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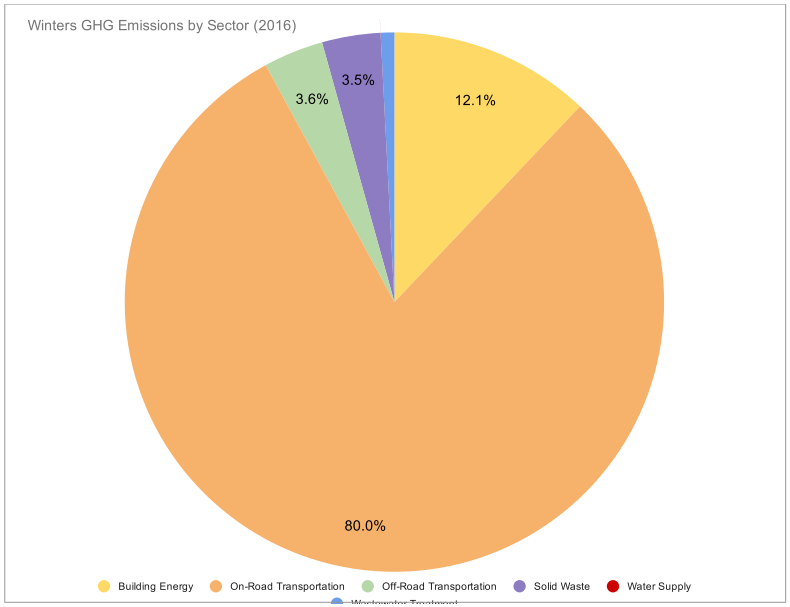

Data Input

City of Winters Greenhouse Gas Emissions Inventory - 2016

Subcategory	Subcategory	Amount	Unit	Year	Source	Notes
Electricity Consumption	Residential	15609552	kWh	2016	Data provided to City through PG&E Winters_EXTNoNDA_PGE_CommunityGHG_2018.xlsx	
Electricity Consumption	Commercial	10896577	kWh	2014	*see above*	This is 2014 data, which is the most recent year available
Electricity Consumption	Industrial		kWh	2016	No data provided due to PG&E's privacy rules	
Natural Gas	Residential	729036	therms	2016	*see above*	
Natural Gas	Commercial	153499	therms	2011	*see above*	This is 2011 data, which is the most recent year available
Natural Gas	Industrial		therms	2016	No data provided due to PG&E's privacy rules	
VMT by Speed Bin	MPH 00 - 05		vehicle miles	2016	Data provided by SACOG 2020 MTP/SCS Yolo County VMT_SACOG.xlsx	no data
VMT by Speed Bin	MPH 05 - 10		vehicle miles	2016	*see above*	no data
VMT by Speed Bin	MPH 10 - 15		vehicle miles	2016	*see above*	no data
VMT by Speed Bin	MPH 15 - 20	17634.73	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 20 - 25	395.24	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 25 - 30	3303.12	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 30 - 35	20001.55	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 35 - 40	8835.27	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 40 - 45	40203.75	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 45 - 50	13352.06	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 50 - 55		vehicle miles	2016	*see above*	no data
VMT by Speed Bin	MPH 55 - 60		vehicle miles	2016	*see above*	no data
VMT by Speed Bin	MPH 60 - 65	6267.51	vehicle miles	2016	*see above*	
VMT by Speed Bin	MPH 65 - 70	102251.75	vehicle miles	2016	*see above*	
Water Consumption	Domestic Water Supply	352.47114	MG/year	2016	Water-Sewer totals.docx	Total water delivered was ~303 mil with a system loss of ~49 mil. Due to leak, this year may be an anomaly. Water is supplied by the City of Winters Public Works Department
Population	City	7,010	residents	2016	Table 2: E-5 City/County Population and Housing Estimates 1/1/2016	
Employment	City	3,400	workers	2016	State of California Employment Development Department, Monthly Labor Force Data for Cities and Census Designated Places, Annual Average 2016 4/19/2019	
Housing	City	2,377	dwelling units	2016	Table 2: E-5 City/County Population and Housing Estimates 1/1/2016	
Agricultural/Open Space	City		acres	2016	No agricultural data	
Waste Disposal	City	5,342.96	annual tons mixed municipal solid waste	2016	Quarterly waste disposal tonnage data from Rick Moore 2/18/2020	
Waste in Place	City		tons	2016	No data found from Old City of Winters Landfill	
Wastewater Influent	City	480000	gallons per day	2016	Water-Sewer totals.docx	City of Winters Wastewater Treatment Facility
Wastewater Treatment - Biochemical Oxygen Demand	City	250	milligrams per liter	2016	http://www.cityofwinters.org/wp-content/uploads/2018/05/WintersWWTFMasterPlan2017-04-27REVISEDDRAFT.pdf	City of Winters Wastewater Treatment Facility

Building Energy Consumption

City of Winters Greenhouse Gas Emissions Inventory - 2016

		Emission Factors and GWP (lb/MWh delivered), (kg/MMBtu)						Total County-wide Emissions (MTCO2e/yr)
	units	CO2	GWP	N2O	GWP	CH4	GWP	
Commercial								
10,896.577	MWH/yr	294.00	1	0.0007	265	0.006	28	1,454.94
15,350	MMBtu/yr	53.06	1	0.0001	265	0.005	28	816.89
Residential								
15,610	MWH/yr	294.00	1	0.0007	265	0.006	28	2,084.22
72,904	MMBtu/yr	53.06	1	0.0001	265	0.005	28	3,879.79
Total								**8,236**

88,254 natural gas

26,506 electricity

On-Road Transportation

City of Winters Greenhouse Gas Emissions Inventory - 2016

MT CO2e/yr
54,550

VMT Distribution by Speed Bin

VMT Speed Bins (MPH)	Unincorporated (VMT/day)	g/CO2e/ mi	g CO2e /day	MT CO2e/day
0 - 5		2191.63	0	0.00
5 - 10		2368.32	0	0.00
10 - 15		1646.97	0	0.00
15 - 20	17635	1132.96	19979449	19.98
20 - 25	395	801.64	316841	0.32
25 - 30	3303	478.39	1580193	1.58
30 - 35	20002	509.74	10195550	10.20
35 - 40	8835	399.23	3527294	3.53
40 - 45	40204	395.05	15882340	15.88
45 - 50	13352	353.14	4715143	4.72
50 - 55		401.10	0	0.00
55 - 60		410.40	0	0.00
60 - 65	6268	436.67	2736851	2.74
65 - 70	102252	885.25	90518595	90.52
Total	**212,245**		**149,452,256**	**149**

Off-Road Emissions

City of Winters Greenhouse Gas Emissions Inventory - 2016

	CO2 (tons/day)	CH4 (tons/day)	N2O (tons/day)	CO2e (tons/day)	CO2e (MT/yr)	Scaling Factor	City Emissions CO2e (MT/year)
Agricultural Equipment	215.03698	0.02058	0.00242	216.3	71606.7	Agricultural/Open Space	0
Construction and Mining Equipment	99.34751	0.00895	0.00049	99.7	33021.9	Employment	1107
Entertainment Equipment	0.26844	0.00001	0.00000	0.3	89.0	Employment	3
Industrial Equipment	16.73856	0.00531	0.00094	17.1	5674.0	Employment	190
Lawn and Garden Equipment	7.93983	0.01185	0.00516	9.6	3192.0	Housing	100
Light Commercial Equipment	13.40245	0.00376	0.00219	14.1	4664.9	Employment	156
Pleasure Craft	46.13128	0.02873	0.00992	49.6	16411.8	Population	533
Railyard Operations	0.00362	0.00000	0.00000	0.0	1.2	Population	0
Recreational Equipment	3.08434	0.01996	0.00530	5.0	1671.5	Population	52
Transport Refrigeration Units	27.71918	0.00222	0.00018	27.8	9215.0	Employment	309
Total							**2451**

Solid Waste

City of Winters Greenhouse Gas Emissions Inventory - 2016

Waste-in-Place Emissions at Landfills Located in the Unincorporated County

Method SW1

Landfill	GHG Emissions (CO2e)	Fugitive CH4 emissions	AR5 Adjusted CO2e	LFG Captured (MMSCFD)	LFG Flaring (MMSCFD)	LFG Electricity Generation	Tonnage Reported (Total)	Metric tons reported (2016)
Yolo County Central Landfill (YCCL)			0	2	0.6	1.4		-

Method SW1.1

Disposed Waste (metric tons)		Source: EPA MMR Reporting in from FLIGHT Database
LFG Capture Efficiency		Source: EPA MMR Reporting in from FLIGHT Database
CH4 Emissions (metric tons)		Source: EPA Landfill Emmissions Tool (LET)
CO2 Emissions (Metric tons)		Source: EPA Landfill Emmissions Tool (LET)
CO2e Total:	-	MT/CO2e/yr

Waste Generation Emissions

Receiving Landfill	Tonnage Delivered from Unincorporated County Only	Total ADC	Percent of Total Tonnage	Percent of year under LFG collection or control in 2016 (%)	Generated Methane Emissions with LFG Capture (MT CH4)	MT CO2	MT CH4	MT N2O	MT CO2e
Yolo County Central Landfill*	5,343	985	100%	100%	85		85		2,392
Total	5,343	985			85		85		2,392

Source: CalRecycle, EPA LMOP Database, EPA FLIGHT Database, US Community Protocol Equation SW.4.1

* Removed from total to avoid double counting since SW1 model included CH4 for 2016 and waste-in-place for YCCL.

Source: CalRecycle, EPA LMOP Database, EPA Greenhouse Gas Emissions from Large Facilities

Note: Excludes compositing faciltiies, transfer stations, inert debris disposal sites, and planned landfills not yet in operation.

Method

Table SW.5 CH_4 Yield for Solid Waste Components		
Waste Component	Emissions Factor, EF_i (mt CH_4/wet short ton waste)	Source
Mixed MSW*	0.06	U.S. EPA AP-42

* – Mixed MSW factor may be used for entire MSW waste stream if waste composition data is unavailable.
U.S. EPA AP-42 – U.S. EPA Emission Factor Database, Chapter 2.4 Municipal Solid Waste Landfills (1998) WARM—Documentation for Greenhouse Gas Emissions and Energy Factors Used in the Waste Reduction Model (WARM) 2006

Water Consumption

City of Winters Greenhouse Gas Emissions Inventory - 2016

KWh/million gallons	KWh/acre-ft	acre-ft/year	Total KWh	MWh	Region	Emission Factor (lb CO2/MWh)	GWP	Emission Factor (lb CH4/MWh)	GWP	Emission Factor (lb N2O/MWh)	GWP	Total CO2e (MT/year)
	145	115	16,654	17	CALI	294.00	1	0.0302	28	0.0081	265	**2**

Source: Water Energy Cost Effectivness Analysis, CPUC/ Navigant, 2015 www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5356

Source: CCAR GRP. 2009. v 3.1 Appendix C. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Wastewater Treatment

City of Winters Greenhouse Gas Emissions Inventory - 2016

				Facility-Specific Data												
Facility	First Year of Operation	Year of Data	Type of Treatment	Capacity (GPD)	Influent (GPD)	Influent (G/yr)	Influent BOD (mg/L)	BOD (Kg/Gal)	BOD (kg/yr)	COD (kg/yr)	Adjusted Emission Factor (kg CH4/kg BOD)	kg CH4/yr	MT CO2e/yr	Default Emission Factor (kg CH4/kg BOD)	CH4 Correction Factor	Adjusted Emission Factor (kg CH4/kg BOD)
														0.6	0.2	0.12
City	**XXXX**	**2016**	primary/secondary	3,000,000	480,000	175,200,000	250	0.0009	165,801		0.12	19,896	**557**			
											Total		**557**			

Notes:

Methane CF of 0.2 is the EF representing the lowest end of the "poorly managed centralized aerobic treatment plant" range.

Source:

City of Woodland and Yolo County Service Areas Water and Wastewater Regionalization Feasibility Study

Assumptions

City of Winters Greenhouse Gas Emissions Inventory - 2016

Category	Value	Notes	Source
Conversions			
g/MT	1000000		
g/lb	453.592		
g/kg	1000		
lb/MT	2204.622622		
kg/MT	1000		
MT/ton	1.10231		
g/ton	907185		
lb/kg	2.20462		
kWh/MWh	1000		
MWh/GWh	1000		
Btu/therm	100000		
MMBtu/therm	0.1		
MMBtu/MWh	3.41214148		
LPG Gallons/GGE	1.344086022		
LNG Gallons/GGE	1.572327044		
gal/cubic foot	7.480519481		
gal/Liter	3.785411784		
therms/gallon propane	0.91		https://www.eia.gov/energyexplained/index.cfm?page=about_energy_units
gallon/acrefoot	325851.429		
Btu/scf natural gas	1029		
MMBtu/btu	1,000,000		
Btu/horsepower-hr	2546		http://convert-to.com/conversion/energy/convert-hp-h-to-btu.html
Liter/gallon	0.2641720524		
kilograms/milligrams	1000000		
year/days	365		
Btu/gallon diesel	137381		https://www.eia.gov/energyexplained/index.php?page=about_btu
million gal/acre-feet	0.325851429		
GWP			
Source (Select)	*IPCC Fifth Assessment Report (Avg)*	<--drop down selection	
CO2	1		
CH4	28		
N2O	265		
	CO2	**CH4**	**N2O**
IPCC Fourth Assessment Report (w/o climate carbon feedback)	1	25	265
IPCC Fourth Assessment Report (with climate carbon feedback)	1	34	298
IPCC Fourth Assessment Report (Avg)	1	25	298
IPCC Fifth Assessment Report (Avg)	1	28	265
IPCC Third Assessment Report	1	23	296
IPCC Second Assessment Report	1	21	310
Electricity Emission Factors			
PG&E	**2016**		**Assumes implementation of SB 350 Targets**
RPS Status	33%		PGE 2016 Power Content Label
PG&E Power Mix 2016			
Natural Gas	17%		
Unspecified Sources	14%		
GHG Free Sources	69%		
PG&E 2016 Calculated EFs			
lb CO2/MWh	294.00		http://www.pgecurrents.com/2018/03/26/independent-registry-confirms-record-low-carbon-emissions-for-pge/
lb CH4/GWh	6.44		Calculated from eGrid 2016 NG and Other Efs
lb N2O/GWh	0.70		Calculated from eGrid 2016 NG and Other Efs
California Average (2016)			
RPS Status	25%		PGE 2016 Power Content Label
CA Average Power Mix 2016			
Natural Gas	37%		
Unspecified Sources	15%		
Coal	4%		
GHG Free Sources	48%		
CA Average 2016 Calculated EFs			
lb CO2/MWh	435.30		Calculated from eGrid 2016 NG and Other Efs
lb CH4/GWh	10.54		Calculated from eGrid 2016 NG and Other Efs
lb N2O/GWh	1.82		Calculated from eGrid 2016 NG and Other Efs
eGrid 2016 Emission Factors			Updated February 2017
Natural Gas EFs: eGRID2016 Average of California Natural Gas Electricity Plant EFs			https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
lb CO2/MWh	867.88		Weighted average based on annual plant net generation
lb CH4/GWh	16.50		Weighted average based on annual plant net generation
lb N2O/GWh	1.66		Weighted average based on annual plant net generation
Coal EFs: eGRID2016 Average of California Coal Electricity Plant EFs			https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
lb CO2/MWh	1,157.82		Weighted average based on annual plant net generation

lb CH4/GWh	13.41		Weighted average based on annual plant net generation
lb N2O/GWh	18.98		Weighted average based on annual plant net generation
Unspecified EFs: eGRID2016 CAMX Emission Factors	**lb**	**kg**	**Assumed to represent unspecified power sources**
CO2/MWh	452.50	0.50	CAMX avg
CH4/GWh	26.00	0.03	CAMX avg
N2O/GWh	3.00	0.00	CAMX avg
PG&E: Natural Gas EFs			EFs from PG&E EDRP workbook (Third party verified through The Climate Registry)
kg CO2/MMBtu	53.06		2017 Climate Registry Emission Factors. Table 12.1. Natural Gas - US Weighted Average
g CH4/MMBtu	4.70		2017 Climate Registry Emission Factors. Table 12.9. Natural Gas - Residential/Commercial
g N2O/MMBtu	0.10	**g/therm**	2017 Climate Registry Emission Factors. Table 12.9. Natural Gas - Residential/Commercial
MT CO2/therm	37.84	37,842,201	Calculated Natural Gas - US Weighted Average
MT CH4/therm	0.00	2,989	Calculated Natural Gas - Residential/Commercial
MT N2O/therm	0.00	64	Calculated Natural Gas - Residential/Commercial
Propane Efs		**g/gal**	
kg CO2/gal	5.72	5,720	2017 Climate Registry Emission Factors. Table 13.1
g CH4/gal	1.96	1.96	2017 Climate Registry Emission Factors. Table 13.3
g N2O/gal	0.09	0.09	2017 Climate Registry Emission Factors. Table 13.3
The Climate Registry 2017 Default Emission Factors			

These emission factors are only used for offroad equipment. On-road vehicles use EMFAC emission factors.

2017 Climate Registry Emission Factors. Table 13.1 US Default CO2 Emission Factors for Transport Fuels

Fuel Type	Carbon Content (Per Unit Energy)	CO_2 Emission Factor (Per Unit Volume)
Fuels Measured in Gallons	**kg C / MMBtu**	**kg CO_2 / gallon**
Gasoline	19.2	8.78
Diesel Fuel	20.2	10.21
Aviation Gasoline	18.9	8.31
Jet Fuel (Jet A or A-1)	19.7	9.75
Kerosene	20.5	10.15
Residual Fuel Oil No. 5	19.9	10.21
Residual Fuel Oil No. 6	20.5	11.27
Crude Oil	20.3	10.29
Biodiesel (B100)	20.1	9.45
Ethanol (E100)	18.7	5.75
Methanol	n/a	4.10
Liquefied Natural Gas (LNG)*	n/a	4.46
Liquefied Petroleum Gas (LPG)	17.2	5.68
Propane (Liquid)	16.8	5.72
Ethane	17.1	4.11
Isobutane	17.7	6.30
Butane	17.8	6.54
Fuels Measured in Standard Cubic Feet	**kg C / MMBtu**	**kg CO_2 / Standard cubic foot**
Compressed Natural Gas (CNG)*	14.47	0.054
Propane (Gas)	16.76	0.1546

Source: Heat content and default emission factors are from EPA Final Mandatory Reporting of Greenhouse Gases Rule Table C-1. Carbon content derived using the heat content and default emission factor. Except those marked * are from EPA Climate Leaders, Mobile Combustion Guidance, Tables B-4, B-5, (2008). A fraction oxidized value of 1.00 is from the IPCC, *Guidelines for National Greenhouse Gas Inventories* (2006). Methanol emission factor is calculated from the properties of the pure compounds.
Note: Carbon contents are calculated using the following equation: (Emission Factor / (44/12)) / Heat Content × Conversion Factor. Heat content factors are based on higher heating values (HHV). NA = data not available.

2014 Climate Registry Emission Factors. Table 13.7 US Default CH_4 and N_2O Emission Factors for Non-Highway Vehicles

These emission factors are only used for offroad equipment

Vehicle Type / Fuel Type	CH_4 (g / gallon)	N_2O (g / gallon)
Ships and Boats		
Residual Fuel Oil	0.11	0.60
Diesel Fuel	0.74	0.45
Gasoline	0.06	0.22
Locomotives		
Diesel Fuel	0.80	0.26
Agricultural Equipment		
Gasoline	1.26	0.22
Diesel Fuel	1.44	0.26
Construction/Mining Equipment		
Gasoline	0.50	0.22
Diesel Fuel	0.58	0.26
Other Non-Highway		
Snowmobiles (Gasoline)	0.50	0.22
Other Recreational (Gasoline)	0.50	0.22
Other Small Utility (Gasoline)	0.50	0.22
Other Large Utility (Gasoline)	0.50	0.22
Other Large Utility (Diesel)	0.58	0.26

Aircraft		
Jet Fuel	0.00	0.31
Aviation Gasoline	7.05	0.11

Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2011 (April 2013) Annex 3, Table A-106. Original factors converted to g/gallon fuel using fuel density defaults from U.S. EPA Climate Leaders, Mobile Combustion Guidance (2008) Table 4.6

Vehicle Type / Fuel Type	CH_4 (g / L)	N_2O (g / L)
Propane Vehicles	0.64	0.028
Propane Vehicles	1.964085295	0.08592873165

Table 13.3 Canadian Default Factors for Calculating CH4 and N2O Emissions from Mobile Combustion. **US factors not available.**

grams per gallon

Vehicle Type and Year	CH_4 (g / mi)	N_2O (g / mi)
Diesel Passenger Cars		
Advanced	0.0005	0.0010
Moderate	0.0005	0.0010
Uncontrolled	0.0006	0.0012
Diesel Light Trucks		
Advanced	0.0010	0.0015
Moderate	0.0009	0.0014
Uncontrolled	0.0011	0.0017
Diesel Medium and Heavy-Duty Vehicles (Trucks and Busses)		
Aftertreatment	0.0051	0.0048
Advanced	0.0051	0.0048
Moderate	0.0051	0.0048
Uncontrolled	0.0051	0.0048
CNG Medium and Heavy-Duty Vehicles (Trucks and Busses)		
CNG	1.9660	0.1750

2014 Climate Registry Emission Factors. Table 13.5 CH4 and N2O Emission Factors for Highway

Fuel Type	Heat Content	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Natural Gas	**Btu / scf**	**kg CO_2 / MMBtu**	**kg CO_2 / scf**
US Weighted Average	1026.00	53.06	0.05
Greater than 1,000 Btu*	>1000	53.06	varies
975 to 1,000 Btu*	975 – 1,000	54.01	varies

2014 Climate Registry Emission Factors. Table 13.5 CH4 and N2O Emission Factors for Highway

Petroleum Products	kg CO2 per gallon	g CH4 per gallon	g N2O per gallon
Propane	5.72	0.27	0.05

U.S. EPA Emission Factors for Greenhouse Gas Inventories (https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf)

Fuel Type / End-Use Sector	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Coal		
Residential	300.7	1.5
Commercial	10.0	1.5
Petroleum Products		
Residential	10.0	0.6
Commercial	10.0	0.6
Natural Gas		
Residential	4.7	0.1
Commercial	4.7	0.1
Wood		
Residential	253.2	3.4
Commercial	253.2	3.4

Countywide Demographics		Year	Source
Population	215,774	2016	California Department of Finance
Employment	101,400	2017	California Employment Developmenty Department
Housing	75,869	2017	California Department of Finance
Agricultural Acres	610,266	2007	Yolo County General Plan, Table LU-3

Climate Action Plan Technical Report

City of Winters

FINAL REPORT

NOVEMBER 2012

Prepared for:

The City of Winters

Prepared by:

UC Davis Sustainable Design Academy

Tracy Heidersbach
Taylor Helgestad
Anna McKenna
Karandev Singh
Dana Rowangould, Project Manager
Prof. Deb Niemeier, Project Director

With Technical Assistance from:

UC Davis Sustainable Design Academy

Devinder Dhillon
Ka I Tang
Lily Tomokovic
Michelle Rugg

Dr. Steven McCord, McCord Environmental, Inc

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Chapter 1: Scope and Purpose

1 Purpose

The Climate Action Plan Technical Report (CAP-TR) provides the calculations and supporting material for the greenhouse gas inventories as well as a detailed summary of actions and strategies that can be used to ensure that the City and its residents reduce energy consumption, and as a result reduce greenhouse gas emissions to 15% below the 2005 baseline by 2020. Scope

The CAP-TR includes an overview of the current science of climate change, the 2005 baseline and 2020 business-as-usual (BAU) inventories, and a detailed assessment of strategies that can be used to reduce energy consumption across the different sectors represented in the inventories. The inventories provide the foundation for assessing how greenhouse gas (GHG) emissions can be reduced consistent with state requirements. Reductions will be necessary across all sectors including residential and commercial energy use, municipal energy use and transportation, water supply and wastewater treatment, and transportation. The EAPC outlines the strategies, measures, and actions that will direct the City's efforts.

Society must shift from an economy powered by fossil fuels to one powered by more efficient and renewable energy sources, and it is critical that such efforts begin as quickly as possible. This kind of societal transformation requires that each of us engage, individually and collectively, in ways to reduce GHG emissions, and that we begin to actively seek out new opportunities to innovatively shift our current reliance on fossil fuels.

2 The Science

The science is clear: the planet is warming as a result of emissions of carbon dioxide and other greenhouse gases that are released from human activities including industrial processes, combustion of fossil fuels, and changes in land use, such as deforestation. If emissions continue as they have in the past, a global temperature increase of 2.0°F to 11.5°F (1.1°C to 6.4°C) by 2100 is projected. Warming in the U.S. is expected to be even higher. The effects of warming will include sea-level rise, changes in precipitation patterns, increased frequencies and intensities of droughts and floods, disruptions to ecosystems, and new challenges to public health.[1]

[1] NRC (2010 *America's Climate Choices: Panel on Advancing the Science of Climate Change,* National Research Council, Washington DC

Warming of the atmosphere is known as the greenhouse effect and the heat-trapping gases are known as greenhouse gases (GHGs). When sunlight reaches the earth's surface, it can be reflected (e.g., by light colored surfaces like snow or white roofs) or absorbed (e.g., by dark surfaces like open water or tree tops). Absorbed sunlight warms the planet surface and is returned to the atmosphere as heat. There are certain gases that are very effective at trapping heat in the atmosphere, and warming the Earth's surface. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are GHGs that both occur naturally and also are released by human activities.

Human activities cause climate change by adding significant amounts of carbon dioxide (CO_2) and certain other heat-trapping gases to the atmosphere. The natural occurrence of these gases produces a natural greenhouse effect. Without the natural greenhouse effect, the earth's surface would be nearly 60°F colder on average, well below freezing. The additional GHGs increasingly added by human activities result in atmospheric concentrations that are much higher than the naturally occurring GHGs in the atmosphere, and this causes more warming than occurs naturally. Scientific evidence from many studies confirms that this "enhanced greenhouse effect" is occurring.

3 Key State Legislation

A number of legislative requirements have been established by state and federal legislation. A brief summary of each of the key regulatory initiatives is provided in Table 1.

Table 1. Summary of Key Legislation

Guiding Legislation	Brief Overview
EO S-3-05	This Executive Order established a GHG reduction target of 80% below 1990 levels by 2050.
AB 32	The California Global Warming Solutions Act of 2006, AB 32, requires a reduction in statewide GHG emissions to 1990 levels by 2020. The bill also directed the California Air Resources Board to develop and implement regulations that reduce statewide GHG emissions.
SB 97	Requires analysis of the impacts on climate change under CEQA. The California Resources Agency is directed to certify and adopt guidelines for mitigating GHG emissions or the effects of GHG emissions.
SB 1771	Requires the California Energy Commission to prepare an inventory of the state's GHG emissions. In addition, the Commission is required to develop methods for estimating costs and reducing GHGs. The California Climate Action Registry is to serve as a certifying agency for companies and local governments, to quantify and register their GHGs for possible future trading systems.
SB 1078	Establishes a Renewable Portfolio Standard requiring electricity providers to procure renewable energy resources equal to 20% per year by 2017. Subsequent legislation accelerated the 20% deadline to 2010 (SB 107) and added a target of 33% by 2020 (SB 2).
SB 375	Establishes regional per capita emission targets for cars and light-duty trucks.
NA	The Air Resources Board's Advanced Clean Cars Program will reduce emissions of air pollutants and greenhouse gas emissions from new vehicles under a recently adopted update to the Low Emissions Vehicle regulations, known as (LEVIII). The Program will also increase the number of zero-emissions vehicles (ZEV) in California.

Chapter 2: GHG Baseline, Projections, Target

1 Introduction

Emissions inventories provide a quantifiable means for measuring progress toward reducing GHG emissions over time. These inventories are typically taken at different periods of time and typically include the key GHGs: CH_4, N_2O, sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). To characterize these emissions, emissions of each gas are typically converted to equivalent carbon dioxide (CO_2e) by weighting each pollutant by its relative global warming potential. For example, CH_4 is 21 times more potent than CO_2 in its heat-trapping ability. A metric ton of CO_2e ($MTCO_2e$) is the usual standard for measuring the amount of GHG emissions produced and released into the atmosphere.

This section presents the results of two inventories: 1) a baseline inventory, and 2) a forecast business-as-usual (BAU) inventory. The baseline inventory is set to 2005 levels (consistent with usual practice) and its purpose is to identify and categorize the major sources of GHG emissions being produced by City residents and the municipal operations. The baseline serves as a reference against which progress in reducing emissions over time may be measured. The second inventory is referred to as the BAU forecast inventory. This inventory provides the basis for gauging the degree to which GHG emissions must be reduced. The BAU scenario assumes that current trends and established policies will continue to a specified year. In this case, the BAU forecast is estimated for year 2020. The choice of the forecast inventory year reflects standard practice and is consistent with target years established by state policy.

The major sources of emissions that are included in the inventory are those generated by energy consumption, transportation and water/wastewater management. The energy-related emissions are those emissions generated by electricity use and use of natural gas. These emissions are primarily attributable to consumption that occurs within residential dwellings, commercial/industrial buildings, and municipal activities. Transportation emissions include those emissions generated as the result of gasoline or diesel vehicle travel or equipment use. Finally, emissions from water and wastewater management are generated from the pumping and conveyance of water and from wastewater treatment. Emissions inventories are usually organized as a community-wide inventory sub-divided by sector. The boundary of the community inventory is generally the city limits. Although they are a subset of the community inventory, emissions from City operations are estimated separately as the municipal inventory.

Community-wide emissions include those emissions that are generated by residents of the city as well as the businesses that operate within the city. Activities that create emissions range from driving vehicles to the power used to heat and cool homes and businesses. Municipal operations also generate emissions when city vehicles (e.g., police or fire trucks) are used and certain types of municipal services are undertaken (e.g., when wastewater treatment is undertaken).

A number of different resources were used to estimate the total GHG emissions. These included energy consumption data provided by the Pacific Gas & Electric Company (PG&E), the California Energy Commission (CEC), the California Department of Transportation (Caltrans), the Sacramento Council of Governments (SACOG), the United States Census Bureau (US Census), and the City of Winters. The City provided the data used to quantify emissions related to municipal operations. Detailed discussions of data, assumptions and methods used to compile the baseline inventory and BAU forecast may be found in Technical Appendices IA (Baseline Inventory) and IB (BAU Forecast Inventory). The corresponding calculations worksheets can be found in electronic Appendices IA1 – IA4 (Baseline Inventory) and IB1 – IB5 (BAU Forecast Inventory).

2 Baseline Inventory, 2005

In 2005, the City emitted approximately 69,495 metric tons of CO_2e, including all emissions estimated[2] across four sectors: residential/commercial energy use; transportation; water and wastewater; municipal energy use, and wastewater reuse. Of those, 57,290 metric tons are reportable emissions, or those that are required by general inventory guidelines. Emissions estimates were derived from data collected for each of the following activities,

- Residential and commercial energy use (included in the community inventory)
  - *Residential electricity and natural gas consumption*
  - *Commercial electricity and natural gas consumption*
- Transportation (included in the community inventory)
  - *Fuel consumption resulting from on-road travel activity for gasoline and diesel powered vehicles, including transit*
  - *Off-road mobile sources including agricultural, industrial, and commercial equipment use and construction, lawn and garden, recreational, air travel, and airport ground support equipment activity*
  - *Well to pump emissions associated with producing and transporting fuel used by on-road vehicles.*
- Water and wastewater (included in the municipal and community inventory)

[2] This estimate includes both reportable emissions and optionally reported emissions, as defined below.

- *Electricity use associated with treating and delivering potable water for domestic and industrial purposes*
- *Electricity use and N_2O process emissions associated with wastewater treatment*

- Municipal energy use and transportation (included in the municipal and community inventory)
  - *On-road activity for gasoline and diesel powered city fleet vehicles*
  - *City facility electricity and natural gas consumption*

The emissions generated by these activities can be divided into two categories: reportable emissions, which include scope 1[3] and 2[4] emissions, and optionally reported emissions, which include scope 3[5] emissions which occur outside the City limits. This report focuses on reportable emissions which adhere to most inventory guidelines, although optionally reported emissions are also provided for information purposes.

It is important to note that the City has influence over some community emissions which they do not control directly. For example, while the City can influence the mode by which residents make local trips via transportation and land use planning, residents' personal vehicle travel is not the City's direct responsibility. Emissions from personal vehicles are excluded from the municipal inventory and included in the community inventory. At the same time emissions from City-owned vehicles, which are directly controlled by the city, are included in the municipal inventory and by extension the community inventory. Likewise, the city can also influence energy efficiency and construction standards through building ordinances. It goes without saying that the City's actions directly influence the municipal inventory; additionally, the City's influence also plays an important role in community emissions. Consequently the City plays a crucial role in implementing the reduction measures targeting community reductions, as discussed later in this report.

One sector that has not been included in the emissions inventories is solid waste-related generation and disposal. These activities are outside the scope of the inventories included in this report[6], although the city can influence solid waste generation through conservation and recycling measures as discussed in Chapter 3 of this report.

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[3] In the community inventory, *Scope 1* includes residents', businesses', and the City's direct emissions from combustion, process, and fugitive emissions. In the municipal inventory, which is a subset of the community inventory, scope 1 emissions are direct emissions for which the City has responsibility.

[4] In the community inventory, *Scope 2* includes indirect emissions from residents', businesses', and the City's purchase of electricity. In the municipal inventory, which is a subset of the community inventory, scope 2 emissions are indirect electricity purchase emissions for which the City has responsibility.

[5] *Scope 3* includes indirect emissions from activities that occur outside of the City limits. In this inventory, scope 3 emissions include emissions from air travel, airport ground support equipment, and well to pump emissions. These emissions are reported for information purposes, but are not required by general inventory reporting guidelines.

[6] The City has limited control over landfill practices, which are the major source of GHG emissions.

In 2005, of the total reportable community-wide emissions, the residential and commercial energy use and transportation related sectors accounted for just under 99% of emissions, with municipal emissions (from municipal energy use and water and wastewater treatment) comprising just over 1% of emissions (Figure 1, Table 2). It should also be noted that the city has installed solar panels, which helps to further reduce GHGs produced by wastewater treatment, which is part of the municipal inventory. Transportation emissions generated by vehicle travel (gasoline and diesel) constituted by far the most significant portion of reportable emissions (77%).

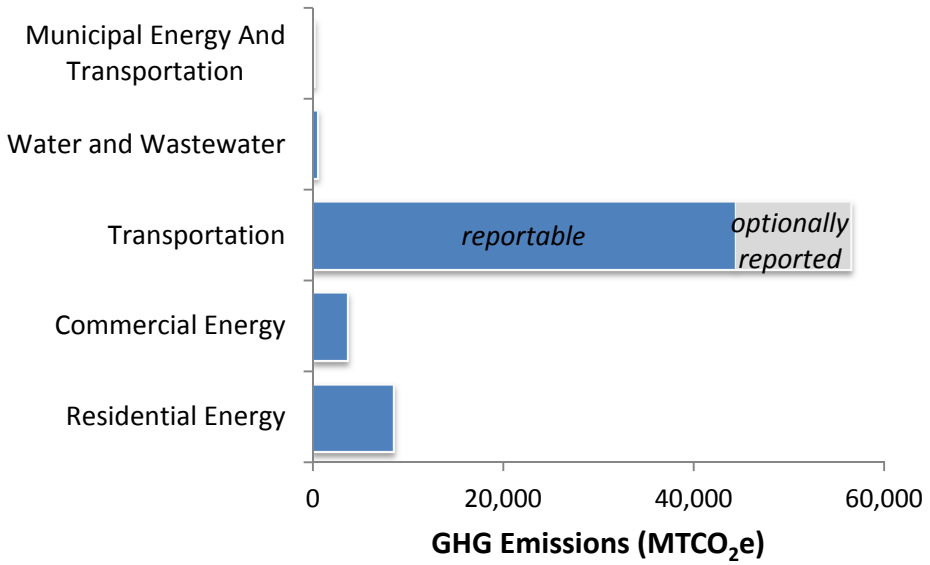

Figure 1. 2005 GHG Inventory

Table 2. 2005 GHG Inventory by Sector (reportable emissions)

Sector	$MTCO_2e$	%
Residential/Commercial Energy Use	12,226	21.3
Transportation (excludes optionally reported emissions)	44,282	77.3
Water and Wastewater	566	<1%
Municipal Energy Use and Transportation	216	<1%
Total GHG Emissions	**57,290**	

3 BAU Forecast Inventory, 2020

The "business-as-usual" (BAU) forecast assumes that current trends and policies continue into the future. The BAU scenario does not account for any new technology innovations, or emissions reductions that are planned, but not yet committed or mandated. For example, the

(mandated) low carbon fuel standard is included in the future year emissions estimate, but increased fleet penetration of electric vehicles that might result from breakthrough battery technology is not included. Creating a BAU forecast is obviously an inherently uncertain process. Many factors may play a role in the future (e.g., economic conditions) and some of these factors may be very difficult to gauge based on only current trends. Local climate action plans, in particular, are heavily dependent on projections of future year population and the estimated number of households. Consequently, several different estimates of future population were considered in the analysis. Population estimates were derived using data from the: California Department of Finance (DOF), US Census, and SACOG (Box 1).

The results of this analysis show that population estimates can vary widely depending on the initial source used for the estimation. The estimated future annual population growth rate based on SACOG data is significantly higher than either the US Census estimate or the estimate provided by DOF. The results presented in this Chapter are based on estimates of future population derived from SACOG data. Using higher population estimates is a more conservative approach; if population growth is lower, GHG emissions will also typically be lower. It is also important to maintain consistency with regional estimates, particularly for estimating and monitoring transportation emissions.

The BAU forecast for the community-wide emissions indicates that without implementing the measures outlined in later Chapters of this report, total reportable GHG emissions are expected to increase approximately 2.4%, from 57,290 $MTCO_2e$ to 58,688 $MTCO_2e$ (Tables 2 and 3). The share of the total reportable community emissions inventory comprising transportation GHG emissions declines slightly from 77.3% of to about 73.5%, as reportable transportation emissions decrease by approximately 1,146 $MTCO_2e$ (Figure 2, Table 3). The GHG emissions for residential/commercial energy use and municipal energy use increase while emissions for water and wastewater decline. On a per capita basis, GHG emissions decrease slightly from 8.5 $MTCO_2e$ per person to 8.0 $MTCO_2e$ per person. This is consistent with expectations from regional analyses and

POPULATION SCENARIOS

Three different future population scenarios were examined:

- 2020 Population using California Department of Finance estimates
- 2020 Population using US Census data
- 2020 Population using SACOG estimates

Source	Est. Annual Pop Growth Rate (%, 2010-2020)
Dept of Finance	0.71%
US Census	1.04%
SACOG	1.38%

Technical details can be found in Appendix 1B.

Box 1. Population Scenarios

reflects expected energy efficiency improvements as well as changes in transportation fuel due to the introduction of various state mandates, which are discussed in more detail in the next section.

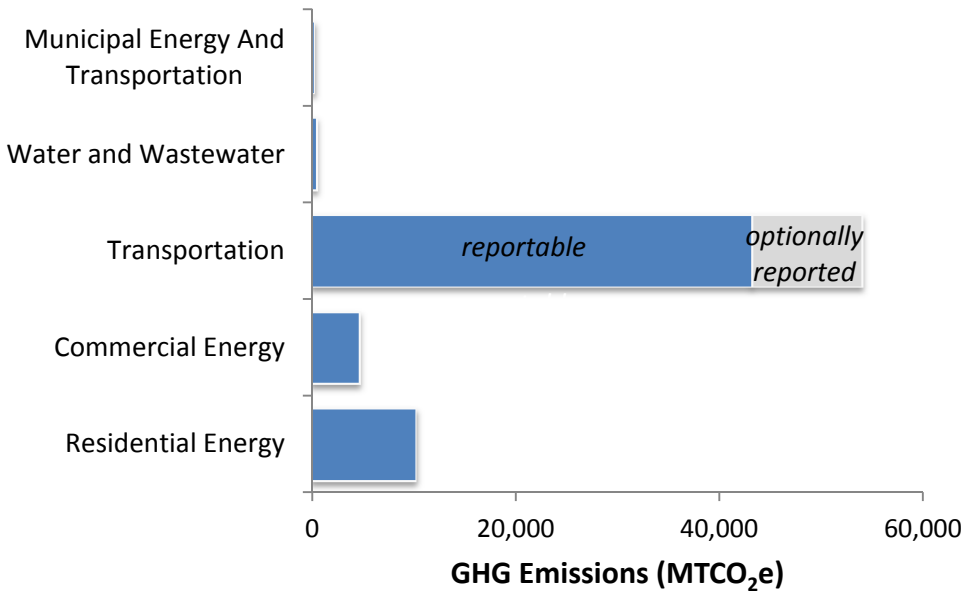

Figure 2. 2020 GHG Inventory

Table 3. 2020 GHG Inventory by Sector (reportable emissions)

Sector	$MTCO_2e$	%
Residential/ Commercial Energy Use	14,859	25.3
Transportation (excludes optionally reported emissions)	43,136	73.5
Water and Wastewater	458	<1
Municipal Energy Use and Transportation	235	<1
Total GHG Emissions	**58,662**	

4 GHG Reduction Target

In June 2005, Governor Schwarzenegger signed Executive Order S-3-05, which established climate change emissions reduction targets for California. The passage of AB32, requiring that the state reduce its greenhouse gas emissions to 1990 levels by 2020, followed in 2006. A roadmap for implementation of AB 32, the Scoping Plan, was approved in 2008 and is in the process of being implemented. The setting of targets and the development of implementation frameworks for action on climate change has not been limited to state government. Out of

1055 mayors,[7] more than 137 California mayors have signed the 2007 U.S. Conference of Mayors Climate Protection Agreement.

Participation and investment in reducing greenhouse gas emissions by cities is critical. Local governments are able to more swiftly and astutely reflect the needs and aspirations of their constituents. Policies that are complementary to the unique circumstances of the individual city can more quickly be identified. Better management of infrastructure and small changes in land use policies can result in significant reductions in GHG emissions over time while still enabling a high quality of life. With the right information, cities can pick and choose the policies and strategies that are most likely to result in cost-efficient implementation, and/or can capitalize on co-benefits that increase access to services or reduce impacts from unexpected weather events.

A target consistent with AB 32 requires a 15% reduction of 2005 baseline emissions by 2020. This reduction is approximately equal to 1990 emissions. A 15% reduction taken from the 2005 baseline and applied to the 2020 BAU yields a reduced emissions target of 48,696 $MTCO_2e$, which is 17 % lower than the BAU emissions estimate. However, there are a number of state and regional policies and actions that will influence future emissions (Box 2).

KEY STATE GHG REDUCTION POLICIES

AB 32
AB 32 specifies the level of GHG reductions to be achieved: 1990 emissions by 2020. This is roughly equal to 15% below 2005 emissions. Executive Order S-3-05 specified a target of 80% below 1990 emissions by 2050. Together these targets identify the general level of reductions that the state is expected to achieve.

Renewable Portfolio Standard (RPS)
Codified in Public Utilities Code §§ 399.11 – 399.31, the RPS requires retail sellers (investor-owned utilities (IOUs), electric service providers (ESPs) and community choice aggregators (CCAs) regulated by the California Public Utilities Commission (CPUC) to procure 33% of retail sales per year from eligible renewable sources by 2020. The RPS also requires retail sellers to achieve intermediate RPS targets of 20% from 2011-2013 and of 25% from 2014-2016.

Box 2. Key Legislation

First, the vehicle tailpipe standards established in AB 1493 (Pavley) and in the Low Carbon Fuel Standard (LCFS) created through Executive Order S-01-07 will reduce transportation emissions over time. Pavley reduces tailpipe GHG emissions, while also improving vehicle fuel efficiency. The LCFS reduces the carbon intensity in vehicle fuels. This measure was included in the state's early actions as part of implementing AB 32. The reductions associated with these mandates

[7] U.S. Mayors (2009) "US conference of mayors: climate protection agreement", accessed Dec 2011; http://usmayors.org/ climateprotection/agreement. htm.

have already been incorporated into the transportation 2020 BAU projection; both measures affect the emissions generated by light duty vehicles.[8]

Finally, future emissions will be influenced by implementation of the California Renewable Portfolio Standard (RPS). The RPS mandates that 33% of the electricity delivered in California must be generated by renewable resources, including solar, wind and geothermal, by 2020. According to the most recent Renewable Portfolio Standard Quarterly Report,[9] over 300 MW of renewable energy capacity came online during the first two quarters of 2012, with another 2,740 MW of capacity expected to be delivered before the end of the year. In March 2012, PG&E reported that 20.1% of its 2011 retail sales were generated with RPS-eligible energy. At this point, despite potential transmission limitations, there is little reason to assume that the state mandated target will not be met. The estimate shown in Table 3 above does not include reductions that will result from RPS. After adjusting for the state implementation of the RPS, the 2020 net reduction required is approximately 5,795 $MTCO_2e$ (Table 4). Recall that transportation emissions were already adjusted for the state implementation of Pavley and the LCFS in the BAU forecast.

Table 4. Net Reduction Required to Meet 2020 Target

Inventory	Estimated GHG ($MTCO_2e$)
Baseline (2005)	**57,290**
1990 Target (15%<2005)	*48,696*
BAU Forecast (2020)	**58,688**
Adjustment for RPS (State)	*-4,171*
Net Reduction Required	**5,821**

[8] Earlier climate action plans estimated these emissions reductions separately because adjustments had not yet been incorporated into California's official mobile source model. With the release of EMFAC2011, the Air Resources Board official mobile source emissions model, emissions data now incorporates fleet information, the latest planning assumptions, and Pavley and LCFS adjustments. The EMFAC2011 model was used to generate the 2020 BAU transportation emissions. The EMFAC2011 rates for CO_2 and N_2O incorporate adjustments for Pavley and LCFS in future emissions rates.

[9] http://www.cpuc.ca.gov/NR/rdonlyres/2060A18B-CB42-4B4B-A426-E3BDC01BDCA2/0/2012_Q1Q2_RPSReport.pdf, accessed August, 2012

Chapter 3: GHG Reduction Strategies

1 Introduction

A wide range of strategies are available for reducing energy use and ultimately GHGs. This Chapter describes potential climate action strategies that might be suitable for implementation. This Chapter's compendium of strategies reflects a wide ranging investigation of climate actions that have been identified or explored by other cities and by organizations such as ICLEI. We also examined best practices in other cities and attempted to include these in the compendium of potential actions if sufficient backup data were available. We also incorporated comments and recommendations by local residents at a public forum in the City of Woodland – where applicable these were combined with strategies from the sources above. Finally, in order to facilitate review and consideration of climate action reduction strategies, information on costs and potential savings were also collected. This Chapter is accompanied by Technical Appendix II and a more detailed version in electronic Appendix II1.

In general, the following considerations played a key role in adding a potential climate action strategy to the inventory of possible actions:

- are sufficient data available on costs and savings,
- is the action technically feasible,
- could the action realistically be implemented, and
- are there other possible benefits to the action (e.g., increased job opportunity, improved quality of life and improved health).

We also included actions if implementation might result in:

- support of regional smart growth principles,
- improved air quality,
- reduction in urban heat island effects,
- improved public spaces
- improved public health, and
- better connected, walkable neighborhoods

Although the reduction strategies in this latter list for the most part do not directly address GHG reductions, they do begin to establish the basic community backbone upon which longer term reductions will depend.

2 Potential Costs and Emissions Reduction for each Strategy

The complete inventory of potential climate strategies is summarized in Appendix II. For each strategy, the appendix provides a description of the strategy and the units from which costs and benefits are measured, the incremental cost, the annual cost saving, the simple payback period, and greenhouse gas reductions, and a score summarizing the potential for successful implementation. Each of the reduction strategies that were assembled have been bundled based on the type of strategy (as described in Chapter 4 below).

Additional details about the strategies are provided in electronic Appendix II1, which includes details about 1) the strategy itself: sources where the strategy was identified, a description of the strategy, community recommendations related to the strategy (from the public forum noted above); 2) details about resource savings, including electricity, natural gas, gasoline or fuel oil, and water; and 3) details about the potential for successful implementation score, including full implementation costs, operation and maintenance costs, return on investment, implementation timeframe, level of effort required by the City, and the degree of implementation control by the City (Figure 3).

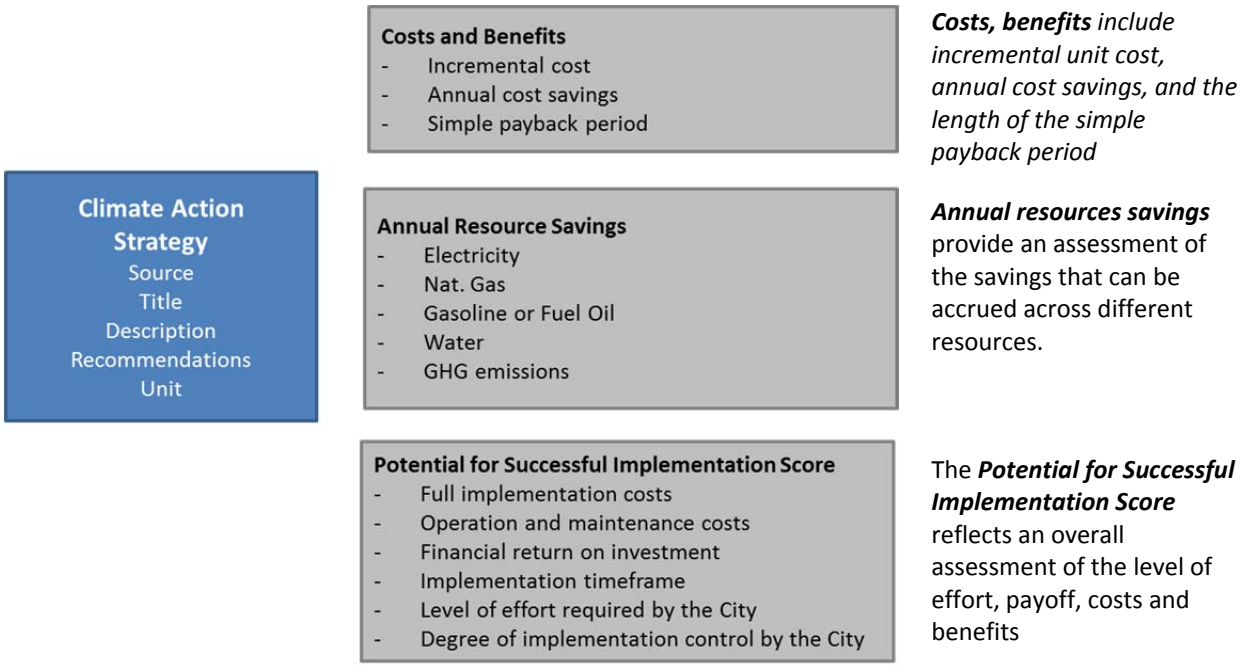

Figure 3. Evaluation information available for each strategy in the electronic Appendix II1.

The information that is available for each strategy, both in Appendix II and II1, is shown in Figure 4.

Reduction Strategy						Costs & Benefits[13]			Annual Resource Savings[13]					Potential for success[13] (5 = Desirable						
ID	Source	Title	Strategy Description	Community Recommendatic	Definition of Unit	Incremental Cost[2] ($/unit)	Annual Cost Saving[2] ($/unit/yr)	ple Payback Period[4] (yrs)	Electricity (kWh/unit/yr)	Natural Gas (therm/unit/yr)	Gasoline/Fuel Oil (gallunit/yr)	er (gallunit/yr)	GHG emission[8] (mtCO2e/unit/yr)	al Implementation Cost[4]	ration & Maintenance Cost[7]	ancial Return on Investment[8]	lementation Timeframe[9]	el of Effort Required by City[10]	l of Implem. Control by City[11]	rage Potential Score[12]
Bundle 1A: Buildings - Lighting (Residential and Commercial Energy)														Average Feasibility Scores:	2.86	5	4.7	3.9	4.4	2.3	3.857
1A-1	CAPPA	Encourage Community Members to Use CFL Bulbs and/or Fixtures	Encourage community members to switch to CFLs by: holding promotional free CFL giveaway days, or subsidizing the cost of the bulbs, or raising awareness about available state and federal subsidies		# of light bulbs replaced with CFLs	2.58	4.35	0.6	44	0	0	0	0.015	4	5	5	4	3	3	4
1A-2	CAPPA	Encourage Installment of LED Exit Signs	Encourage the replacement or initial installment of old exit signs with LED exit signs; LED exit signs last much longer, and fail less frequently, reducing maintenance costs		Exit signs replaced with LED exit signs	U	26.87	2.1	272	0	0	0	0.093	3	5	5	5	5	2	4.167
1A-3	CAPPA	Encourage Installment of Occupancy Sensors	Encourage commercial sectors to install motion sensors in buildings to automatically turn the lights on and off		Square feet installed with occupancy sensors	0.06	0.236	0.2	2.398	0	0	0	0.00082	2						
1A-4	Stephen McCord	Encourage the Installment of Solar Tubes	Encourage the installment of solar tubes in buildings; Solar tubes add natural light and reduce the need for artificial lighting		NA	340	U	U	U	0	0	0	U	U	U					
1A-5	CAPPA	Encourage Commercial Lighting Fixture Upgrades	Encourage the replacement of older fixtures with magnetic ballasts and T-12 size fluorescent tubes with T-8 size tubes; Local government can subsidize the disposal and/ or replacement cost		Square feet of facilities retrofitted with efficient lighting	0.06	0.203	0.3	2.06	0	0	0	0.0007	2	5					

Figure 4 (a) Expanded information by strategy and sector included in electronic Appendix II1.

ID #	New Reduction Strategy	Definition of Unit	Incremental Cost[1,6]	Annual Cost Saving[2,6]	Simple Payback Period[3,6]	GHG reductions[4,6]	Potential Success Score[5,6]
			$/unit	$/unit/yr	yrs	mtCO2e/ unit/ yr	1 - 5; 5 = Desirable
Bundle 1A: Buildings - Lighting (Residential and Commercial Energy)							3.9
1A-1	Encourage Community Members to Use CFL Bulbs and/or Fixtures	# of light bulbs replaced with CFLs	2.58	4.35	0.6	0.015	4.0
1A-2	Encourage Installment of LED Exit Signs	Exit signs replaced with LED exit signs	U	26.87	2.1	0.093	4.2
1A-3	Encourage Installment of Occupancy Sensors	Square feet installed with occupancy sensors	0.06	0.236	0.2	0.00082	3.7
1A-4	Encourage the Installment of Solar Tubes	NA	340	U	U	U	
1A-5	Encourage Commercial Lighting Fixture Upgrades	Square feet of facilities retrofitted with efficient lighting	0.06	0.203	0.3	0.000	

Figure 4 (b) Summary information included in Appendix II

3 Assessing Strategy Deployment

The strategies target both community and municipal actions. Most of the strategies require some level of participation by residents, households and businesses within the City. In order to understand the effectiveness of different types of strategies and the impact of participation rates, curves showing the reductions that will result from different levels of participation have been developed for all community strategies and municipal transportation strategies (Appendix IV). Each city also has access to excel-based tools that can be used to set goals for reductions from these strategies, as well as to develop new participation curves and to assist in tracking and monitoring over time (electronic Appendices IV1 – IV4). Spreadsheet tools and participation curves are grouped by sector. In the remainder of this chapter, we describe the participation curves and how the spreadsheet tools can be used to modify, track or develop new curves.

Participation Curves

Participation curves have been developed that allow the city to estimate the magnitude of reductions for a given strategy. There may also be strategies, which when combined, produce greater or fewer reductions than estimated by a single strategy. These combined benefits (or disbenefits) have not been assessed. Each of the curves shown in Appendix IV is a product of an excel-based tool (electronic Appendices IV1 – IV4) that contains a user input form, curves for each strategy, and an assumptions datasheet (Figures 5 and 6). Briefly, each of the main worksheets is described below.

Inputs Worksheet. The inputs worksheet is the main user interface for developing the participation curves. This worksheet has a list of strategies, based on Appendix II. To assist the city in beginning to define the target percent of emissions reductions for each strategy, the user can define the target percent of emissions reductions (from the BAU projection that accounts for RPS implementation) for a given strategy, and the spreadsheet calculates the level of participation required and the total estimated GHG savings. The strategies are also arranged in bundles, which are discussed further in Chapter 4.

Participation Curves. A number of participation curves have been developed for all community strategies and for municipal transportation strategies (Appendix IV). The results of these initial simulations illustrate the various levels of target achievement for each strategy and the resulting GHG reductions. To calculate the GHG reductions, a variety of assumptions are required. The assumptions used to estimate the GHG reductions are documented in each sector's corresponding datasheet (electronic Appendices IV1 – IV4, see Figure 6). Implementation costs have not been included on these graphs and should obviously also be assessed alongside the GHG reduction estimates.

Datasheet Worksheet. A list of assumptions that have been used to estimate the GHG reductions along with any data that are used are also documented in the 'datasheet' tab of each Excel workbook. Some of these assumptions could change over time as, for example, technology develops, or there may be changes in the data values initially provided by the city or other parties. Data values are identified by their source. Assumptions that are not based on a data source have been highlighted in yellow on each datasheet.

Target and Constraint Values	
Total Reduction Required (mtCO2e)	15,838
Total Number of Households In City	2,186

COMMUNITY - Residential

Bundle 1A: Buildings - Lighting (Residential Energy)		User Input		Calculated			
				hh's needed to particip			
Applicable Strategies	Measure	Goal % of mtCO2e	GHG savings mtCO2e/unit/yr	no.	% of applic hh	max no. of applic hh	TotGHGSavings (mtCO2e/yr)
Encourage Community Members to Use CFL Bulbs and/or Fixtures	1A-1	1	0.015	377	17%	2186	158.38
LED Holiday Light Exchange	1A-6	0.1	0.0051	1027	94%	1093	15.84
Halogen Torchiere Lamp Exchange	1A-7	0.32	0.056	656	165%	398	50.68

Bundle 1B: Buildings - Appliances (Residential Energy)		User Input		Calculated	
				hh's needed to particip	
Applicable Strategies	Measure	Goal % of mtCO2e	GHG savings mtCO2e/unit/yr	no.	% of applic hh
ENERGY STAR Computer Replacements	1B-1	0.5	0.069	1481	85%
ENERGY STAR Monitor Replacements	1B-2	1	0.021	17141	1376%
ENERGY STAR Printer Replacements	1B-3	1	0.127	1890	131%

Figure 5. Example User Input Sheet

Source Provider	Generalization Values Needed	Values	Source/Notes
ENERGY STAR	Avg no. of light sockets per home	40.00	http://www.energystar.gov/ia/products/downloads/CFL_Market_Profile_2010.pdf
ENERGY STAR	Avg no. of cfls already in the avg home	12.00	http://www.energystar.gov/ia/products/downloads/CFL_Market_Profile_2010.pdf
US Census Bureau	Avg sqft per home in the western United States	2,386.00	http://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf
US Census Bureau	Avg sqft of roofing per home	1,193.00	Assumes roofing can be installed on all existing homes; Assumes avg. number of floors in single family residence is 2; http://www.census.gov/construction/chars/pdf/soldstories.pdf
Northwest Energy Efficiency Alliance	Avg no. of fluoresecent torchieres per household of households that have torchieres	1.38	http://neea.org/docs/reports/RESIDENTIANEWCONSTRUCTION5CC78C1BD226.pdf?sfvrsn=6
Northwest Energy Efficiency Alliance	Fraction of households that do not have torchieres	0.82	http://neea.org/docs/reports/RESIDENTIANEWCONSTRUCTION5CC78C1BD226.pdf?sfvrsn=6
Assumption	Avg strings of Christmas lights per household of households that have Christmas lights	3.00	Assumption
Assumption	Avg fraction of households that have Christmas Lights	0.50	Assumption
US Bureau of Labor Statistics	Avg no. of inefficient computers per home for computer owners	0.78	Using the national value for 2008 and assuming 50% of existing computers are not EN http://www.bls.gov/opub/focus/volume1_number4/cex_1_4.htm

Figure 6. Datasheet provided for all assumptions and references

Chapter 4: Implementation Framework

1 Introduction

The City of Winters has identified a target of reducing GHG emissions to 15% below 2005 levels by 2020. This Chapter describes various ways to organize and prioritize the potential reduction strategies discussed in Chapter 3 so that the City can not only achieve their 2020 target, but also establish the strongest possible foundation for achieving their 2050 target of 80% below 1990 emissions.

This Chapter is divided into four sections that present ways in which strategies can be organized and prioritized. In the first section, strategies are organized into bundles – i.e., those strategies that should be implemented together in order to achieve optimal effectiveness. Bundles typically include a mix of both short- and long-term strategies. In the second section, the individual strategies are divided into categories that correspond to: 1) strategies that should be implemented quickly in order to achieve reductions for the 2020 target; 2) strategies that should be implemented now, but will likely contribute GHG reductions after 2020, and 3) strategies that are larger infrastructure improvements and will take planning and capital. The third and fourth sections briefly describe funding strategies and plan adaptation respectively.

2 How Strategies Can Be Implemented Together

Chapter 3 outlined the characteristics of each of the individual strategies. In this chapter, the strategies are organized into objectives by sector. For each objective, there may be one or more sets of "bundled" reduction strategies. These bundles are groups of strategies that are complementary to each other and should be considered and implemented together to improve the ease of implementation or to achieve greater reductions. For example, within the transportation sector, an objective might be to encourage smart growth. For this objective, there are bundled strategies such as promoting transit-oriented development, participating in regional planning, and implementing bikeable, walking streets. All of these strategies require community ordinances and policies to be synchronized and consistent with regional goals, and when implemented together these actions will likely achieve greater reductions.

The objectives and bundled strategies are organized by sector (Figure 7). For example, within the residential/commercial energy use sector, there are three objectives, ranging from reducing building energy consumption to decreasing urban heat. Each objective is accompanied by one or more bundles of reduction strategies. For reducing building energy consumption, there are bundled strategies for lighting; appliances; comprehensive building improvements; and

temperature control. Each of these bundled strategies has a reference number that corresponds to the reduction strategies in Appendix II. For example, the lighting bundle outlines strategies such as: replacing incandescent bulbs with CFLs; installation of occupancy sensors; implementation of a halogen torchiere lamp exchange, etc. The actual reductions that can be achieved through any given bundle targeting community reductions in most cases depend on the numbers of households or businesses participating, as discussed in Chapter 3. Appendix IIIA shows the community and municipal implementation bundles.

Sector	Objective	Bundle(s)
Community Emissions Reductions		
Residential and Commercial Energy Use	Reduce building energy consumption	Lighting (1A), Appliances (1B), Comprehensive Improvements (1C), Temperature Control (1D)
	Increase use of low-carbon energy sources	Electricity Generation and Procurement (2)
	Increase use of shade	Urban Forestry (4)
Solid Waste (not in inventory)	Decrease waste	Diversion and Reduction (3)
Transportation Energy Use	Reduce transportation energy use	Miscellaneous (5), Transport Infrastructure (6), Transportation Equipment and Operations (8), Vehicle Efficiency (13)
	Reduce vehicle miles traveled	Transit and Bike/Ped (9), Parking (10), Land Use (11), Carpool and Rideshare (12)
	Increase use of low-carbon energy sources	Transportation Fuels (7)
Municipal Emissions Reductions		
Municipal Energy Use	Reduce building energy consumption	Lighting (15A), Appliances (15B), Comprehensive Improvements (15C), Temperature Control (15D)
	Increase use of low-carbon energy sources	Electricity Generation and Procurement (16)
Municipal Transportation Energy Use	Reduce transportation energy use	Transportation Equipment and Operations (19), Vehicle Efficiency (21), Miscellaneous Transport (22)
	Reduce vehicle miles traveled	Transit and Bike/Ped (20), Miscellaneous Transport (22)
	Increase use of low-carbon energy sources	Transportation Fuels (18)
Municipal Water Supply and Wastewater Treatment	Reduce water use and increase efficiency of water procurement	Water Conservation (23)
	Reduce emissions from wastewater treatment and reuse wastewater	Wastewater (24)

Figure 7. Bundles and corresponding sectors and objectives.

Implementation Framework

For each reduction strategy there are a range of approaches to implementation. We identify four different approaches to implementation that can apply to each reduction strategy or bundle of reduction strategies:

Education/Outreach

Educational and Outreach programs can result in reduced GHG emissions through increased public knowledge and awareness of activities that can help to reduce GHG emissions. While some strategies are purely educational, most other reduction strategies also include an educational/outreach component to help extend awareness of reduction strategies, programs, and regulations that can result in emission reductions. These efforts are likely to have a relatively small effect on their own and are likely to be more effective when they occur in conjunction with one or more other implementation approaches, as listed below. Despite the fact that the effects of educational and outreach programs are typically difficult to quantify, these efforts help to ensure successful implementation of any reduction strategy which hinges on actions taken by individuals. Educational campaigns can target residents, commercial businesses, and/or city officials depending on the level at which actions should occur.

When designing education and outreach campaigns it can be useful to target communities that are less aware or that would benefit more from being informed of particular information. It is also important that educational information be available in the languages spoken by the community. It is worth noting that once a comprehensive educational program is implemented, it can be relatively inexpensive to add additional topics: essentially, there is an economy of scale to combining related reduction measures in educational and outreach programs.

Incentive/Rebate Programs

Incentive and rebate programs can motivate residents, businesses, and city departments to adopt reduction strategies. They also may require more resources, depending on whether they leverage existing third-party programs or require the creation of new city-run programs. Using an existing rebate program typically requires a smaller financial investment and is therefore easier to implement. However, it is often difficult to obtain and use information from these third-parties to quantify the emissions reductions that result from implementation. Note that these programs are still voluntary, so while they may be more effective than educational programs alone, they are likely less effective than regulations or municipal action.

City-run rebate programs require a larger financial and time investment. These programs require funding, as well as a continued time investment to determine potential participants' eligibility and to distribute awards. When implementing these types of programs, forming partnerships with other agencies or utility companies or soliciting grants to share costs or administrative burdens can increase the cost effectiveness of these programs. One benefit of city-run incentive programs is that they can target City-specific needs and typically are easier to track, since the City itself is involved in distributing awards.

Regulatory/Policy

Regulatory approaches to implementation can be an effective way to accelerate adoption of reduction strategies, especially when adoption requires overcoming market failures such as landlord-tenant problems (e.g. when a landlord buys appliances but a tenant pays electricity bills), or imperfect information (e.g. when a home builder knows the R-value of insulation, but a buyer does not.) Regulatory approaches to strategy implementation can consist of new city regulations that require or encourage practices that reduce GHG emissions. To be effective, regulatory approaches require time up front for design of effective regulatory policies as well as continued time and effort for enforcement. New regulations can have unintended political and economic consequences, so it is important that the potential implications of new rules be vetted before taking regulatory action.

Municipal Action or Service

The implementation of some reduction strategies may require direct action by the City, or expansion or creation of city services. The cost of direct action by the City and creating and maintaining additional services can be substantial, but it can have very high potential for GHG reductions. Expansion of existing services can sometimes be accomplished at a relatively lower incremental cost.

Most reduction strategies can be implemented using any of these four approaches. For example, the city can encourage the use of CFL light bulbs (reduction strategy 1A-1) by educating the community about CFL bulbs via a marketing campaign. Or, the City could create an incentive or rebate program that reduces the cost of purchasing CFL bulbs, by initiating a policy that new or upgraded businesses must use CFL or LED light bulbs. In most cases we have written the reduction strategy in a general way, reflecting the level of detail specified in the reference documents used to estimate strategy costs and benefits in the reduction strategies table (Appendix II). This provides the City with the flexibility to determine which implementation approach they can feasibly use for each reduction strategy.

There are many that factors that play a role in deciding how, or even whether to implement a particular bundle or a specific strategy. The desired timeframe for implementing each reduction strategy may depend on the available budget, the cost of creating and enforcing the strategy, the expected emissions pay-off, barriers to adoption or success, and city-specific contexts. These factors also play a role in how easy it may be to achieve different approaches to implementation.

Monitoring Framework

The primary means for tracking progress is periodically reevaluating the City's GHG inventory. However, the information used to generate the inventory is aggregate in nature, and will not reveal progress (or lack of progress) made by individual reduction strategies. Additionally, the effects of some strategies may not be captured in the inventory. It is therefore important to track the progress of individual strategies in order to understand the effectiveness of strategies that have been implemented in the past, so that the City can identify challenges and adapt their efforts to achieve their GHG reduction target. At the same time we note that many of these strategies target the same emissions and as a result some metrics overlap in terms of the reductions that they track. Therefore, the total emissions reductions for multiple metrics should not be added to obtain a total emissions reduction from a group of strategies. In summary, information from the inventory is better suited for tracking overall emissions reductions from particular emissions sources, while strategy-specific metrics are better suited for tracking reductions from a particular strategy.

Not all emissions reductions can be quantified and tracked directly. We present several possible metrics that might be used to track emissions reductions from each reduction strategy. In some cases, a metric is only feasible using one implementation approach – for example, if the City implements an incentive/rebate program, they can track the use of that program directly. However this tracking method does not apply if the reduction strategy is only implemented as part of an educational/outreach campaign.

The metrics presented are given in terms of the units to track (e.g. number of participating households), and each metric is categorized based on the means of data collection. The primary means for collecting information are:

- PG&E Data and Reports: This category includes city-specific data that PG&E provides to the City. This data comes in several reports – energy consumption reports provide information about electricity and natural gas consumption by facility type, energy savings reports provide information about estimated energy savings that result from PG&E incentive programs, and energy generation reports provide photovoltaic energy generation.

- Incentive/Rebate records: If the City or third party has implemented an incentive or rebate program, it may be possible to track use of the program directly. It will be easier to obtain this data if it is a City-run program.
- Self-Reporting Survey: For metrics that are difficult to track using other means and about which residents or businesses can easily answer, it may be desirable to include them on a regular City-wide survey of residents and/or businesses. If a survey is used, it would be desirable to include all metrics on the same survey, and to use the same survey each time the metrics are evaluated.
- City Operations Reporting: For reduction strategies that involve direct action by City staff (e.g. City purchases, City programs, etc), it may be possible for staff to track progress directly.
- Other Organization Reporting: For reduction strategies that involve direct action by another agency or organization (e.g. a transit agency), the City can request data about metrics of interest.

For a few cases reduction strategies we are unable to provide a recommended tracking method because the GHG reduction benefits of a reduction strategy are unknown, so tracking estimated GHG reductions is not possible.

For each reduction strategy we describe a recommended monitoring metric and we also describe alternative monitoring metrics that can be used in addition to or instead of the recommended metric if the recommended metric is infeasible to track. The desirability of potential metrics can be evaluated using several criteria. In general, metric recommendations were based predominantly on the metric's accuracy, the ease of obtaining the data, whether the metric exclusively measures the strategy, and whether the metric can be used to directly estimate the strategy's GHG effect. For metric accuracy we evaluated which data source best measures the impacts of the action. Thus, we categorized desirable metrics as measuring the effect of an action in its entirety, and not over- or under-valuing a strategy's impact. When evaluating the ease of obtaining data we factored in the existence and accessibility of representative data.

We also took into account the resources and effort that would be required to collect and compile the data from a given metric. Additionally, we identified a measurement's ability to exclusively measure the impact of an action. We prefer metrics that measure a strategy's GHG emissions exactly ('targeted' metrics) over those that measure a strategy's impact on GHG emissions in combination with other strategies ('aggregated' metrics). For example, a count of the number of households obtaining appliance rebates is a more 'targeted' measure of the effect of an appliance rebate program than the 'aggregated' measure of average household energy use obtained from electricity use records. Last, we considered a metric's ability to measure GHG effects (e.g. whether it is a 'measure' rather than just an 'indicator' of a trend).

For example, a measurement of the change in vehicle miles traveled by residents can be used to generate a reasonable estimate of the change in transportation GHG emissions, whereas a measure of a change in a walkability index (calculated based on land uses and street layouts), while useful, is an indicator of a factor that might influence travel behavior but does not provide a measure of actual behavior and cannot be used to reliably estimate transportation GHGs.

Whichever metrics the City collects, it is desirable to track each metric initially and regularly over time. An initial measure can provide a baseline before additional action is taken, and as the City takes action future measures of the same metric can provide a time trend that can inform the City and the public about the City's progress. The frequency of measuring a metric may depend on the expected speed of the reduction strategy's effects, as well as the difficulty of obtaining the metric. While it may be useful to evaluate metrics periodically and alter them if needed, there is some value in selecting a sound metric initially so that each measure is comparable to the measures taken before it.

How to read the bundle summary sheets

The bundles are categorized as community or municipal based on their expected effect on the community or municipal inventory. For instance, water-use reduction strategies targeted at city residents would be classified as a municipal strategy since the actual reduction of emissions would come from a decrease in the pumping and treating of water by the city. Figure 8 shows how to read the implementation bundle descriptions.

For each bundle, the header provides summary information including the bundle number (which corresponds to the bundle headings in the reduction strategies table shown in Appendix II), the bundle name, the emissions source (which corresponds to the inventory categories), and a qualitative assessment of the GHG reduction potential. The GHG reduction potential is based on the *per unit* GHG reductions for each reduction strategy in the bundle, as shown in Appendix II, and is described as low, medium, or high. The potential to expand, or scale reductions up, is also assessed as low, medium, or high. Thus, for a measure that has substantial reductions for a large unit that is small in number in the City (e.g. a unit of municipal buildings retrofit), the GHG reduction potential would be high, with low expandability. This is in contrast to reduction strategies that have low reductions for a small unit, of which there are many in the city (e.g. a unit of light bulbs replaced), which would have low GHG reduction potential and high expandability. The header also provides a qualitative indication of the level of feasibility/effort required by local government for each type of approach to implementation. We categorize each bundle's type of approach to implementation as green, yellow, or red to indicate that the types are easy, moderate, or difficult to implement, respectively.

Below the header, each bundle sheet also contains a summary of the bundle's objective and a chart providing the tracking metric options for each bundle. We indicate all possible metrics with an "X" and our recommended metric for each strategy is shaded in green. Where applicable, we also include a column that references applicable incentive/rebate programs that already exist. These references correspond to items in Appendix IIIC. The sections that follow describe the recommended and alternative tracking measures and the effectiveness and ease of implementation for each reduction strategy. The education/outreach section describes the particular challenges and opportunities related to educating the community about the reduction strategies included in the bundle. Each bundle sheet closes with any additional notes.

How to Read Bundle Summaries

3: Waste Diversion & Reduction

Emissions Source: Residential & Commercial

Ease of Implementation:
- Education/Outreach
- Incentive/Rebate
- Regulatory/Policy
- Municipal Action/Service

GHG Reduction Potential: Low (per unit basis) High Scalability

Objective

Create programs to reduce waste-creation and divert waste from residential and commercial operations that would otherwise end up in landfill for reuse. This can occur via educational and incentive programs.

Tracking Options

Reduction Strategy	Incentive/Regulation Tracking: Weight of Waste Diverted Per Sq ft of Construction	Incentive/Regulation Tracking: Per Capita Weight Waste Reduced Per Year	Self-Reporting Survey: Per Capita Weight Diverted Waste Per Year	Applicable Incentive #
3-2. Encourage Reuse or Recycling of Construction and Demolition Materials	X		X	11-b
3-3. Implement "Pay-As-You-Throw" Program		X		NA

Recommended Tracking Method

Strategy 3-2 consists of programs to encourage the reuse and/or recycling of construction materials. CAPPA provides emissions factors using the weight of waste diverted per square foot of construction. If this action is implemented as an incentive program, this value could be obtained through incentive tracking. If this action is implemented as an educational program then a self-reporting survey could be used.

Strategy 3-3 would require new regulations. Emissions reductions can be quantified by applying a CAPPA emissions factor using the per capita amount of waste reduced. Since these regulations would be enforced directly by the city, the city can obtain these values using data from the regulation/enforcement process.

Alternative Tracking Methods

Action 3.2 allows for the possibility of self-reporting surveys. However, as mentioned above, self-reporting surveys can be unreliable and subject to large margins of estimation/tracking error. Moreover, surveys can be expensive and timely to create, collect, and compile.

Effectiveness and Ease of Implementation

Action 3-2 would require funding and City staff time to determine incentive eligibility and distribute awards. This item has a low per-unit GHG emissions reduction potential, with units of pounds of waste per square foot of construction, which is moderately expandable since many pounds of waste can potentially be diverted but item only applies only to construction projects in the city, which are limited.

Action 3-3 requires enforcement, which may make implementation time-intensive. Per-unit reduction potential for 3-3 is moderate, while expandability is moderately high since the average person generates many pounds of trash per year. Thus, the amount of trash generated has good potential for reduction.

Education/Outreach

Educational programs would be necessary in conjunction with the advent of any new waste-reuse collection programs. These programs would need to teach participators how to sort trash appropriately and about the importance of trash reduction and diversion.

Additional Notes

The bundle 3 Waste Diversion & Reduction strategies aim to prevent GHG emissions that are generated when trash is disposed of at a landfill. These emissions were not included in the baseline inventory.

Bundle Summary:
Bundle name and emissions source and GHG reduction potential, defined as:
- Low, Medium, High overall potential for reductions per unit, where the unit is defined for each reduction strategy in Chapter 3 and Appendix II.
- Expandability or reductions refers to how many units could be affected in the City.

3. **Ease of implementing** the bundle for the various implementation approaches.
- = Easy
- = Moderate
- = Challenging

Objective: Overview of the bundles' objective and the means with which it can be implemented.

Tracking Options: This table shows:
1. The reduction strategies included in the bundle. Details about these strategies are included in Appendix II.
2. The means of tracking each reduction strategy. The metric that we recommend (if possible) is highlighted in green.
3. Applicable incentives. This column lists any rebates/incentives that apply to the reduction strategy, corresponding to rebates listed in the Appendix. This columns is only included in bundles with at least one reduction strategy that has an applicable rebate.

Recommended Tracking Method: describes the tracking method highlighted in green in the "Tracking Options" chart.

Alternative Tracking Methods: Description of tracking methods that might be used to monitor the progress of each reduction strategy in lieu of or in addition to the recommended method. Includes description of why the alternative methods are considered 'second best'.

Effectiveness and Ease of Implementation: Describes easily achieved reduction measures, resources needed to implement strategies for the various implementation approaches, and identifies challenges to implementing each reduction strategy.

Education/Outreach: Discusses the challenges and opportunities associated with educating the community about the reduction strategies in this bundle.

Additional notes: Describes any additional information about this bundle and its implementation.

Figure 8. How to Read Bundle Summaries

3 Which Strategies Should Be Implemented Right Away?

A large number and variety of strategies will be needed to achieve the City's 2020 reduction targets. In this section, we divide the individual reduction strategies into categories that correspond to: 1) strategies that should be implemented quickly in order to achieve reductions for the 2020 target; 2) strategies that should be implemented now, but will likely contribute to GHG reductions after 2020, and 3) strategies that are larger infrastructure improvements and will take longer term planning and capital. The timing of implementation and benefits of all strategies is summarized in Appendix IIIB.

Implementation in the short-term to achieve 2020 target

Most of the strategies documented in this report can be implemented now and will begin to produce GHG reductions in the short-term. Note, however, that the speed and scale of reductions will depend in part on the type of implementation approach selected by the city. As discussed above, education and outreach programs may have the smallest and slowest impact, while City-run programs may achieve greater results.

The following community GHG reduction strategies should be implemented in the short-term in order to achieve reductions by 2020:

- Bundle 1A: Buildings – Lighting: All strategies
- Bundle 1B: Buildings – Appliance: All strategies related to appliance replacement (1B-1 – 1B-10)
- Bundle 1C: Buildings – Comprehensive: Most strategies related to retrofits (1C-1, 1C-6, 1C-15), conservation and energy use awareness (1C-2, 1C-3, 1C-4, 1C-18), and recognition of low-energy buildings (1C-16, 1C-17)
- Bundle 1D: Buildings – Temperature Control: All strategies
- Bundle 2: Renewable Generation/Procurement: all small scale generation and procurement options (2-1, 2-2, 2-3, 2-4, 2-5, 2-6)
- Bundle 3: Waste Diversion/Reduction: All strategies
- Bundle 5: Transportation Miscellaneous: All strategies
- Bundle 6: Transportation Infrastructure: Strategy related to traffic light synchronization (6-2)
- Bundle 7: Transportation Fuels: Strategies related to conversion to electric vehicles (7-3) and CNG vehicles (7-2)
- Bundle 8: Transportation Equipment and Operations: All strategies
- Bundle 9: Transit and Bike/Pedestrian: Strategies related to TDM (9-5) and high school bus passes (9-6).
- Bundle 10: Parking Policies: Strategies related to shifting travel to more fuel efficient vehicles (10-3, 10-5).
- Bundle 13: All strategies

The following municipal GHG reduction strategies should be implemented in the short-term in order to achieve reductions by 2020:

- Bundle 14: Municipal Miscellaneous: Strategies related to education, contracts, and hiring a staff expert (14-1, 14-3, 14-5)
- Bundle 15A: Facilities – Lighting: All strategies
- Bundle 15B: Facilities – Appliances: All strategies
- Bundle 15C: Facilities – Comprehensive: Strategies related to retrofits (15C-3, 15C-4) and purchasing carbon credits (15C-2)
- Bundle 15D: Buildings – Temperature Control: All strategies
- Bundle 16: Renewable Generation/Procurement: Strategies related to purchasing renewable energy (16-2, 16-3) and installing renewable generation facilities (15-4, 16-5, 16-6, 16-7, 16-8, 16-9)
- Bundle 18: Transportation Fuels: All strategies
- Bundle 19: Transportation Equipment and operations: All strategies
- Bundle 20: Transit and Bike/Ped: All strategies (20-2 is anticipated to have shorter term returns than similar community strategies because of the land use patterns near City offices)
- Bundle 21: Vehicle Efficiency: All strategies (21-1 is anticipated to have shorter term returns than similar community strategies because of the land use patterns near City offices)
- Bundle 22: Transportation Miscellaneous: Strategy related to telecommunicating (22-1)
- Bundle 23: Water Conservation: All strategies that are applicable as retrofits to existing facilities (23-2, 23-3, 23-4, 23-5, 23-6, 23-10, 23-11)
- Bundle 24: Wastewater management: Strategies related to anaerobic digestors (24-2, 24-3), wastewater reuse (24-4), aeration system retrofits (24-5), and hydroelectric turbines in wastewater outflow (24-6).

Implementation short-term to achieve reductions <u>after</u> 2020

Many of the strategies listed above focus on retrofits of existing homes and strategies whose results are likely to occur in the short-term. Some strategies, however, will have more substantial delays between when they are implemented and when they produce the majority of their benefits (e.g. strategies that target new construction or that provide opportunities to residents but rely on behavioral change and other (longer term) infrastructure changes for actual reductions to occur). It is beneficial to implement these strategies in the short term although the bulk of their benefits may come in the future.

The following community GHG reduction strategies should be implemented in the short-term in order to achieve reductions after 2020:

- Bundle 1B: Buildings – Appliance: Strategies related to model homes (1B-11), which will influence new construction.
- Bundle 1C: Buildings – Comprehensive: Strategies that will predominantly influence new building construction (1C-5, 1C-8, 1C-9, 1C-10, 1C-11), buildings sold (1C-7), or increase the cost of energy (1C-12).
- Bundle 4: Urban Forestry: All strategies, which will have delayed results due to the rate of tree growth.
- Bundle 7: Transportation fuels: Strategy related to use of Neighborhood Electric Vehicles (7-1), which may complement longer-term land use changes.
- Bundle 9: Transit and Bike/Ped: Most strategies related to education (9-1), transit ridership (9-2, 9-3, 9-4), bike and pedestrian travel (9-7, 9-8, 9-10, 9-11), which may complement longer-term land use changes.
- Bundle 10: Parking Policies: Most strategies related to shifting travel to alternative modes (10-1, 10-2), which may complement longer-term land use changes.
- Bundle 11: Land use: All strategies, which will result in longer-term land use changes.
- Bundle 12: Carpool and Carshare: Most strategies which encourage car or ride-sharing (12-1, 12-2), which may complement longer-term land use changes.

The following municipal GHG reduction strategies should be implemented in the short-term in order to achieve reductions after 2020:

- Bundle 14: Municipal Miscellaneous: Strategy related to the General Plan (14-2) which affects long term land use patterns and the strategy related to tree planting for shade (14-4) which will have delayed benefits due to tree growth rates.
- Bundle 15C: Facilities – Comprehensive: Strategy related to new construction (15C-1)
- Bundle 17: Waste Diversion/Reduction: All strategies, which are related to landfill emissions reductions which occur slowly over time.
- Bundle 23: Water Conservation: Strategies related to new construction (23-8, 23-9)

Longer term planning and capital to implement

Several strategies require more time to plan and fund before they can be fully implemented, and as a result their implementation and benefits are both longer term prospects. These tend to be strategies with large up-front costs and heavy public involvement.

The following community GHG reduction strategies will require longer-term planning and capital to implement, achieving reductions after 2020:

- Bundle 1C: Buildings – Comprehensive: Strategy related to new housing projects (1C-13) and funding for efficiency and renewable energy (1C-14) which both may require longer term planning and financing.

- Bundle 2: Renewable Generation/Procurement: Strategy related to creating community solar facility (2-7), which may require longer term planning and financing.
- Bundle 6: Transportation Infrastructure: Strategies related to non-asphalt pavements (6-1) and roundabout use (6-3)
- Bundle 7: Transportation Fuels: Strategy related to local biofuel production (7-4)
- Bundle 9: Transit and Bike/Ped: Strategies related to transit systems (9-12), expanded bus service (9-9), and bicycle infrastructure (9-13), which would require longer term planning and financing.
- Bundle 10: Parking Policies: Strategy related to park-n-ride lots (10-4), which would likely occur in conjunction with longer term transit planning and may require financing.
- Bundle 12: Carpool and Carshare: Strategy related to HOV lane creation, which would require longer term planning and may require financing.

The following community GHG reduction strategies will require longer-term planning and capital to implement, and so will achieve reductions after 2020:

- Bundle 16: Renewable Generation/Procurement: Strategy related to long term financing (16-1)
- Bundle 23: Water Conservation: Strategy related to large scale change in water procurement and use (23-1), which would require longer term planning and may require financing, and strategy related to long term financing (23-7)
- Bundle 24: Wastewater management: Strategy related to sludge incinerators (24-1).

4 Funding Strategies

Partnerships and Rebates

Harnessing partnerships with agencies and utility districts may ameliorate the cost of implementing many strategies. Costs may be supplemented directly by using funding programs such as rebates or tax breaks. Costs may also be supplemented indirectly by partnering with organizations that can help alleviate administrative burdens by providing information and alleviating the need for independent data collection.

We have identified PG&E and third party rebates that can help finance some of the proposed reduction strategies. A full list is provided in Appendix IIIC. References to rebate numbers have also been included in the implementation bundle sheets for strategies with applicable rebates. Many of the identified rebates are scheduled to expire relatively soon for administrative reasons. However, most of these rebates are scheduled to be renewed for the term that follows. Check with the rebate provider for the most up-to-date list of rebates and conditions for each rebate.

5 Plan Adaptation and Evolution

As the City tracks the progress of reductions strategies and the overall inventory, it will be necessary to revisit the strategies and approaches to implementation that could be strengthened. In addition, the technical and political landscape will continue to shift, so it is necessary to periodically reassess progress, reductions strategies, implementation approaches, and monitoring methods. Maintaining strong partnerships with state and local agencies, technical experts, other cities, residents, and businesses will facilitate an adaptive approach to climate action planning.

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Technical Appendix IA: Baseline Inventory Calculations, 2005

Appendix IA:
2005 Baseline Inventory Supporting Calculations

Prepared by:
Sustainable Design Academy at UC Davis

April 2012

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Introduction

This document describes the calculations used to estimate the 2005 Baseline Emissions for the City of Winters Greenhouse Gas (GHG) Inventory. We divide these calculations into 2 categories (community and municipal inventory) and 4 subcategories (residential and commercial electricity and natural gas use, transportation, municipal operations, and water and wastewater).

This baseline inventory includes emissions from public and private activities that occur within the Winters City limits with the exception of Yolo County operational emissions, which we exclude because they are tracked and controlled by the County. The full Winters inventory includes electricity and natural gas use by residents and businesses, City operations, and 'district' governments operating within the City. We include emissions from on- and off-road vehicle emissions and air travel from residents, businesses, and City operations, as well as emissions from transit and school buses. The community inventory section of calculations includes emissions from public and private electricity use, natural gas use, and transportation with the exception of municipal (and County) activities. The municipal inventory section of calculations includes emissions from municipal electricity and natural gas use, transportation, and water and wastewater treatment activities.

Where applicable we estimate emissions using California Air Resources Board guidance documents, primarily the Local Government Operations (LGO) Protocol and the Statewide Energy Efficiency Collaborative (SEEC) documents (California Air Resources Board, California Climate Action Registry et al. 2010, Statewide Energy Efficiency Collaborative 2011). We use local and regional data as available to estimate emissions. Many of the calculations rely on population data for 2005: where applicable we use population estimates provided by the California Department of Finance (California Department of Finance 2011) because at present it is the best available source for 2001 - 2009 population data for locations in California[1].

We report all emissions estimates in metric tonnes of CO_2 equivalents ($MTCO_2e$) and grouped into scopes. *Scope 1* includes direct emissions from combustion, process, and fugitive emissions, which result from heating fuel use, on-and off-road transportation, and wastewater treatment processes. *Scope 2* includes indirect emissions from the generation of the electricity used in Winters. *Scope 3* includes emissions that occur outside of the City limits as a result of residents' and businesses' activities and that are not Scope 2 emissions. Emissions associated with air travel, for example, are Scope 3 emissions.

We provide additional details about all calculations in the accompanying spreadsheets which are referenced throughout this report.

[1] Department of Finance estimates populations based on Census 2000 and 2010 data and their data are designed to provide population counts. Although the US decennial Census is the best source for total population counts, it only provides data every 10 years. Data available through the US Census Population Estimates Program, which estimates the population in years between the decennial Census, has not yet been calibrated to the 2010 Census. The American Community Survey, which relies on annual samples of the population, is not designed to represent population counts (and its counts for small cities are aggregated across years and scaled using US Census Population Estimates Program data.)

Community Inventory

The *community inventory* includes emissions from public and private activities that occur in the City of Winters, with the exception of Winters municipal and Yolo County operational emissions. To avoid double counting emissions from City operations, we separate the calculations of community and municipal emissions into two sections. In this section we present community emissions from electricity and natural gas use and transportation occurring within the City (Municipal electricity and natural gas use and transportation are described in the next section.)

Residential and Commercial Electricity and Natural Gas Emissions

In this section we present GHG emissions estimates from electricity and natural gas used by residents, businesses, and district government emissions within the City of Winters. We include emission from natural gas in scope 1 while we include emissions from electricity use in scope 2. We estimate emissions from electricity and natural gas used in City operations in the municipal inventory.

Data Sources

The Pacific Gas and Electric Company (PG&E) provided electricity and natural gas use data (pers. comm. from John Joseph 2011). The raw data set provides yearly total and average monthly use of electricity and natural gas from 2003 through 2010 for Nongovernment, City, County, and District energy accounts. We use data from the City category in the municipal inventory (municipal operations and water and wastewater emissions) so do not include it in this section. We exclude energy use from the County category, consistent with our exclusion of County activities from the inventory. We use 2005 data from the categories of Nongovernment and District to estimate the baseline GHG emissions for residential and commercial energy users and government entities outside of the City and County purview.

The data for residential and commercial electricity and natural gas usage is summarized in Table 1 and in Figure 1. The original data set from PG&E provides totals that are aggregated for all of residential and commercial operations, alongside average monthly usage as an average per customer. The dataset also has fields for "Industrial" energy use and emissions. However, these fields were left blank so they were excluded from the analysis and reporting.

We perform a basic reasonableness check of the nongovernment portion of the 2005 energy use data as a means to spot check for egregious data errors. We calculate the average annual electricity use per residential and commercial customer from the average monthly use (from Table 1, nongovernment data only). We then divide the total yearly electricity use (from Table 1, nongovernment) by the average annual use per customer to arrive at an estimate of the number of nongovernment residential and commercial customers included in the PG&E data. We compare these values with the number of households in Winters in 2005[2] and the number of businesses in Winters in 2007 (US Census Bureau 2012). These numbers are on the same order of magnitude, differing by -2% and 48% for residential and

[2] We estimate the number of 2005 households by dividing the 2005 population from the California Department of Finance [California Department of Finance (2011). E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts.] by the 2005 – 2009 average household size for Winters from the US Census American Community Survey [US Census Bureau (2009). American Community Survey and Population Estimates Program; 2005-2009 five-year data profile.]

commercial units respectively. We perform a similar check for natural gas use, yielding 1% and 75% differences for residential and commercial units respectively. The estimate of the number of commercial customers appears lower than the actual number of businesses, possibly due to businesses sharing meters. The number of natural gas units that PG&E services is also lower than the actual number of units, possibly because not all residences and businesses use natural gas.

Methods

We estimate 2005 GHG emissions for residential and commercial operations by multiplying electricity and natural gas use (for both nongovernment and district customers) by the corresponding emissions factor and a unit conversion factor for each gas. An emissions factor is a measure of the amount of CO_2 emitted per activity (e.g. kilowatt-hour of electricity produced or therm of natural gas burned). The electricity that PG&E delivers to customers comes from a variety of generation sources in any given year. Since PG&E's electricity generation sources vary, the GHG emission factor for its electricity also varies from year to year. This factor is annually calculated by PG&E and third-party-verified and submitted to the California Climate Action Registry (CCAR). For both residential and commercial users, we calculate emissions from electricity and natural gas use, respectively, according to equations 1 and 2:

$$E_{E\ i} = U_{E\ i} \cdot EF_{E\ i} \cdot C \qquad [1]$$

where:

Term	Description	Value	Units
$E_{E\ i}$	Emissions from electricity use	See Table 2	MT gas/year
$U_{E\ i}$	Electricity usage	See Table 1	kWh/year
$EF_{E\ i}$	Electricity emission factor	0.489	lb gas/kWh
C	Unit conversion factor	1/2204.6[3]	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

$$E_{NG\ i} = U_{NG\ i} \cdot EF_{NG\ i} \cdot C \qquad [2]$$

where:

Term	Description	Value	Units
$E_{NG\ i}$	Emissions from natural gas use	See Table 2	MT gas/year
$U_{NG\ i}$	Natural gas usage	See Table 1	Therm/year
$EF_{NG\ i}$	Natural gas emission factor	11.7	lb gas/therm
C	Unit conversion factor	1/2204.63	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

[3] We obtain the conversion factor for lbs per Metric Ton (MT) from PG&E raw data.

Table 1: Historical residential and commercial electricity and natural gas use and emissions factors for nongovernment and district customers[4]

Year	Annual Electricity Use (kWh)				Electricity Emission Factor (lb CO_2/ kWh)	Annual Natural Gas Use (therms)				Natural Gas Emission Factor (lb CO_2/ therm)
	Residential		Commercial			Residential		Commercial		
	Non-Government	District	Non-Government	District		Non-Government	District	Non-Government	District	
2003	16,020,048	0	9,365,405	1,482,878	0.62	825,891	0	131,109	26,973	11.7
2004	17,219,494	0	9,984,326	1,608,582	0.566	924,408	0	151,586	33,266	11.7
2005	**17,238,186**	**0**	**10,674,690**	**1,573,786**	**0.489**	**877,795**	**0**	**150,634**	**29,923**	**11.7**
2006	17,900,745	0	11,133,234	1,587,355	0.456	885,137	0	163,230	27,583	11.7
2007	17,400,517	0	11,655,512	1,728,075	0.6357	827,423	0	158,815	34,395	11.7
2008	17,617,849	0	11,275,281	1,754,195	0.641	855,918	0	147,493	45,787	11.7
2009	17,926,889	0	11,401,591	1,518,370	0.575	859,274	0	155,370	41,742	11.7
2010	17,010,618	0	11,816,899	1,284,263	0.559	871,512	0	144,016	33,615	11.7

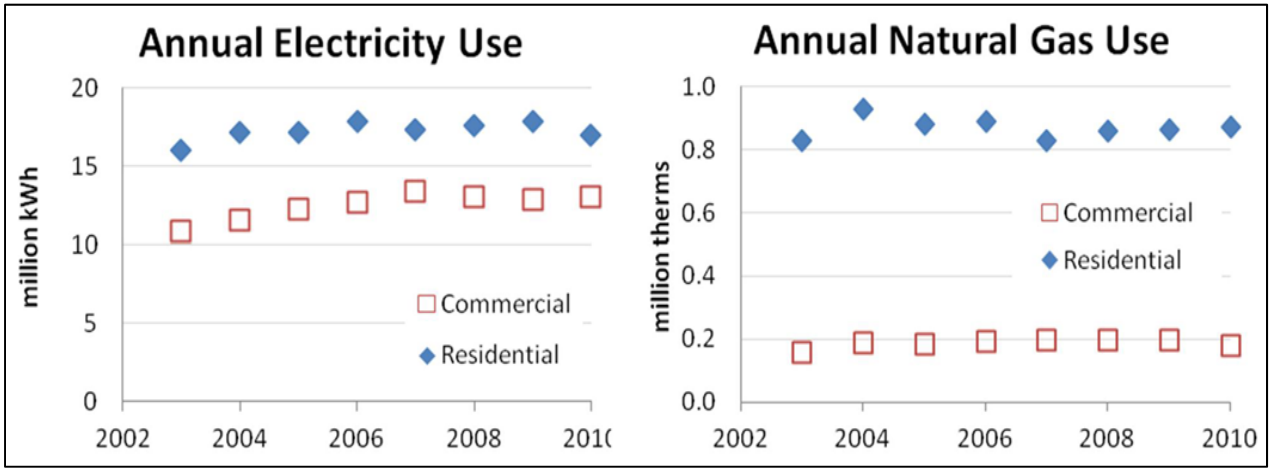

Figure 1: Historical electricity and natural gas use in the City of Winters.

[4] This table shows summaries of information provided by PG&E [pers. comm. from John Joseph (2011). Community Wide Inventory Report City of Winters 2003 to 2010, Pacific Gas and Electric Company.]

We assume that the emissions factors for PG&E are constant for any given year, although they can change from year to year.

Finally, for both residential and commercial customers electricity and natural gas use, we convert CO_2, N_2O, and CH_4 emissions to $MTCO_2e$ using the Global Warming Potential (GWP) factors recommended by the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) as described in the LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010), as shown in equation 3.

$$E_{CO_2e} = (GWP_{CO_2} * E_{CO_2}) + \left(GWP_{N_2O} * E_{N_2O}\right) + \left(GWP_{CH_4} * E_{CH_4}\right) \quad [3]$$

where:

Term	Description	Value	Units
E_{CO_2e}	CO_2 equivalent emissions	See Table 2	$MTCO_2e$/year
E_{CO_2}	emissions from CO_2	See Table 2	$MTCO_2$ /year
E_{CH_4}	emissions from CH_4	See Table 2	MT CH_4 /year
E_{N_2O}	emissions from N_2O	See Table 2	MTN_2O /year
GWP_{CO_2}	Global warming potential (GWP) of CO_2	1	$MTCO_2e$/ $MTCO_2$
GWP_{N_2O}	Global warming potential (GWP) of N_2O	310	$MTCO_2e$/ MTN_2O
GWP_{CH_4}	Global warming potential (GWP) of CH_4	21	$MTCO_2e$/ $MTCH_4$

Results

Table 2 shows the results of our 2005 baseline emissions estimates as well as the PG&E provided CO_2 emissions. Our estimated 2005 CO_2 emissions are identical to those reported by PG&E.

Table 2: 2005 baseline results for residential and commercial electricity and natural gas use by residents, businesses, and district governments[5]

	Electricity (kWh)		Natural Gas (therms)	
	Residential	Commercial	Residential	Commercial
Total energy use (kWh or therms)	17,238,186	12,248,476	877,795	180,557
Emissions factor (lbs CO_2/kWh or lbs CO_2/therms)	0.489	0.489	0.5	0.49
PG&E reported CO_2 emissions ($MTCO_2$)	3,824	2,717	4,659	958
CO_2 emissions ($MTCO_2e$)	3,824	2,717	4,659	958
N_2O emissions (MTCO2e)	27	19	3	1
CH_4 emissions (MTCO2e)	5	4	9	2
Total emissions (MTCO2e)	**3,855**	**2,739**	**4,670**	**961**

Comparative Analysis

To check for egregious estimation errors, we compare the magnitude of emissions from the City of Winters to emissions from two cities of a roughly comparable size: Menlo Park, CA, located in San Mateo County, and Piedmont, CA, located in Alameda County. According to the City of Piedmont Inventory

[5] Calculations are in the "Calc.EnergyAndEmissions" tab of the "AppendixIA2_2005Inventory_ResidentialCommercial_WN.xlsx" file, hereafter referred to as the Residential and Commercial energy excel file.

(ICLEI's Cities for Climate Protection Campaign and City of Piedmont 2006), residential and commercial community emissions in Piedmont in 2005 were 27,898 and 1,622 tons of CO2e respectively, or 25,309 and 1,471 $MTCO_2e$. According to the Menlo Park Climate Change Action Plan (ICLEI – Local Governments for Sustainability 2009), the community emissions generated in Menlo Park in 2005 were 491,054 $MTCO_2e$. Of this, commercial and industrial uses generated 30.1% (147,807 $MTCO_2e$) while residential emissions contributed 11.4% of the total (55,980 $MTCO_2e$). The populations of Menlo Park and Piedmont in 2005 were 30,355 and 10,690, or roughly 450% and 160%, respectively, of Winters' 52,474 (California Department of Finance 2011). Therefore the residential emissions in 2005 are approximately 1.3, 2.4, and 1.8 $MTCO_2e$/person in Winters, Piedmont, and Menlo Park respectively. According to the US Census Bureau quick facts, the number of firms in Winters in 2007 was 376, while in Piedmont and Menlo Park it was 1,471 and 4,691 respectively. Thus, the commercial emissions in Winters, Piedmont, and Menlo Park (assuming that the firm counts were similar in 2005) are roughly 9.8, 1.0, and 31.5 $MTCO_2e$/ firm respectively. On a per unit basis, the emissions of Piedmont and Menlo Park residents are roughly 47% and 32% (respectively) different than those of Winters, while per unit emissions of Piedmont and Menlo Park's businesses are -882% and 69% respectively. Per household residential estimates are within the same order of magnitude. Per unit commercial estimates vary more widely, although Winters is within the range of the other two estimates. Commercial energy use may vary more widely in general due to the variable nature of commercial activities. City-wide averages are likely more variable for smaller cities, where the number and variation in firm activities may be smaller.

Transportation Emissions

We include emissions from on-road as well as off-road mobile sources for the 2005 baseline community-wide transportation greenhouse gas emissions inventory. On-road mobile sources include passenger vehicles, light-duty trucks, motorcycles, heavy-duty trucks, non-transit buses, and transit buses (Yolobus) traveling within the City limits. Transit bus travel includes travel that occurs within the City limits. Off-road mobile sources include emissions from agricultural, construction, industrial, light commercial, lawn and garden, recreational, and airport ground support equipment used in the City limits in addition to emissions from aircraft travel by residents which occurs outside of the City limits. We exclude rail emissions because there is no active rail track in the City of Winters. We exclude emissions from vehicle refrigerants due to insufficient data.

We further divide on-road and off-road mobile sources into scope 1 and scope 3 emissions. Table 3 identifies each mobile source as generating scope 1 or scope 3 emissions for the purposes of the community-wide transportation greenhouse gas inventory.

The transportation section of this report has four sections. The first section provides background information about the various information sources used to estimate direct and indirect GHG emissions from on-road and off-road sources. The second section discusses the limitations of the analysis due to the data used to estimate GHG emissions. The methodologies section explains various calculation methods used in the baseline community-wide transportation GHG inventory. This section is further separated into six sub-sections covering each of six types of sources. The final two sections present the findings of the analysis and compare the results against other published Climate Action Plans and GHG inventories.

Table 3: Categorization of mobile emission sources into scope 1 and 3

	Scope 1: Direct Emissions	Scope 3: Indirect Emissions
On-Road (Pump to Wheel)		
Passenger Vehicles	✓	
Light Trucks	✓	
Motorcycles	✓	
Heavy Trucks	✓	
Non-Transit Buses (school buses, coaches and motorhomes)	✓	
Transit Buses (Yolobus)	✓	
On-Road (Well to Pump)		
On-road well to pump (excluding transit)		✓
Off-Road (Pump to Wheel)		
Agricultural Equipment	✓	
Construction and Other Commercial Equipment	✓	
Lawn and Garden Equipment	✓	
Recreational Equipment	✓	
Aircraft Use		✓
Airport Ground Support Equipment		✓

Data Sources

On-Road

For the purposes of this analysis, we categorize on-road vehicles[6] into vehicle types described in SEEC guidance (Statewide Energy Efficiency Collaborative 2011). We also add a "Non-Transit buses[7]" category for bus-like vehicles whose emissions we estimate using similar methods to non-transit vehicles. Table 4 shows the main data sources that we use to estimate emissions from each category of on-road vehicles.

For passenger vehicles, light and heavy duty trucks, motorcycles, and non-transit buses, we obtain CO_2 emissions for Yolo County from the California Air Resources Board's (CARB) 2011 Emission Factors model[8] (EMFAC 2011) (California Air Resources Board n.d.) We estimate Yolo County CH_4 emissions using a combination of CH_4 emissions and fuel consumption estimates from EMFAC 2011 and 2007 models. We calculate Yolo County N_2O emissions using Vehicle Miles Travelled (VMT) and fuel consumption data from EMFAC 2011 in combination with N_20 emission factors[9] obtained in hierarchical order from following sources – the Local Government Operations (LGO) Protocol v1.1 (California Air Resources Board, California Climate Action Registry et al. 2010), EPA Climate Leaders GHG Inventory

[6] As shown in the tab titled "calc.OnRoad_VehicleCategories" in the AppendixIA3_2005Inventory_Transportation_WN.xlsx excel file, hereafter referred to as the Transportation excel file.
[7] Includes school buses, motor coaches, and motor homes.
[8] Data from EMFAC is available in the tabs titled "raw&calc.OnRoad_EMFAC 2011", and "calc.OnRoad_EMFAC 2007" in the Transportation excel file.
[9] We tabulate emission factors under the tab titled "calc.OnRoad_N20_EF" in the Transportation excel file.

Protocol (US Environmental Protection Agency 2008), and EMFAC 2007 User Guide v2.30 (California Air Resources Board n.d.).

Table 4: Primary data sources used for calculating on-road GHG emissions

	EMFAC (2011 and 2007)	LGO	EPA Climate Leaders	Yolobus
Passenger Vehicles	Yolo County CO_2 emissions (2011) Yolo County CH_4 emissions (2007) Yolo County VMT (2011) Yolo County fuel consumption (2007 and 2011) N_20 emissions factors (2007)	N_20 emissions factors	N_20 emissions factors	-
Light Trucks				-
Motorcycles				-
Heavy Trucks				-
Non-Transit Buses				-
Transit Buses	-	CO_2, CH_4, N_20 emission factors	-	Fuel efficiency, routes

Table 5: Yolobus routes in Winters, their miles accrued, and compressed natural gas (CNG) consumed[10]

Route #	Miles accrued per week [11] (miles/ week)	Miles accrued per year [12] (miles/ year)	Fuel Efficiency [13] (miles/ therm)	CNG Consumed [13]	
				(therm/ year)[14]	(ft^3/ year)[15]
220	79	4,118	3.76	1,095	106,652
220c	36	1,846	3.76	491	47,805
Total:		**5,964**			**154,457**

We estimate emissions from transit buses using fuel efficiency data provided by Yolobus, VMT data estimated from Google Maps based on the route information from Yolobus website and staff, and emission factors from the LGO Protocol v 1.1 (California Air Resources Board, California Climate Action Registry et al. 2010). Table 5 shows VMT data and fuel consumption estimates for Yolobus activities.

Off-Road excluding Airport

We obtain baseline greenhouse gas emissions data for off-road mobile sources from CARB's "Off-Road Engine Database for 2005" (TIAX LLC 2006). The database contains roughly 43,000 records separated by equipment type, power rating, fuel type, geographical location (county, and air basin), population, activity, fuel consumption, and CO_2, N_2O and CH_4 exhaust emissions in tons/day (TIAX LLC 2007). Table 6 summarizes the data for Yolo County in metric tonnes (MT) of each gas.

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[10] The tab titled "calc.Transit" in the Transportation excel file provides data and calculations shown in this table.

[11] We estimate weekly mileage using route information from the Yolobus website for all local and pass through routes through the City of Winters.

[12] $Miles\ accrued\ per\ week * \left(\frac{52\ weeks}{year}\right) = Miles\ accrued\ per\ year$

[13] Yolobus fleet fuel type and efficiency information provided by Erik Reitz (ereitz@yrcd.org), Associate Transport Planner, Yolo County Transportation District

[14] $\frac{(Miles\ accrued\ per\ year)}{(Fuel\ Efficiency)} = CNG\ Consumed\ \left[\frac{therms}{year}\right]$

[15] $\frac{therms}{year} * \frac{100{,}000BTU}{therms} * \frac{1000ft^3}{1.027*10^6BTU} = 97.371\frac{ft^3}{year}$

Aircraft Use

We estimate emissions from aircraft use by Winters residents using fuel consumption for Sacramento International Airport (SMF) provided by Allied Aviation, fuel providers at SMF, and data capturing regional trips to and from SMF provided by the Sacramento Area Council of Governments (SACOG). Table 7 and Table 8 show fuel consumption and trip data.

Airport Ground Support Equipment

We estimate baseline greenhouse gas emissions data for airport ground support equipment using CARB's "Off-Road Engine Database for 2005" (TIAX LLC 2006). Table 9 summarizes the results for Sacramento County in metric tonnes (MT) of each gas.

Table 6: Summary of results obtained from CARB's "Off-Road Engine Database for 2005"[16]

Equipment	Population	Activity (hr/day)	Fuel Consumption (gal/day)	Exhaust		
				MT CO_2 /day	MT N_2O /day	MT CH_4 /day
Agricultural Equipment	8,476	6,531	19,975	236	0.003	0.05
Airport Ground Support Equipment	0	0	0	0	0.000	0.00
Construction and Mining Equipment	945	1,806	7,385	88	0.001	0.01
Dredging	0	0	0	0	0.000	0.00
Entertainment Equipment	3	2	26	0	0.000	0.00
Industrial Equipment	195	775	2,022	19	0.002	0.02
Lawn and Garden Equipment	57,253	5,250	1,136	7	0.006	0.01
Light Commercial Equipment	2,461	1,373	2,278	22	0.003	0.01
Logging Equipment	0	0	0	0	0.000	0.00
Military Tactical Support Equip	0	0	0	0	0.000	0.00
Oil Drilling	74	204	3,413	41	0.00	0.00
Other Portable Equipment	0	0	0	0	0.000	0.00
Pleasure Craft	10,076	1,468	5,563	43	0.01	0.07
Railyard Operations	0.04	0.07	0.3	0	0.00	0.00
Recreational Equipment	3,587	10,654	358	4	0.00	0.01
Transport Refrigeration Units	383	1,401	1,525	18	0.00	0.01

[16] TIAX LLC. (2006). "California off-road engine database for 2005." 2008. from http://www.energy.ca.gov/ab1007/ca-greet_model/ttw_off_road_2005.xls. The tab titled "raw.OffRoad" in the Transportation excel file shows the full raw dataset while "calc.OffRoad" shows the summary calculation.

Table 7: 2005 Fuel consumption estimates for Sacramento International Airport[17]

Fuel Type	Aviation Gasoline	Jet Fuel
Fuel Consumption (gallons/ year)	14,887	136,244,833

Table 8: Airport to/from trips summary[18]

From \ To	Sacramento International Airport	
	Daily Trips	Trip Ratio[19]
All TAZs within SACOG	24,229	-
City of Winters	33	0.14%

Table 9: Airport ground support equipment emissions data for Sacramento County[20]

Emissions	**$MTCO_2$/ year**	12,137
	MTN_2O/ year	1.4
	$MTCH_4$/ year	2.9

Well to Pump

Well to pump emissions are the indirect emissions that result from the production of fuel whereas pump to wheel emissions are direct tailpipe emissions from combustion of fuel. We estimate well to pump emissions using the well to pump (W2P) to pump to wheel (P2W) ratio as suggested by US Department of Energy's Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET) model. According to Greenhouse Gas Inventory for City and County of Denver, the GREET model gives 0.27, and 0.21 W2P to P2W ratio for gasoline, and diesel fuel types, respectively (Ramaswami, Janson et al. 2007). The well to pump emissions calculation is a voluntary component of this inventory so we estimate only non-transit on-road mobile sources. These sources make up the majority of emissions in this inventory and our non-transit on-road are easily categorized by diesel and gasoline fuel use.

Scaling Factors

For most mobile emissions estimates we use scaling factors to scale emissions estimates from regional data to the city level. We select scaling characteristics based on data availability and a known or posited relationship to on-road and off-road mobile sources. We use population, area, agricultural area, VMT, and trips to the airport to scale various types of mobile emissions (as shown in Table 10). The values we use to scale emissions for each characteristic are shown in Table 11.

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[17] The tab titled "raw.AircraftFuelUse" in the Transportation excel file shows raw data provided by Leonard Green (lenny.green@alliedaviation.com), Operations Manager, Allied Aviation. We tabulate total fuel dispensed to estimate fuel consumed by aircraft.

[18] The tab titled "raw.AirportTrips" in the Transportation excel file shows raw origin-destination matrix data provided by SACOG from their travel demand model. We highlight trips from City of Winters traffic analysis zones (TAZs) to SMF TAZs. We then calculate the ratio of Winters trips to SMF versus all trips to SMF in the "Detailed Winters Airport Trips" table at the bottom of the "calc.Aircraft" tab of the Transportation excel file.

[19] $Trip\ Ratio = \frac{Trips\ from\ Woodland\ to\ SMF}{Trips\ from\ all\ SACOG\ region\ TAZs\ to\ SMF}$

[20] TIAX LLC. (2006). "California off-road engine database for 2005." 2008. from http://www.energy.ca.gov/ab1007/ca-greet_model/ttw_off_road_2005.xls. The tab titled "raw.OffRoad" in the Transportation excel file shows the full raw dataset while "calc.AirportSupportEquip" shows the summary calculation.

To the extent that the scaling characteristic used is not directly proportional to emissions at the state or county level, the estimates are not a true reflection of the emissions. However, we compare all results to other entities' greenhouse gas emissions estimates in the Comparative Analysis section to identify egregious differences.

Table 10: Type of administrative units used to scale each source of mobile emissions

	Area	Agricultural Area	VMT	Trips to Airport
On-Road (Pump to Wheel)				
Passenger Vehicles			Yolo County to Winters	
Light Trucks				
Motorcycles				
Heavy Trucks				
Non-Transit Buses				
Transit Buses[21]				
On-Road (Well to Pump)				
On-road well to pump (except transit) [22]			(Implicit: Yolo County to Winters)	
Off-Road (Pump to Wheel)				
Agricultural Equipment		Yolo County to Winters		
Construction and Other Commercial Equipment	Cities of Winters, Davis, Woodland, & West Sacramento to Winters			
Lawn and Garden Equipment				
Recreational Equipment				
Aircraft Use				SACOG area to Winters
Airport Ground Support Equipment				

[21] We do not use a scaling factor for transit buses because emissions are calculated at the city level.
[22] We calculate well to pump emissions indirectly by multiplying the emissions from on-road mobile sources by a fuel-based factor. Thus, no scaling factor is required, although the on-road scaling relationship is implicit in this estimate.

Table 11: Summary of 2005 values used to scale emissions from each geographic unit to the City of Winters[23]

	SACOG Area	Yolo County	Cities of Winters, Davis, Woodland, & West Sacramento Combined	City of Winters
Area (square miles)[24]	-	-	48	2.8
Agricultural Area (acres)[25]	-	451,048	-	757
VMT (miles/day) [26]	-	3,287,759	-	105,516
Trips to Sacramento International Airport (trips/day)[27]	24,229	-	-	33

Methods

The transportation greenhouse gas emissions inventory from mobile sources relies on multiple sources for the emissions data, each requiring a unique approach to calculate the GHG emissions. This section is divided into six subsections – on-road excluding transit buses, on-road transit buses, off-road (excluding airport and rail emissions), aircraft use, airport ground support equipment, and well to pump emissions.

Emissions from on-road mobile sources excluding transit buses

We obtain emissions from on-road mobile sources from the EMFAC 2007 and 2011 On-Road Emissions Model by CARB (California Air Resources Board n.d.). Both models provide data by vehicle category, fuel type, and model year for Yolo County in 2005. We aggregate the EMFAC 2007 and 2011 vehicle categories into six vehicle types[28], namely, passenger vehicles, light duty trucks, motorcycles, heavy-duty trucks, non-transit buses, and transit buses. Since there is no shipyard within the city limits, we exclude heavy-duty trucks pertaining to drayage vehicles from the analysis. We also exclude heavy-duty trucks that are described as 'public fleet' vehicles to avoid double counting of emissions from the city-owned fleet (which we calculate using City data in the municipal inventory). Lastly, we exclude transit buses from this part of the analysis as Yolobus-specific data are analyzed in the next subsection. We include heavy-duty trucks classed as 'power take-off' equipment in the on-road data although they may be

[23] The "calc.ScalingFactors" and "calc.Aircraft" tabs of the Transportation excel file show calculations of all scaling data.
[24] We estimate land area by summing the year 2000 and 2010 averaged value for each jurisdiction obtained. We obtain 2000 and 2010 land area values from the US Census Bureau.
[25] For the City of Winters, we approximate the area from Google Earth imagery. For Yolo County, we obtain data from http://www.yolocounty.org/Modules/ShowDocument.aspx?documentid=4807.
[26] $VMT\left[\frac{miles}{day}\right] = VMT\ per\ household * Number\ of\ households$. We estimate the number of 2005 households by dividing the 2005 population from the California Department of Finance (above) by the 2005 – 2009 average household size from the US Census American Community Survey, which equal 3.2 for Winters and 2.78 for Yolo County [US Census Bureau (2009). American Community Survey and Population Estimates Program; 2005-2009 five-year data profile.] We obtain VMT generated per household for the City (50 VMT/HH/day) and County (49 VMT/HH/day) from SACOG modeling results reported on page 245 of the Yolo County 2030 General Plan EIR Transportation and Circulation chapter, available at http://www.yolocounty.org/Modules/ShowDocument.aspx?documentid=9182. Although VMT generated per household in the city versus county (which centers on the origin of travel) is not as useful as VMT occurring in the city limits versus the county (which centers on the location of travel itself), it is the best scaling data available at this time.
[27] We calculate residents' contributions to aircraft use and airport ground support emissions using the trip ratio derived from the modeled origin/destination matrix provided by SACOG (which covers the SACOG region). See Table 8.
[28] As shown in the tab entitled "calc.OnRoad_VehicleCategories" in the Transportation excel file.

agricultural equipment, as we assume that CARB modeling efforts have eliminated potential overlaps since we are using both on- and off-road data that are consistent with CARB models.

For Yolo County CO_2 emissions, we use the results provided by EMFAC 2011 directly. For all included vehicle types, we sum the reported emissions to obtain 2005 Yolo County CO_2 emissions, which are equal to 3,391 $MTCO_2$/day for all 6 vehicle categories[29]. Assuming that these emissions occur 365 days/year, we estimate 1,237,660 $MTCO_2$/year occur in Yolo County as a result of non-transit on-road sources.

N_2O emissions are not available directly from EMFAC 2011 or 2007 outputs so they are calculated from EMFAC 2011 VMT data for over 1700 included vehicle type and model year combinations using equation 4 as recommended by SEEC (Statewide Energy Efficiency Collaborative 2011).

$$E_{N_2O} = \frac{VMT * EF_{N_2O}}{C} \qquad [4]$$

where:

Term	Description	Value[30]	Units
E_{N_2O}	N_2O emissions	Calculated Values	metric ton/year
EF_{N_2O}	N_2O emission factor	Input Values	g/mile
VMT	vehicle miles traveled	Input Values	miles/ year
C	unit conversion	10^6	g/MT

The results are summed for all included vehicle type and model year combinations to obtain county-wide N_20 emissions. Overall we estimate that 2005 Yolo County VMT for included vehicle types equal 5,344,576 miles/day, or 1,950,770,339 miles/year (assuming 365 travel days per year). Using vehicle specific VMT and emissions factors as shown above, we obtain a 2005 N_20 emissions estimate of 0.197 MTN_20/day, or 72 MTN_20/year.

Note that emission factors for N_2O emissions depend on the control and combustion technology in addition to the fuel type (US Environmental Protection Agency 2008). The LGO Protocol v1.1 (California Air Resources Board, California Climate Action Registry et al. 2010) includes only some emission factors for N_2O dating as far back as the 1965 vehicle model year (used in EMFAC) for gasoline powered vehicles. The missing data are estimated using the EPA Climate Leaders GHG Inventory Protocol (US Environmental Protection Agency 2008), and then EMFAC 2007 User Guide v2.30 (California Air Resources Board n.d.) using equation 5 below.

$$EF = \sum_i (\%TCT * \mathrm{EF_{TCT}}) \qquad [5]$$

where:

[29] See the "calc.OnRoad_CO2&N2O" tab of the Transportation excel file for more details.
[30] We show input values and N_2O emissions estimates for all vehicle type and model year combinations in the "raw&calc.OnRoad_EMFAC2011" tab in the Transportation excel file. See the "calc.OnRoad_CO2&N2O" tab of the Transportation excel file for a summary of N_2O emissions estimates. The "calc.OnRoad_N2O_EF" tab summarizes the N_2O emissions factors used, as we explain in more detail below.

Term	Description	Value[31]	Units
EF	emission factor	Calculated Values	g/mile
EF_{TCT}	emission factor for type of control technology	Input Values	g/mile
TCT	type of control technology	Input Values	%
i	technology type	Vehicle technology type by vehicle type, fuel type, and model year	

Example: Passenger Vehicle, Year 1980, N_2O: Type of Control Technology: 20% Non-catalyst, 80% Oxidation

$$N_2O\ EF = 0.2 * 0.0218 + 0.8 * 0.0639 = 0.05548$$

The data sources used to generate all on-road N_2O emission factors used in this inventory are shown in Table 12.

Table 12: Emissions factor data sources for gasoline and diesel operated on-road mobile sources[32]

Vehicle Type	LGO Protocol v1.1 Table G.12	EPA Climate Leaders GHG Inventory Protocol Tables A-1 through A-4	EMFAC 2007 User Guide v2.30 Table A-1 with EPA Climate Leaders Protocol Table A-1
Passenger Vehicles	Gas: 1984-2005 Diesel: 1965-2005	Gas: 1973-1983	Gas: 1965-1972
Light Duty Trucks	Gas: 1987-2005 Diesel: 1965-2005	Gas: 1973-1987	Gas: 1965-1972
Motorcycles	-	Gas: 1965-2005	-
Heavy Duty Trucks	Gas: 1985-2005 Diesel: 1965-2005	Gas: 1965-1985	-
Non-Transit Buses[33]	[No data available: assumed same as for heavy duty trucks]		

EMFAC 2011 outputs do not include Yolo County CH_4 emissions directly, although EMFAC 2007 outputs do include CH_4 emissions. However, EMFAC 2007 CH_4 emission estimates are aggregated across vehicle types that are both included and excluded from this section of the analysis or excluded from the inventory outright. At the same time VMT and fuel consumption estimates differ between EMFAC 2007 and 2011 reflecting a number of model updates that were implemented in the 2011 model version.

To estimate CH_4 emissions for the non-transit on-road sources included in this inventory, we first scale CH_4 emissions provided by EMFAC 2007 (converted to MT) using the ratio of fuel consumption estimates from EMFAC 2011 and EMFAC 2007 as shown in equation 6 (for each of 10 vehicle category and fuel use combinations) in order to reflect the updated 2011 model. Next we use the fuel consumption ratio between the entire fleet modeled by EMFAC and just the inventoried fleet (which excludes public and

[31] We show input values and calculations in the tabs entitled "raw.OnRoad_N2OEmissionsFactors" and "calc.OnRoad_ControlTechnology" in the Transportation excel file.
[32] All emission factors used are summarized in "calc.OnRoad_EmissionsFactors" in the Transportation excel file.
[33] Vehicles analyzed as non-transit buses include school buses, motor coaches, and motor homes.

drayage use vehicles altogether and transit buses from this section of the analysis) to arrive at the final CH_4 emissions estimate for the inventoried fleet of non-transit on-road vehicles (as shown in equation 7), again for each vehicle category and fuel type combination.

$$\frac{FC_{EMFAC2011}}{FC_{EMFAC2007}} * E_{CH_4,EMFAC\ 2007} = E_{CH_4,EMFAC\ 2011} \quad [6]$$

$$\frac{FC_{EMFAC2011}'}{FC_{EMFAC2011}} * E_{CH_4,EMFAC\ 2011} = E_{CH_4,EMFAC\ 2011}' \quad [7]$$

where:

Term	Description	Value[34]	Units
$FC_{EMFAC2011}$	Fuel consumption estimate from EMFAC 2011 INCLUDING public fleet, transit buses, drayage vehicles	Input Values	1000 gallons
$FC_{EMFAC2007}$	Fuel consumption estimate from EMFAC 2007 INCLUDING public fleet, transit buses, drayage vehicles	Input Values	1000 gallons
$E_{CH_4,EMFAC\ 2007}$	CH_4 emissions estimate from EMFAC 2007 INCLUDING public fleet, transit buses, drayage vehicles, converted to MT	Input Values	MT/day
$E_{CH_4,EMFAC\ 2011}$	CH_4 emissions estimate adjusted to EMFAC 2011 INCLUDING public fleet, transit buses, drayage vehicles	Input Values	MT/day
$FC_{EMFAC2011}'$	Fuel Consumption estimate from EMFAC 2011 EXCLUDING public fleet, transit buses, drayage vehicles	Input Values	1000 gallons
$E_{CH_4,EMFAC\ 2011}$	CH_4 emissions estimate adjusted to EMFAC 2011 EXCLUDING public fleet, transit buses, drayage vehicles [This value is used in the inventory.]	Calculated Values	MT/day

We apply this procedure for each vehicle category and fuel type and sum the results, yielding an estimate of 0.35 $MTCH_4$/day for included vehicle types in Yolo County in 2005, or 126 $MTCH_4$/year.

Finally, we apply the city to county VMT $\left(\frac{105{,}516}{3{,}287{,}759} = 0.0321\right)$ scaling factor to each gas to estimate the emissions at the city level using the data from Table 11.

Emissions from transit buses

GHG emissions from transit buses only include emissions from operations of Yolobus within the city limits. We estimate these emissions using equations 8, 9, and 10 for travel along all routes active in 2005.

$$E_{CO_2} = \frac{FC\ *\ EF_{CO_2}}{C_1} \quad [8]$$

[34] See "calc.OnRoad_CH4" tab in the Transportation excel file for input values and calculated values by vehicle and fuel type. Note that as a check for a major methodological error, we conduct a similar analysis using VMT instead of fuel consumption to scale EMFAC 2007 results, finding that results differ by less than 5%.

$$E_{N_2O} = \frac{VMT \ * \ EF_{N_2O}}{C_2} \quad [9]$$

$$E_{CH_4} = \frac{VMT \ * \ EF_{CH_4}}{C_2} \quad [10]$$

where:

Term	Description	Value	Units
EF_{CO_2}	CO_2 emission factor	0.054[35]	kg/cubic foot
EF_{N_2O}	N_2O emission factor	0.175[35]	g/mile
EF_{CH_4}	CH_4 emission factor	1.966[35]	g/mile
E_{CO_2}	CO_2 emissions	359[36]	metric ton/year
E_{N_2O}	N_2O emissions	0.04[36]	metric ton/year
E_{CH_4}	CH_4 emissions	383[36]	metric ton/year
FC	annual fuel (CNG) consumption	6,640,722[37]	cubic feet/ therms
VMT	vehicle miles traveled	256,433[37]	miles/year
C_1	Unit conversion factor	10^3	kg/metric ton
C_2	Unit conversion factor	10^6	g/metric ton

Emissions from off-road mobile sources (excluding airport aircraft, airport ground support, and rail use)

We obtain 2005 Yolo County off-road data from CARB's Off-Road engine database (TIAX LLC 2006). We exclude off-road emissions from the "pleasure craft" equipment category because this category includes emissions from watercraft and there is no large recreational water body[38] within the city limits of City of Winters. We also exclude airport ground support equipment, dredging, logging equipment, military tactical support equipment, oil drilling, and rail yard operations using similar reasoning. We exclude "other portable equipment" because its emissions are zero. We combine construction and mining equipment, industrial equipment, light construction equipment, and transport refrigeration units into a category called "Construction and Other Commercial Equipment". We combine and categorize recreational and entertainment equipment as "Recreational Equipment". Table 13 shows all the categories provided by CARB with notes on whether or how they are included in the analysis.

Since the raw data includes tons per day of CO_2, N_2O, and CH_4, we need only to sum emissions by category and convert tons to metric tonnes to estimate Yolo County off-road GHG emissions. Overall we estimate the total included off-road emissions for Yolo County[39] as 395, 0.018, and 0.19 MT/day of CO_2, N_2O, and CH_4 respectively, or 144,255, 6.5, and 68 MT/year of CO_2, N_2O, and CH_4 respectively.

[35] Tables G.11 and G.13 of California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability and The Climate Registry (2010). Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.1.
[36] See the "calc.Transit" tab in the Transportation excel file for calculations and route-specific values.
[37] See Table 5.
[38] Putah Creek has a swimming area but we assume that watercraft are not used there.
[39] See the "calc.Offroad" tab in the Transportation excel file for details by off-road equipment category.

To scale Yolo County non-agricultural equipment emissions to the City of Winters, we use a ratio of the City of Winters area to the sum of the areas of Woodland, Davis, Winters, and West Sacramento $\left(\frac{2.8}{48} = 0.0593\right)$. For agricultural equipment, we use the ratio of city to county agricultural land $\left(\frac{757}{451{,}048} = 0.00168\right)$ to scale emissions to the City level. Table 10 documents the scaling factors.

Table 13: Inclusion of off-road mobile source categories provided by CARB

Equipment	Included in this inventory as...
Agricultural Equipment	Agricultural Equipment
Construction and Mining Equipment	Construction and Other Commercial Equipment
Industrial Equipment	
Light Commercial Equipment	
Transport Refrigeration Units	
Entertainment Equipment	Recreational Equipment
Recreational Equipment	
Lawn and Garden Equipment	Lawn and Garden Equipment
Other Portable Equipment	Not included because emissions are zero
Airport Ground Support Equipment	Not included in the City off-road analysis because no such activity occurs within the city limits. However it is used in the analysis of off-site emissions from air travel from the Sacramento airport (below)
Dredging	Not included because no such activity reported or likely within the city limits (no railyard, no large water body, etc)
Logging Equipment	
Military Tactical Support Equip	
Pleasure Craft	
Oil Drilling	
Railyard Operations	

Emissions from aircraft use

We assume that the only emissions from residents' aircraft use occur at Sacramento International Airport. We calculate 2005 GHG emissions from aircraft use using the annual fuel consumption data provided by Allied Aviation, fuel provider at Sacramento International Airport, in Table 7, the trip ratio in

Table 8, and emission factors provided by the LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010). Since air travel occurs outside the city boundaries, we treat emissions from aircraft use as scope 3 indirect emissions.

We use Winters' share of all modeled trips to the Sacramento International Airport (SMF) from all travel activity zones (TAZs) within the Sacramento Area Council of Government (SACOG) region, or the trip ratio, to determine the City's share of emissions resulting from aircraft use at Sacramento SMF in accordance with equations 11, 12, and 13.

$$E_{CO_{2i}} = \frac{FC_i * EF_{CO_{2i}}}{a} * TR \quad [11]$$

$$E_{N_2O_i} = \frac{FC_i * EF_{N_2O_i}}{b} * TR \quad [12]$$

$$E_{CH_{4i}} = \frac{FC_i * EF_{CH_{4i}}}{b} * TR \quad [13]$$

where:

Term	Description	Value[40]		Units
		aviation gasoline	jet fuel	
EF_{CO_2} [41]	CO_2 emission factor	8.31	9.57	kg/ gallon
EF_{N_2O} [41]	N_2O emission factor	0.11	0.31	g/gallon
EF_{CH_4} [41]	CH_4 emission factor	7.04	0.27	g/gallon
E_{CO_2}	Winters air travel CO_2 emissions	0.2	1,780	MT/year
E_{N_2O}	Winters air travel N_2O emissions	0.000002	0.06	MT/year
E_{CH_4}	Winters air travel CH_4 emissions	0.0001	0.05	MT/year
FC[42]	2005 fuel consumption at Sacramento International Airport	14,877	136,244,833	gallons/year
i	fuel type	aviation gasoline, jet fuel		
TR[43]	Trip ratio: trips from City of Winters to SMF divided by trips from all the TAZs within the SACOG region to SMF	0.14		%
a	Unit conversion factor	10^3		kg/MT
b	Unit conversion factor	10^6		g/MT

Emissions from airport ground support equipment

We obtain 2005 airport ground equipment data for Sacramento County from CARB's 2005 Off-Road engine database (TIAX LLC 2006). We assume that Sacramento International Airport (SMF) is the only source of airport ground support emissions in Sacramento County. Since the raw data includes tons per day of CO_2, N_2O, and CH_4, we need only to sum Sacramento County emissions by the airport ground equipment category and convert tons to metric tonnes (MT) to estimate airport ground support emissions for SMF. As with our estimates of emissions from aircraft use, we assume that SMF is the only airport used by Winters residents and allocate their share accordingly. We compute the emissions estimate in accordance with equations 14, 15, and 16. Since the airport is located outside the city boundaries, we treat emissions from airport ground support equipment as scope 3 indirect emissions.

$$E_{CO_2}' = E_{CO_2} * TR \quad [14]$$

[40] The tab "calc.Aircraft" in the Transportation excel file has input values and calculations.

[41] California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability and The Climate Registry (2010). Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.1.

[42] See Table 7

[43] See Table 8

$$E_{N_2O}{}' = E_{N_2O} * TR \quad [15]$$
$$E_{CH_4}{}' = E_{CH_4} * TR \quad [16]$$

where:

Term	Description	Value[44]	Units
E_{CO_2}	CO_2 emissions from SMF airport ground support equipment	12,137	MT /year
E_{N_2O}	N_2O emissions from SMF airport ground support equipment	1.4	MT /year
E_{CH_4}[45]	CH_4 emissions from SMF airport ground support equipment	2.9	MT / year
$E_{CO_2}{}'$	City of Winters' share of CO_2 emissions from SMF airport ground support equipment	17	MT / year
$E_{N_2O}{}'$	City of Winters' share of N_2O emissions from SMF airport ground support equipment	0.002	MT/ year
$E_{CH_4}{}'$	City of Winters' share of CH_4 emissions from SMF airport ground support equipment	0.004	MT/ year
TR[45]	Trip ratio: trips from City of Winters to SMF divided by trips from all the TAZs within the SACOG region to SMF	0.14	%

Well to Pump Emissions

Well to pump (W2P) emissions include emissions resulting from the fuel refinement process (in contrast to pump to wheel, or P2W, emissions estimated earlier). The Greenhouse Gases Regulated Emissions, and Energy Use in Transportation (GREET) model maintained by the US Department of Energy provides well to pump emissions for a number of fuel types. The model suggests 0.27 and 0.21 W2P/P2W ratios for gasoline and diesel, respectively (Ramaswami, Janson et al. 2007). In our analysis on-road (non-transit) emissions data from EMFAC 2011 are easy to disaggregate by gasoline and diesel use (which is not the case for other sources) and these emissions make up a large portion of the inventory. Therefore we include on-road non-transit sources in our W2P estimates. We calculate well to pump emissions by multiplying the corresponding W2P/P2W ratio by the on-road CO_2, N_2O, and CH_4 emissions data by fuel type.

Results

We convert all emissions estimates to $MTCO_2e$ in accordance with equation 3 given in the Residential and Commercial energy section. Table 14 and Figure 2 show the tabulated GHG emissions from transportation sources for the baseline year 2005.

We estimate that the total indirect and direct GHG emissions from transportation sources in the City of Winters in 2005 equals 56,487 $MTCO_2e$. Of those, 78% (44,282 $mtCO_2e$) are scope 1 emissions, or direct emissions occurring within the geographical boundaries of City of Winters. On-road mobile sources constitute the majority of the direct as well as indirect emissions: 92% of the direct (scope 1), and 85% of the indirect (scope 3) emissions result from on-road mobile sources. We check for egregious errors in the transportation GHG inventory in the Comparative Analysis section that follows.

[44] The "calc.AirportSupportEquip" tab of the Transportation excel file has input and calculated values.
[45] See
Table 8

Table 14: Baseline year 2005 transportation GHG emissions by source, gas, and scope

	Emissions			
	$MTCO_2$	**MTN_2O**	**$MTCH_4$**	**$MTCO_2e$**[46]
On-Road (Pump to Wheel)				
Passenger Vehicles	12,072	0.90	1.59	12,385
Light-duty Trucks	15,476	1.12	1.70	15,858
Motorcycles	59	0.00	0.16	64
Heavy-duty Trucks	11,889	0.28	0.59	11,989
Non-Transit Buses	224	0.01	0.00	227
Transit Buses	8	0.00	0.01	9
Off-Road (Pump to Wheel)				
Agricultural Equipment	145	0.00	0.03	146
Construction and Other Commercial Equipment	3,187	0.11	1.04	3,243
Lawn and Garden Equipment	161	0.12	0.29	206
Recreational Equipment	93	0.09	1.68	156
Total Scope 1 (Direct) Emissions	**43,316**	**3**	**7**	**44,282**
On-Road (Well to Pump)				
On-road well to pump (except transit)	1,780	0.06	0.05	1,799
Off-Road (Pump to Wheel)	17	0.00	0.00	17
Aircraft Use				
Airport Ground Support Equipment	10,172	0.62	1.08	10,388
Total Scope 3 (Indirect) Emissions	**11,969**	**0.68**	**1.14**	**12,205**

[46] We compute results using equation 3. The "summary.Emissions" tab sheet in the Transportation excel file shows compiled results.

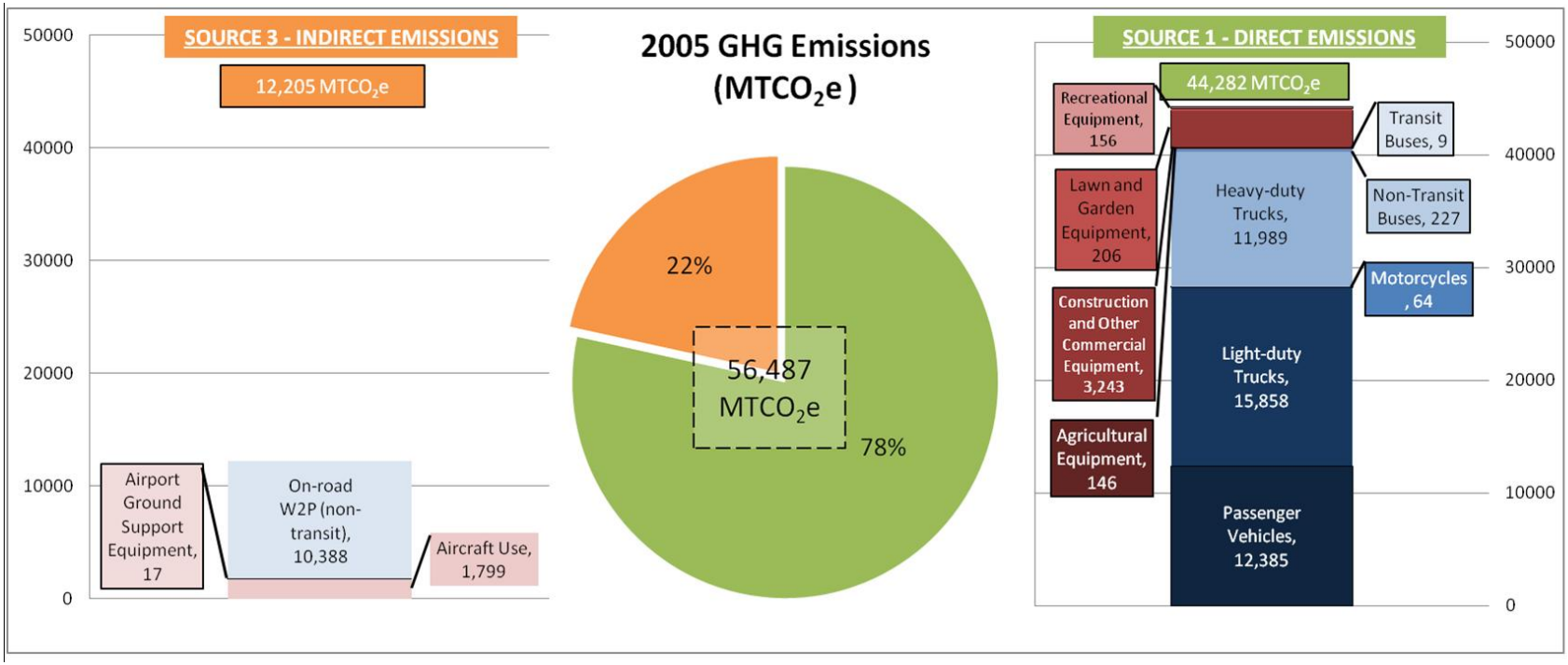

Figure 2: Baseline year 2005 transportation GHG emissions by source and scope.

Comparative Analysis

We use four documents to qualitatively assess the magnitude of the results obtained. We expect estimates to be of a similar magnitude (but not necessarily identical values) when we compare them using appropriate performance measures (e.g. per capita emissions for emissions sources that are closely tied to population levels). Where estimates dramatically differ they may require more scrutiny to better understand whether the difference can be explained by differences in emissions generating activities, different estimation methods, or an estimation error.

To compare on-road emissions estimates, we use per capita estimates from the Statewide Greenhouse Gas Emissions Inventory prepared by California Air Resources Board and City of Piedmont's Greenhouse Gas Inventory (ICLEI's Cities for Climate Protection Campaign and City of Piedmont 2006). CARB relies on fuel sales in California and the VMT data from the EMFAC model to compute GHG emissions by on-road vehicles (California Air Resources Board 2009). We select the City of Piedmont for comparison because it is roughly the same size as the City of Winters. Since we use the techniques outlined by the City of Denver in their GHG inventory to calculate emissions from aircraft use, airport ground support equipment, and well to pump activities, we compare our emissions estimates for those sources with the per capita estimates provided by the City of Denver. We also compare emissions from aircraft use and airport ground support equipment with the statewide per capita average. Lastly, we compare the emissions from use of agricultural equipment at the University of California, Davis to our per acre emissions estimates for the City of Winters. Table 15 shows the GHG emissions, population, and agricultural acreage for each region compared. Table 16 shows the per capita and per acre emissions estimates.

The on-road per capita estimates for the City of Winters are above the statewide average and the City of Piedmont's estimates and below the City of Denver's estimates. For aircraft operations, the per capita emissions estimate for the City of Winters is lower than both the state and Denver estimates, and it is much closer to the statewide value than the City of Denver value. Per capita emissions from airport ground support equipment is higher for the State of California and City of Denver than the City of Winters. Well to pump emissions are lower for the City of Winters than for the City of Denver on a per capita basis. Lastly, agricultural equipment emissions per acre from the City of Winters are higher than those of the University of California, Davis.

Although it can be difficult to draw meaningful comparisons between a city and the state or another city (e.g., due to methodological differences and differences in the calculation of actual emissions), the results provided subsequent tables fall within the same order of magnitude for each emissions source.

Table 15: 2005 GHG emissions for various entities

		City of Winters	City of Piedmont[47]	State of California[48]	City of Denver[49]	University of California, Davis
2005 Population[50]		6,753	10,690	35,869,173	570,578	-
Agricultural Land (acres)[51]		757	-	-	-	3,743
GHG Emissions (mtCO2e/ year)	**On-Road**	40,531	26,827	170,820,000	4,345,000	-
	Aircraft Operations	1,799	-	32,991,649	1,011,273	-
	Airport Ground Support	17		321,282	3,091	
	Well to Pump	10,388	-	-	1,100,000	-
	Agricultural Equipment	146	-	-	-	-

[47] Source of emissions estimates: http://www.ci.piedmont.ca.us/publicworks/CAP/2005_inventory.pdf
[48] Source of emissions estimates: California Air Resources Board. (2010). "California Greenhouse Gas Inventory for 2000-2008 — by Category as Defined in the Scoping Plan." from http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_00-08_2010-05-12.pdf.
[49] Source of emissions estimates: Ramaswami, A., B. Janson, T. Hillman, J. Wendrowski, M. Reiner and M. Posner (2007). Greenhouse gas inventory for the City & County of Denver: Prepared for Mayor John Hickenlooper's Greenprint Denver Initiative.
[50] We obtain California 2005 population estimates from the California Department of Finance [California Department of Finance (2011). E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts.] City of Denver population estimate is based on the US Census Population Estimates program (2009 estimate of 2005 population), which has not yet been calibrated to the 2010 Census.
[51] For City of Winters, see Table 11. For UC Davis, agricultural area obtained from Rowan, D., M. Eldridge, D. Niemeier (2011) Incorporating Regional Growth into Forecasts of Greenhouse Gas Emissions From Project-Level Residential and Commercial Development: Supplementary Material, Working Paper (10/27/2011)

Table 16: 2005 GHG Emissions per capita or per acre for various entities

		City of Winters	City of Piedmont	State of California	City of Denver	University of California, Davis[52]
GHG emissions per capita (mtCO2e/ year/ capita)[53]	**On-Road**	6.0	2.5	4.8	7.6	-
	Aircraft Operations	0.27	-	0.92	1.8	-
	Airport Ground Support	0.0026		0.0090	0.0054	
	Well to Pump	1.5	-	-	1.9	-
GHG emissions per acre (mtCO2e/ year/acre)[54]	**Agricultural Equipment**	0.19	-	-	-	0.13

[52] Source of per acre emissions estimate: Rowan, D., M. Eldridge, D. Niemeier (2011) Incorporating Regional Growth into Forecasts of Greenhouse Gas Emissions From Project-Level Residential and Commercial Development: Supplementary Material, Working Paper (10/27/2011)

[53] We estimate per capita GHG estimates by dividing emissions and corresponding 2005 population estimates, both from Table 15.

[54] We estimate per acre GHG estimates by dividing emissions and corresponding 2005 acreage estimates, both from Table 15.

Municipal Operations Inventory

The Winters municipal inventory captures emissions from municipal operations, including emissions from electricity and natural gas use, from the vehicles that are registered to the city, from stationary sources that use fuel, and from emissions associated with wastewater treatment (WWT) and potable water supply (PWS), both managed by the City.

The municipal inventory includes emissions from vehicle and natural gas use as well as wastewater treatment process emissions in scope 1 (direct emissions). The municipal inventory includes emissions from electricity purchased in scope 2 (indirect emissions).

Municipal Energy Use Emissions (excluding water and water treatment)

In this section we estimate emission from energy used by municipal mobile and stationary sources. We exclude energy used for wastewater treatment operations and operations that pump or convey freshwater or wastewater from this section, as we include them in the next section.

Data Sources

Carol Scianna, Environmental Services Manager for the City of Winters, provided municipal vehicle fuel data. PG&E provided municipal electricity and natural gas use data (pers. comm. from John Joseph 2011).

Electricity and Natural Gas

The electricity and natural gas use data span the years 2003-2010. The data summarizes billing information for each municipal meter totaled for each year. The data provides kilowatt-hours, months billed[55], revenue, rate schedule, natural gas therms, CO_2 emissions factors, CO_2 emissions, and several billing account details. We categorize each meter as “water”, “wastewater”, “other”, or “wastewater generation” based on the 'business activity', 'premise type', and ‘service address’ listed in the raw PG&E data and from information provided by the City of Winters and PG&E[56]. In this section of the inventory we analyze only meters categorized as “other”.

The “other” data includes streetlights, public park facilities, vehicle charging stations, and municipal buildings that are owned and operated by the city of Winters, including City Hall, the library, and the Community Center. The rate schedule for each category of use varies slightly.

[55] Although it is tempting to normalize the number of months billed to 12 months, in several cases there are multiple bills for short periods of time that appear to be for the same service (although the exact address, business activity, account ID, and service agreement number may differ.) We suspect that in many cases the billing details switched during the course of the year. We have simply used energy use reported as totals rather than normalizing use to a 12 month billing period because although there are likely to be small errors imposed by this assumption (e.g. for bills that apply to an 11.8 month period), the error that would be introduced by aggregating bills for identical services in order to normalize all bills to a 12 month period are likely to be greater (e.g. identifying bills for 1, 3, 4, and 4 months for identical services based on billing details that are similar but not identical).

[56] Jillian Rich (PG&E) provided information about solar electricity generation at the Wastewater Treatment Plant in consultation with Lorie Rodgers (City of Winters).pers. comm. from Jillian Rich of PG&E (2012). Email titled: Woodland/Winters CAP Meeting Follow-Up.

Table 17 shows the electricity and natural gas usage from 2003 to 2010 for all municipal operations, as indicated by PG&E records. The amount of energy used in 2005 is comparable to usage in other years reported.

Table 17 Yearly Winters Municipal Electricity and Natural Gas Use[57]

	Electricity		Natural Gas	
Year	Use (kWh)	Emissions Factor (lb CO_2/kWh)	Use (therms)	Emissions Factor (lb CO_2/therm)
2003	397,642	0.620	3,357	11.7
2004	394,284	0.566	3,886	11.7
2005	**386,008**	**0.489**	**3,394**	**11.7**
2006	394,809	0.456	3,530	11.7
2007	401,131	0.6357	3,213	11.7
2008	390,435	0.641	3,387	11.7
2009	401,748	0.575	3,625	11.7
2010	396,044	0.559	3,114	11.7

Vehicles

We use 2005 mobile and stationary vehicle fueling data supplied by Carol Scianna of the City of Winters for the baseline. The data includes public works vehicles, police department vehicles, and all mobile and stationary diesel vehicles. The data is based on beginning and end meter logs from communal fuel tanks. Vehicle-specific mileage or fuel use data are not available.

Table 18 shows the total vehicle fuel usage in the year 2005 by fuel type. The raw data[58] includes fuel use breakdown by public works vehicles, police department vehicles, and municipal mobile and stationary diesel vehicles. Emissions from non-City vehicles are not included.

Table 18: 2005 Municipal vehicle fuel use and mileage[59]

	Unleaded Gasoline	Diesel
Fuel use (gal)	11,394	1,149

Methods

Electricity and Natural Gas

We convert 2005 electricity and natural gas data from municipal buildings and services to GHG emissions using equations 17 and 18 respectively. We use PG&E emissions factors for CO_2 emissions estimates and LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010) emissions factors for N_2O and CH_4 estimates, for which no PG&E value was provided. CO_2 emissions factors from the LGO Protocol are identical to values in PG&E documents.

[57] As shown in the "Summary.HistoricalEnergyUse" tab of the AppendixIA1_2005Inventory_MunicipalEnergy_WN.xlsx excel file (hereafter referred to as the Municipal energy excel file.)
[58] As shown in the "raw.VehicleData" tab of the Municipal energy excel file.
[59] Calculated from data provided by Carol Scianna of the City of Winters.

$$E_{E\,i} = U_{E\,i} \cdot EF_{E\,i} \cdot C \quad [17]$$

where:

Term	Description	Value[60]	Units
$E_{E\,i}$	Emissions from electricity use	Calculated Value	MT gas
$U_{E\,i}$	Electricity usage	386,008[61]	kWh
$EF_{E\,i}$	Electricity emission factor	0.489[61]	lb gas/kWh
C	Unit conversion factor	1/2204.6[62]	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

$$E_{NG\,i} = U_{NG\,i} \cdot EF_{NG\,i} \cdot C \quad [18]$$

where:

Term	Description	Value[60]	Units
$E_{NG\,i}$	Emissions from natural gas use	Calculated Value	MT gas
$U_{NG\,i}$	Natural gas usage	3,394[61]	therm
$EF_{NG\,i}$	Natural gas emission factor	11.7[61]	lb gas/therm
C	Unit conversion factor	1/2204.6[62]	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

Vehicles

We estimate 2005 CO_2 emissions from the municipal vehicle fleet using fuel-based emissions factors from the LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010) as shown in equations 19 and 20.

$$E_D = U_D * EF_D \quad [19]$$

where:

Term	Description	Value	Units
E_D	CO_2 emissions from diesel vehicles	Calculated Value[63]	kg CO_2
U_D	Usage of diesel	1,149[64]	gal
EF_D	Diesel emission factor	10.21[65]	kg CO_2/gal

$$E_G = U_G * EF_G \quad [20]$$

where:

[60] The "calc.ElectricityNaturalGas" in the municipal energy excel file shows electricity and natural gas usage and emissions calculations.
[61] See Table 17
[62] PG&E raw data provided the unit conversion factor from MT to lbs.
[63] We estimate vehicle CO_2 in the tab entitled "calc.Vehicle" in the municipal energy excel file.
[64] See Table 18.
[65] From Appendix G in LGO Protocol: California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability and The Climate Registry (2010). Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.1.

Term	Description	Value	Units
E_G	CO_2 emissions from unleaded gas vehicles	Calculated Value[63]	kg CO_2
U_G	Usage of unleaded gas	11,394[64]	gal
EF_G	Unleaded gas emission factor	8.78[65]	kg CO_2/gal

We estimate 2005 vehicle CH_4 and N_2O emissions for diesel and gasoline vehicles of unknown categories as shown in equation 21. Note that we do not know each vehicle type or distances traveled. Therefore we rely on emissions factors that scale N_20 and CH_4 emissions from CO_2 emissions for unknown diesel or gasoline powered vehicles (based on generic data for passenger cars and light trucks) from the most recent draft General Reporting Protocol from the Climate Registry (The Climate Registry 2012).

$$E_{unk\ i} = E_{unk\ CO2} \cdot EF_i * C \qquad [21]$$

Where:

Term	Description	Value	Units
$E_{unk\ i}$	Emissions from travel by vehicles of unknown type	Calculated Value	g gas /year
$E_{unk\ CO2}$	CO_2 emissions of vehicles of unknown type	Input value[63]	$MTCO_2$
$EF_{Unk\ i}$	Emissions factor for travel by gasoline or diesel vehicles of unknown type	Input value	MT gas/ $MTCO_2$
i	Greenhouse gas	N_20 or CH_4	

Finally, we convert both N_20 and CH_4 emissions to $MTCO_2e$ in adherence with equation 3 given in the Residential and Commercial Energy section of this report.

Results

Table 19 shows the total emissions in metric tonnes of CO_2 equivalent ($MTCO_2e$) from municipal electricity, natural gas, unleaded fuel use, and diesel fuel use. As expected, CO_2 emissions comprise a large portion of this part of the inventory while N_20 and CH_4 comprise a much smaller share. Emissions from gasoline use contribute the most to the total municipal energy emissions, followed by emissions from electricity, natural gas, and diesel use.

Table 19: Emissions from municipal operations

	Use		Emissions ($MTCO_2e$)			
	value	units	CO_2	N_2O	CH_4	Total
Electricity	386,008	kWh	86	0.60	0.11	86
Natural Gas	3,394	therms	18	0.01	0.04	18
Total Electricity and Natural Gas			**104**	**0.61**	**0.15**	**104**
Gasoline	11,394	gallons	100	0.0070	0.0062	100
Diesel	1,149	gallons	12	0.0008	0.0007	12
Total Vehicle Fuel			**112**	**0.0078**	**0.0070**	**112**

Last, we note that some of the electricity emissions are from meters located outside of the Winters City limits. Although the municipal inventory includes all meters used by the City (so all of the usage and

emissions tallied above), it is worthwhile to note that 4.583%[66] of electricity is consumed outside the City of Winters, and so 4.583% of the electricity emissions listed above should be excluded from the community inventory.

Comparative Analysis

In order to identify egregious errors, we compare the emissions from Table 19 with Yolo County's 2006 municipal facilities emissions (Lutsey, Jungers et al. 2008). The population of Winters in 2005 was 6,753 (California Department of Finance 2011). Yolo County, with a population of 189,078 in 2006 (California Department of Finance 2011), had 28 times the population of Winters. The overall facilities emissions of Yolo County were 5,960 $MTCO_2e$ in the year 2006, which is 57.1 times the emissions as Winters. We expect some difference in these proportions based on differences in the government services and facilities and the different dates used for the emissions estimates.

We can similarly compare vehicle emissions to the population ratio. Yolo County's emissions from mobile sources in 2006 were 2,027 $MTCO_2e$, 18.1 times the 2005 emissions for Winters. Once again we expect some difference in these proportions based on differences in the government services and the different dates used for the emissions estimates.

Municipal Water and Wastewater Emissions

In this section we describe the estimation of emissions from both wastewater treatment (WWT) and from potable water supply and stormwater pumping (PWS). We include emissions from electricity use as scope 2. We include N_2O process emissions from wastewater treatment and from nitrogen discharged in wastewater effluent as scope 1 because they are emitted directly from a biogenic source.

Data Sources

Electricity and Natural Gas Data

We use municipal electricity and natural gas use data and CO_2 emission factors for the years 2003 to 2010 from Pacific Gas and Electric (PG&E) (pers. comm. from John Joseph 2011). PG&E data breaks electricity and natural gas use down into line items by meter, which include address, premise type, business activity, electricity and natural gas used, emissions factors, emissions, costs, and months billed[67]. We categorize each meter as "water", "wastewater", or "other" for bills that indicate energy consumption, and "wastewater generation" for a bill that indicates energy generation. We assign categories based on the business activity, service address, the premise type, and information provided

[66] This calculation is shown in the "calc.ElectricityNaturalGas" tab in the municipal energy excel file. We determine the location of the meter based on the PG&E data field "(TOT) CITY NAME".

[67] Although it is tempting to normalize the number of months billed to 12 months, in several cases there are multiple bills for short periods of time that appear to be for the same service (although the exact address, business activity, account ID, and service agreement number may differ.) We suspect that in many cases the billing details switched during the course of the year. We have simply used energy use reported as totals rather than normalizing use to a 12 month billing period because although there are likely to be small errors imposed by this assumption (e.g. for bills that apply to an 11.8 month period), the error that would be introduced by aggregating bills for identical services in order to normalize all bills to a 12 month period are likely to be greater (e.g. identifying bills for 1, 3, 4, and 4 months for identical services based on billing details that are similar but not identical).

by the City of Winters and PG&E[68]. In this section of the inventory we analyze only meters categorized as "water" (PWS), "wastewater" (WWT), and "wastewater generation" (WWT).

PWS Data

The PWS inventory includes emissions associated with city irrigation and storm water pumping operations, as well as emissions from the procurement of drinking water (see Figure 3). One hundred percent of the city's potable water supply comes from ground water pumping[69]. Currently, five operational city groundwater well sites pump approximately 530 million gallons of water annually. Water is pumped on demand with no on-site storage.

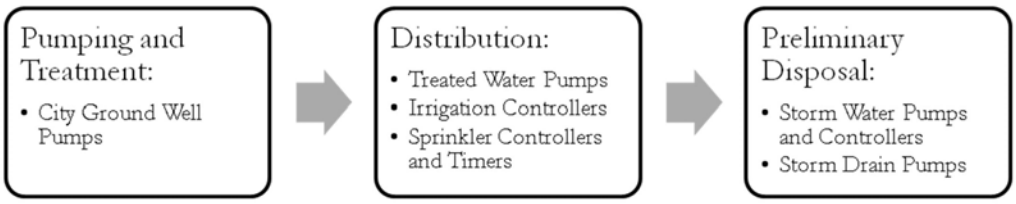

Figure 3: PG&E energy items included in PWS calculations. We include all other PG&E energy items that may be indirectly associated with PWS in municipal electricity and natural gas emissions estimates.

WWT Data

The WWT inventory includes emissions associated with the operation of the sewage lift stations, sewage pumps, and wastewater treatment facility (WWTF) (see Figure 4). The City of Winters WWTF is municipally owned and located within the city limits. However the plant is privately operated via contract with South West Water. The plan treats wastewater from the City's residential, commercial, and industrial customers. The facility consists of a secondary treatment system that treats approximately 204 million gallons per year. Effluent treated at the plant is discharged by land application to a city-owned field. A photovoltaic solar array was recently installed at the WWTF. The array currently provides 100% of the electricity needed at the WWTF. The City has a Power Purchase Agreement with MP2 Capital, who owns the array[70].

Figure 4: PG&E energy items included in WWT calculations. We include all other PG&E energy items that may be indirectly associated with WWT in municipal emissions calculations.

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[68] Jillian Rich (PG&E) provided information about solar electricity generation at the Wastewater Treatment Plant in consultation with Lorie Rodgers (City of Winters).[pers. comm. from Jillian Rich of PG&E (2012). Email titled: Woodland/Winters CAP Meeting Follow-Up.]
[69] http://www.cityofwinters.org/pdf/2010WQR.pdf
[70] http://www.grosolar.com/case-studies/case-study-winters.html

Table 20 and Figure 5 provide the annual electricity use and generation data for PWS and WWT from 2003 – 2010. According to the PG&E data, there is no natural gas use for PWS and WWT from 2003 - 2010. Note that in 2010 in addition to returning energy to the grid, the new solar array likely also covered some of the year's energy demand on-site[71], leading to reduced electricity use from WWT in 2010.

Table 20: Electricity use and generation from PWS and WWT[72]

	Electricity			
	Use (kWh)		Solar generation: negative indicates energy returned to grid (kWh)	Emissions Factor
Year	**PWS**	**WWT**	**WWT**	**lb CO2/kWh**
2003	1,070,675	759,822	0	0.6200
2004	1,064,988	808,347	0	0.5660
2005	**941,156**	**832,304**	0	**0.4890**
2006	887,225	625,304	0	0.4560
2007	1,044,996	595,171	0	0.6357
2008	917,529	488,582	0	0.6410
2009	822,282	659,042	0	0.5750
2010	755,343	309,864	-184,320	0.5590

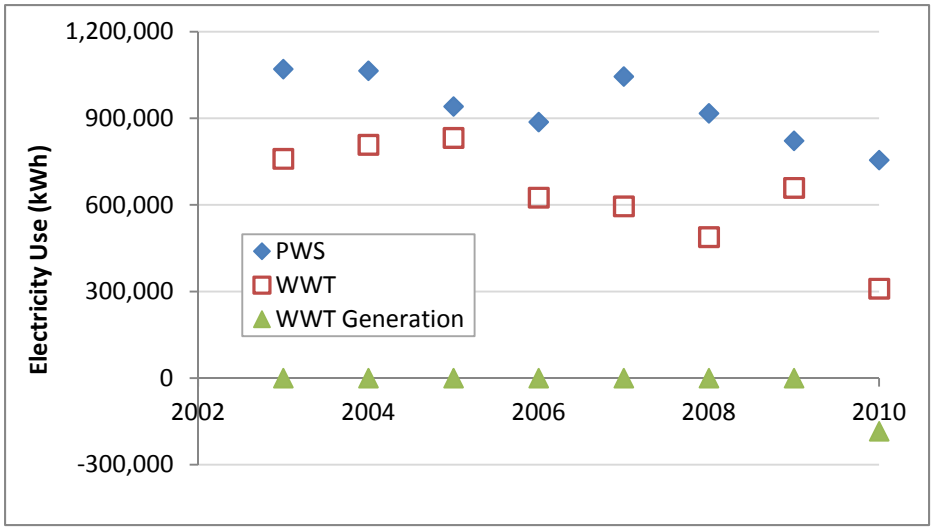

Figure 5: Annual electricity use and generation from PWS and WWT (2003 – 2010)

[71] Jillian Rich (PG&E) provided information about solar electricity generation at the Wastewater Treatment Plant in consultation with Lorie Rodgers (City of Winters).[pers. comm. from Jillian Rich of PG&E (2012). Email titled: Woodland/Winters CAP Meeting Follow-Up.]

[72]The "Summary.HistoricalEnergyUse" tab of the AppendixIA4_2005Inventory_WaterWastewater_WN.xlsx file (hereafter referred to as the Water/Wastewater excel file) has calculated totals for each year. The "raw.PG&E_Data" tab provides raw data.

Emissions Factors

To estimate the baseline emissions inventory, we use the electricity CO_2 emission factor provided by PG&E. We use LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010) emissions factors for N_2O and CH_4 estimates, for which we did not receive PG&E values.

Wastewater treatment also results in process emissions from treatment and from nitrogen in wastewater effluent. To determine N_2O process emissions from treatment and from effluent discharge, we use 2005 City population data from the California Department of Finance (California Department of Finance 2011).

Methods

PWS

2005 CO_2, N_2O, and CH_4 emissions from PWS are due to electricity use (there is no natural gas use associated with PWS). We estimate emissions of each gas from PWS using equation 22.

$$E_i = U \cdot EF_i \cdot C \qquad [22]$$

where:

Term	Description	Value	Units
E_i	GHG emitted from electricity use	Calculated Values[73]	MT gas
U	Yearly electricity use	941,156[74]	kWh
EF_i	Electricity Emissions Factor	Input Values[75]	lb gas/kWh
C	Conversion factor	1/2204.6	MT/lb
i	Greenhouse gas	CO_2, N_2O, CH_4	

We then convert all PWS emissions to $MTCO_2e$ in accordance with equation 3 given in the community inventory residential and commercial energy section of this report. Upon converting the electricity use to CO_2 emissions with equation 23 we compare our CO_2 estimates to the emissions reported in PG&E's raw data and find that they are identical.

WWT

In order to calculate the 2005 WWT emissions inventory for Winters, we first characterize the wastewater treatment plant (WWTP) based on our visit to the treatment plant and information provided by Carol Scianna of the City of Winters. Winters operates a secondary aerobic WWTP without nitrification or denitrification and without the use of lagoons and septic tanks. An aerobic plant is to one that depends on the use of bacteria to break down the organic matter in the water in the presence of oxygen. If sufficient oxygen is provided for the bacteria by aerating the basins during secondary treatment, the organic matter can break down without releasing significant quantities of CH_4. In order to

[73] The "calc.Electricity" tab shows calculations of emissions.
[74] See Table 20..
[75] See the tab entitled "calc.ElectricityEmissionsFactor" in the Water/Wastewater excel file.

provide enough oxygen, the Winters WWT ponds are aerated and maintained at a specified depth. The depth is maintained by spraying treated water on the City field that surrounds the plant.

Because the WWT plant is an aerobic facility without treatment lagoons or septic tanks, we assume that emissions of CH_4 are insignificant in accordance with the Local Government Operations Protocol (California Air Resources Board, California Climate Action Registry et al. 2010). Additionally, because the WWTF does not use nitrification/denitrification, we estimate process emissions from treatment using an equation specific to facilities without nitrification/denitifrication. Because the wastewater is sprayed onto City fields that are saturated (like wetlands), we can assume that the same types of bacteria that process nitrogen in an open water system also process nitrogen in the soil (Water Pollution Control 1990). This assumption allows us to use the equation for N_2O emissions from wastewater effluent discharge into aquatic environments. Because we do not have data on the nitrogen load of the effluent in 2005, we use a population-based estimate.

Based on the WWT characteristics of Winters, we estimate three types of emissions. We estimate emissions from electricity used for WWT as for PWS using equation 22 (with an electricity input value from Table 20). We also estimate process N_2O emissions from effluent discharge using equation 23[76]. Finally, we estimate N_2O process emissions that occur during treatment using equation 24[76].

$$E_{Eff} = P \cdot FIC \cdot [(N_{tot} - (N_{up} \cdot BOD_5)] \cdot EF_{Eff} \cdot C_1 \cdot (1 - F_N) \cdot C_2 \cdot C_3 \quad [23]$$

where:

Term	Description	Value	Units
E_{Eff}	Process N_2O emissions from wastewater effluent discharge into aquatic environments	0.52[77]	MTN_2O
P	Population served by WWTF	6,753[78]	people
FIC	Factor for industrial and commercial co-discharge waste into the sewer system	1.25	
N_{tot}	Total Nitrogen Load	0.026	(kg N/(person*day)
N_{up}	Nitrogen Uptake for Cell Growth in Aerobic System	0.05	kg N/kg BOD_5
BOD_5	Amount of BOD_5 produced per person per day	0.090	kg BOD_5/ (person*day)
EF_{Eff}	Effluent Emission factor	0.005	kg N2O-N/kg sewage-N produced
C_1	Unit conversion factor	44/28	mol N_20/mol N
F_N	Fraction of nitrogen removed for the centralized WWTP without nitrification/denitrification	0.0	Fraction N removed
C_2	Unit conversion factor	365.25	days/yr
C_3	Conversion from kg to metric tonne	10^{-3}	MT/kg

[76] In accordance with California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability and The Climate Registry (2010). Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.1.
[77] Calculations are shown in "calc.WWT_ProcessEmissions" tab of the Water/wastewater excel file.
[78] 2005 Winters population: California Department of Finance (2011). E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts.

$$E_{Treat} = P \cdot FIC \cdot EF_{Treat} \cdot C_5 \quad [24]$$

where:

Term	Description	Value	Units
E_{Treat}	Process N_2O treatment emissions from a WWTF without Nitrification/Denitrification	0.0270[77]	MTN_2O
P	Population served by WWTF	6,753[78]	people
FIC	Factor for industrial and commercial co-discharge waste into the sewer system	1.25	N/A
EF_{Treat}	Emission factor for a WWTP without Nitrification/Denitrification	3.2	g N_2O/person/year
C_5	Conversion factor	10^{-6}	MT/g

All WWT emissions are then converted to $MTCO_2e$ in accordance with equation 3 given in the community inventory residential and commercial energy section of this report.

Results

The total estimated PWS emissions generated in 2005 is 210 $MTCO_2e$. These emissions are solely due to electricity use. The total estimated WWT emissions generated in 2005 is 356 $MTCO_2e$. These emissions are from electricity usage, the N_2O from wastewater treatment and the N_2O created from discharge of treated effluent to the City's fields. Table 21 shows emissions estimates.

Table 21: Estimated 2005 emissions from PWS and WWT for the City of Winters.[79]

	Emissions ($MTCO_2e$)			
	CO_2	N_2O	CH_4	Total
Potable Water Supply (PWS)				
Electricity	209	1.5	0.3	210
Total PWS	**209**	**1.5**	**0.3**	**210**
Wastewater Treatment (WWT)				
Electricity	185	1.3	0.2	186
Process: treatment	0	8	0	8
Process: effluent	0	161	0	161
Total WWT	**185**	**171**	**0**	**356**
Total PWS and WWT	**393**	**173**	**1**	**566**

Last, we note that some of the electricity emissions are from meters located outside of the Winters City limits. Although the municipal inventory includes all meters used by the City (so all of the usage and emissions tallied above), it is worthwhile to note that 0% of PWS electricity and 1.908% of WWT electricity[80] is consumed outside the City of Winters, and so 0% of PWS and 1.908% of WWT of electricity emissions listed above should be excluded from the community inventory.

[79] The "Summary.Emissions" tab of the Water/wastewater excel file gives emissions estimates.
[80] This calculation is shown in the "calc.Electricity" tab in the municipal energy excel file. We determine the location of the meter based on the PG&E data field "(TOT) CITY NAME".

Comparative Analysis

We compare our estimates to those of other cities in order to identify potential egregious errors. While we expect to see some variation in the estimates between cities, a dramatic difference would indicate the need for further scrutiny.

Due to the information available in other cities' Energy Action Plans, we aggregate the emission values for PWS and WWT for these comparisons. We first compare the PWS and WWT emissions from the City of Winters to the City of Piedmont, which is of comparable size. Winters' emissions from PWS and WWT are 0.084 $MTC0_2e$/person while Piedmont's are 0.101 (see Table 22). The fairly small difference in total emissions between the two cities may be due to the more industrial nature of Piedmont.

Table 22: Comparison of City of Winters PWS and WWT emissions to the City of Piedmont

			PWS and WWT emissions	
	Year	Population[81]	MTCO2e	per capita
Winters	2005	6,753	566	0.051
Piedmont	2005	10,690	1,084[82]	0.043

Summary

The total emissions from all sectors for scopes 1, 2, and 3 are shown in Table 23.

Table 23: Summary of baseline inventory emissions

	Emissions ($MTCO_2e$)			
Emissions Source	**Scope 1**	**Scope 2**	**Scope 1/2 Total**	**Scope 3**
Community				
Electricity: Residential	0	3,855	3,855	0
Electricity: Commercial	0	2,739	2,739	0
Natural Gas-Residential	4,670	0	4,670	0
Natural Gas-Commercial	961	0	961	0
Transportation	44,282	0	44,282	12,205
Municipal				
Electricity	0	86	86	0
Natural Gas	18	0	18	0
Vehicle Use	112	0	112	0
PWS	210	0	210	0
WWT	356	0	356	0
Total	**50,609**	**6,680**	**57,291**	**12,205**

[81] Population estimates from California Department of Finance (2011). E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts.
[82] ICLEI's Cities for Climate Protection Campaign and City of Piedmont (2006). City of Piedmont Baseline Greenhouse Gas Emissions Inventory Report.

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Technical Appendix IB: BAU Forecast Calculations, 2020

Appendix IB:
2020 BAU Forecast Inventory Supporting Calculations

Prepared by:
Sustainable Design Academy at UC Davis

September 2012

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Abbreviations

ACS	American Community Survey (U.S. Census)
ARB	California Air Resources Board
BAU	Business as Usual
CEC	California Energy Commission
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOF	California Department of Finance
EMFAC	Emission Factors Model
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation
kWh	Kilowatt hour
lb	Pound
LGO Protocol	Local Government Operations Protocol
MT	Metric Tonnes
$MTCO_2$	Metric Tonnes CO_2
$MTCO_{2e}$	Metric Tonnes CO_{2e}
MWh	Megawatt Hour
N_2O	Nitrous Oxide
P2W	Pump to Wheel Emissions (tailpipe emissions)
PG&E	Pacific Gas and Electric Company
PWS	Potable Water Supply
RPS	California's Renewables Portfolio Standard

SACOG	Sacramento Area Council of Governments
SEEC	Statewide Energy Efficiency Collaborative
SGCS	Sacramento Area Council of Governments Total Number of Households Estimates with Census Person Per Household Data
VMT	Vehicle Miles Travelled
W2P	Well to Pump Emissions (fuel refining emissions)
WDOF	Weighted Population Growth Estimates Using County Department of Finance Data
WCS	Weighted Population Growth Estimates Using United States Census State Data
WWT	Wastewater Treatment
WWTP	Wastewater Treatment Plant

Introduction

This document extends the 2005 baseline emissions estimates from Appendix IA into the year 2020. Projected emissions are estimated and reported similarly to the baseline inventory; this report focuses on differences in data sources, assumptions, and calculation methods used to generate the projections. Projected emissions follow a 'business as usual' (BAU) trajectory. We provide additional details about calculations in the accompanying spreadsheets.

Community Inventory

Population

In projecting emissions to 2020, we assume that the emissions of most sectors will grow at a rate comparable to local population growth. Yearly total population estimates are also used to calculate per capita emissions. Since population and population growth estimates have a substantial impact on the estimated projections we have examined a number of different population estimates. To generate our projections we examined three different estimates of population:

1) Weighted Population Growth Estimates Using County Department of Finance Data (WDOF)

2) Weighted Population Growth Estimates using United States Census State Data (WCS)

3) Sacramento Area Council of Governments Total Number of Households Estimates with Census Person Per Household Data (SGCS)

The California Statewide Energy Efficiency Collaborative (SEEC) standard projection guidance uses county population growth estimates from the California Department of Finance (DOF). Since U.S. Census data indicate that the city of Davis accounts for a disproportionate percent of Yolo County's growth, we weighted these DOF estimates with United States Census city population data for our first population estimate, WDOF. As discussed in further detail in the 'population calculation methods' section below, we performed this weighting using a ratio of historical city-to-county growth.

For our second estimate, WCS, we used United States Decennial Census data and projections. However, yearly census city-level projections were not yet available for 2010 to 2020. Thus, for this estimate we used Census state-level projection data and weighted this estimate with census city population growth data. We again performed this weighting using a ratio of historical city-to-state growth rates.

For both of these estimates we assume that relative population growth rates between city, county, and states from 2000 to 2010 will remain the same for 2010 to 2020. In other words, we assume that the city population growth will make up the same percent of total state or county growth during the entire examined time span.

For our third estimate, SGCS, we used city-level 'total number of households' estimates from the Sacramento Area Council of Governments (SACOG). SACOG is an association of local governments that serves the general Sacramento area, including Winters. City officials use SACOG projections when population data is required for municipal business. Thus, at the city's request, the SGCS growth rate estimates were used from 2008-2020. To convert the SACOG household estimates into population estimates we used the 2010 United States Decennial Census DP-1 city average residents per household data, as reported by the U. S. Census American Fact Finder. For this estimate we assume that the city's average residents per household value is the same from 2005 to 2020.

Population Data Sources

Our baseline and projected yearly city population estimates for 2005 to 2010 were obtained from Department of Finance form E-4 population estimates. To obtain these E-4 estimates the DOF used original internal Demographic Research Unit estimates together with "Error of Closure" corrections that were performed to correct projected trends to align with actual 2010 decennial census population data.

Yolo County Population Estimates were obtained from the California DOF *Population Projections by Race/Ethnicity for California and Its Counties 2000-2050* for the years 2000, 2010, and 2020. Actual state, county, and city population data for the years 2000 and 2010 were obtained from the United States Decennial Census 2000 Summary File 1 (SF1) 100-Percent Data and Decennial Census 2010 Summary File 1 (SF1) respectively. Year 2020 state population estimates were obtained from United States Census Projections based on year 2010 census data.

SACOG total projected number of household estimates for the city for the years 2008 and 2020 were obtained from Appendix E of the SACOG Metropolitan Transportation Plan/Sustainable Communities Strategy report, which is a federally mandated long-range transportation plan. The city average person-per-household estimates were obtained from the U.S. Census Bureau's American Fact Finder DP-1 (from the 2010 Decennial Census) fact sheet for the city.

Methods

We use the same formulas for different calculations throughout this section. In order to avoid repeating formulas, when a formula is first given it is presented with generalized variables. Each calculation provides a specific definition for the variables.

Population Growth Values from 2005 to 2010

For the WDOF and WCS estimates, 2005 to 2010 yearly population estimates were obtained directly from the DOF E-4, as discussed in the data sources section above. These E-4 estimates were only used from 2005 to 2007 for the SGCS estimate since SACOG data became available beginning in year 2008.

Weighted Population Growth Estimates Using County DOF Data (WDOF)

We used Equation 1 to find $R_{10_County_DOF}$, the Yolo County 10-year population growth rate between 2000 and 2010 using DOF population estimates.

$$R_n = (P_F - P_I)/P_I \quad [1]$$

Where:

Term	Description	Value	Units
R_n	Yolo County population growth rate from 2000 to 2010 from DOF ($R_{10_County_DOF}$)	21.1	%
P_F	Final county population in 2010 from DOF	206,100	People
P_I	Initial county population in 2000 from DOF	170,190	People

We then used Equation 1 again to find $R_{10_City_Census}$, the historic 10 year population growth rate for the city (referred to as below) using U.S. Decennial Census Data, where:

Term	Description	Value	Units
R_n	Population growth rate for City from 2000 to 2010 from US Census ($R_{10_City_Census}$)	8.15	%
P_F	Final City population in 2010 from US Census	6,624	People
P_I	Initial City population in 2000 from US Census	6,125	People

We combined these results using Equation 2 to find WF_{DOF}, a city to county weighting factor for growth from 2000 to 2010 for use with DOF data.

$$WF_{ORG} = R_{city}/R_{ORG} \quad [2]$$

Where:

Term	Description	Value	Units
WF_{ORG}	Weighting factor for use with DOF data (WF_{DOF})	0.39	Unitless
R_{city}	City population 10 year growth rate from US Census ($R_{10_City_Census}$)	8.15	%
R_{ORG}	County population 10 year growth rate from DOF ($R_{10_County_DOF}$)	21.1	%

We assumed that this city to county growth-based DOF weighting factor will be the same from 2010 to 2020 as it was for 2000 to 2010.

We then calculated $R_{20_County_DOF}$, the county population growth rate from 2010 to 2020 using Equation 1 and DOF data, where:

Term	Description	Value	Units
R_n	Yolo County population growth rate from 2010 to 2020 from DOF ($R_{20_County_DOF}$)	18.9	%
P_F	Final county population in 2020 from DOF	245,052	People
P_I	Initial county population in 2010 from DOF	206,100	People

Next we find WR_{20_City}, a weighted city growth rate estimate for 2010 to 2020, by applying the weighting factor for DOF data (WF_{DOF}) to our DOF Yolo County population growth rate for 2010 to 2020 ($R_{20_County_DOF}$) using Equation 3.

$$WR_{ORG} = WF_{ORG} * R_{ORG} \quad [3]$$

Where:

Term	Description	Value	Units
WF_{ORG}	Weighting factor for use with DOF data (WF_{DOF})	0.39	Unitless
R_{ORG}	Yolo County population growth rate from 2010 – 2020 from DOF data ($R_{20_County_DOF}$)	18.9	%
WR_{ORG}	Weighted city population growth rate for 2010 – 2020 (WR_{20_City})	7.3	%

We then plugged this rate into Equation 4 to find the annual effective weighted city population growth rate between 2010 and 2020 (AR_{20_City}).

$$AR_e = (1 + R_n)^{(1/n)} - 1 \quad [4]$$

Where:

Term	Description	Value	Units
n	Number of years in time period	10	Years
R_n	Weighted city population growth rate from 2010 – 2020 (WR_{20_City})	7.3	%
AR_e	Annual effective city population growth rate from 2010 – 2020 (AR_{20_City})	0.71	%

Using the annual effective weighted city population growth rate between 2010 and 2020 (AR_{20_City}) we then applied Equation 5 to get the WDOF estimated yearly total city population values for the years 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020.

$$P_N = (1 + AR_e)P_{N-1} \quad [5]$$

Term	Description	Value	Units
AR_e	Annual effective weighted city population growth rate from 2010 – 2020 (AR_{20_City})	0.71	%
P_N	Estimated WDOF city population for year N	Calculated Values	People
P_{N-1}	WDOF city population value for year N-1	Calculated Values	People

Weighted Population Growth Estimates using Census State Data (WCS)

We followed a similar process to determine the weighted US Census growth rate estimate for 2010 to 2020. Recalling from above, the 10-year city population growth rate between 2000 and 2010 from the U.S. Decennial Census ($R_{10_City_Census}$) was 8.15%. We then used Equation 1 to find the state 10-year population growth rate between 2000 and 2010 ($R_{10_State_Census}$) using 2000 and 2010 U.S. Decennial data where:

Term	Description	Value	Units
R_n	State population growth rate from 2000 to 2010 from U.S. Census ($R_{10_State_Census}$)	9.93	%
P_F	Final state population in 2010 from Census	37,235,956	People
P_I	Initial state population in 2000 from Census	33,871,648	People

Then we used Equation 2 to find a city to state-based weighting factor for use with Census data from 2000 to 2010 (WF_{Census}) where:

Term	Description	Value	Units
WF_{ORG}	Weighting factor for use with Census data (WF_{Census})	0.821	Unitless
R_{city}	City population 10 year growth rate from US Census ($R_{10_City_Census}$)	8.15	%
R_{ORG}	State population growth rate from 2000 to 2010 from U.S. Census ($R_{10_State_Census}$)	9.93	%

We assumed that this city to state-based growth weighting factor will be the same for 2010 to 2020 as it was for 2000 to 2010. Next we used 2020 state population projections and recorded 2010 state population data from the U.S. Census to find the projected 10-year state population growth rate from 2010 to 2020 ($R_{20_State_Census}$) using Equation 1, where:

Term	Description	Value	Units
R_n	State population growth rate from 2010 to 2020 from U.S. Census ($R_{20_State_Census}$)	13.35	%
P_F	Final state population in 2020 from Census	42,206,743	People
P_I	Initial state population in 2010 from Census	37,235,956	People

We then applied the Census weighting factor (WF_{Census}) to the Census state 10-year population growth rate from 2010 to 2020 ($R_{20_State_Census}$) using Equation 3 to find a weighted 2010 to 2020 city growth rate estimate (WR_{20_City}), where:

Term	Description	Value	Units
WF_{ORG}	Weighting factor for use with Census data (WF_{Census})	0.821	Unitless
R_{ORG}	State population growth rate from 2010 – 2020 from Census data ($R_{20_State_Census}$)	13.35	%
WR_{ORG}	Weighted city population growth rate for 2010 – 2020 (WR_{20_City})	10.9	%

We then plugged the weighted 2010 to 2020 city growth rate estimate (WR_{20_City}) into equation 4 to find the annual effective city population growth rate from 2010 to 2020 (AR_{20_City}), where:

Term	Description	Value	Units
n	Number of years in time period	10	Years
R_n	Weighted city population growth rate from 2010 – 2020 (WR_{20_City})	10.9	%
AR_e	Annual effective city population growth rate from 2010 – 2020 (AR_{20_City})	1.04	%

Using the annual effective city population growth rate from 2010 to 2020 (AR_{20_City}), we also applied Equation 5 to get WCS population values for the years 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020, where:

Term	Description	Value	Units
AR_e	Annual effective weighted city population growth rate from 2010 – 2020 (AR_{20_City})	1.04	%
P_N	Estimated WCS city population for year N	Calculated Values	People
P_{N-1}	WCS city population value for year N-1	Calculated Values	People

SACOG Total Number of Households Estimates with Census Person Per Household Data (SGCS)

We used Equation 1 to find the SACOG 12-year rate of growth in the number of households ($R_{20_City_SACOG}$) using year 2008 and 2020 SACOG household estimates, where:

Term	Description	Value	Units
R_n	City household growth rate from 2008 to 2020 from SACOG ($R_{20_City_SACOG}$)	17.86	%
P_F	Final city households from SACOG in 2020	2,415	Households
P_I	Initial city households from SACOG in 2008	2,049	Households

We then plugged the SACOG rate of growth in the number of households ($R_{20_City_SACOG}$) rate into Equation 4 to find the effective annual households growth rate from 2008 to 2020 (AR_{20_City}),where:

Term	Description	Value	Units
n	Number of years in time period	12	Years
R_n	City household growth rate from 2008 to 2020 from SACOG ($R_{20_City_SACOG}$)	17.86	%
AR_e	Annual effective city household growth rate from 2008 – 2020 (AR_{20_City})	1.38	%

We then used Equation 6 and SACOG 2008 city household data to determine the total estimated population in year 2008.

$$P_N = NHH_N * PHH \qquad [6]$$

Where:

Term	Description	Value	Units
P_N	Estimated population for 2008	6,208	People
NHH_N	Total number of households in 2008 from SACOG	2,049	None
PHH	Average household size in the city from U.S. 2010 Decennial Census	3.03	People/ Household

We assumed that the average number of people per household (PHH) will remain constant from 2008-2020. This allowed us to use the annual household growth rate as an annual population growth rate. Then using the 2008 population estimate (P_N) and the 2008 – 2020 annual city population growth rate (assumed equal to AR_{20_City}), we applied Equation 5 to obtain estimated SCGS population values for the years 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020, where:

Term	Description	Value	Units
AR_e	Annual effective city household growth rate from 2008 – 2020 (AR_{20_City})	1.38	%
P_N	Estimated SCGS city population for year N	Calculated Values	People
P_{N-1}	SCGS city population value for year N-1	Calculated Values	People

Results

The results of the calculations above are presented in Tables 1 and 2. The estimated yearly population growth rates (shown in Table 1) suggest that the choice of population data source has the potential to significantly impact population (and therefore emissions) projections. The largest annual projected growth rate of 1.38% (SCGS) is 94% larger than the smallest annual projected growth rate of 0.71% (WDOF).

Table 1: Estimated Annual Population Growth Rates

Estimate	Applicable Years	Annual Projected Growth Rate (%)
WDOF	2010-2020	0.71%
WCS	2010-2020	1.04%
SGCS	2008-2020	1.38%

Table 2: Total Yearly Population by Estimate Type

Year	Estimate		
	WDOF	**WCS**	**SGCS**
2005	6,753	6,753	6,753
2006	6,602	6,602	6,602
2007	6,584	6,584	6,584
2008	6,648	6,648	6,208
2009	6,638	6,638	6,294
2010	6,630	6,630	6,381
2011	6,677	6,699	6,469
2012	6,724	6,769	6,558
2013	6,772	6,840	6,649
2014	6,819	6,911	6,740
2015	6,868	6,984	6,833
2016	6,916	7,056	6,927
2017	6,965	7,130	7,023
2018	7,014	7,205	7,120
2019	7,064	7,280	7,218
2020	7,114	7,356	7,317

Renewables Portfolio Standard (RPS) and Electricity Emission Factors

Background

California's Renewables Portfolio Standard (RPS) was established in 2002 under Senate Bill 1078, accelerated in 2006 under Senate Bill 107 and expanded in 2011 under Senate Bill 2. The California Public Utilities Commission and the California Energy Commission jointly implement the RPS program. The RPS program requires investor-owned utilities, electric service providers and community choice aggregators to increase procurement from eligible renewable energy resources to 33% of total procurement by 2020.

PG&E, the primary energy provider in the city, is an investor owned utility. If the goals in this legislation are realized, projected emissions associated with electricity use will be substantially lower than if no changes were made to the share of energy generated from renewable sources. RPS is one of the most ambitious renewable energy standards in the country (California Public Utilities Commission 2011) and it is not entirely certain that the 2020 goal will be obtained. Current PG&E renewables percentages are already falling short of previously projected targets[1]. Thus, the inclusion of RPS accounting may be inconsistent with the city climate action plan. The SEEC lets report creators decide if they would like to account for RPS or not in their standard projection calculation plan. To account for this uncertainty we will estimate projected emissions with and without RPS and will compare the results. RPS can be accounted for by using projected electricity emissions factors that account for changes in the renewable percentage.

Data and Methods

For 2005 to 2010 emissions calculations we used actual PG&E third party verified emissions factors (see Table 3). For 2011-2020 emissions projections we used emissions factors that do and do not account for RPS. These 2011 – 2020 emission factors were obtained from SEEC's *Government Operations Forecast Assistant.*

[1] Determined by comparing projected PG&E RPS emissions factors and current PG&E emissions factors.

Table 3: PG&E Electricity Emission Factors ($MTCO_2$/kWh). Shaded values are used to project emissions.

Year	Factors Reported by PG&E[2]	RPS Projection Rate[3]	No RPS (Constant) Projection Rate[4]
2005	0.000222	0.000222	0.000222
2006	0.000207	0.000207	0.000207
2007	0.000288	0.000288	0.000288
2008	0.000291	0.000244	0.000244
2009	0.000261	0.000234	0.000244
2010	0.000202	0.000225	0.000244
2011	-	0.000215	0.000244
2012	-	0.000205	0.000244
2013	-	0.000196	0.000244
2014	-	0.000187	0.000244
2015	-	0.000177	0.000244
2016	-	0.000168	0.000244
2017	-	0.000158	0.000244
2018	-	0.000149	0.000244
2019	-	0.000139	0.000244
2020	-	0.000131	0.000244

[2] 2005 – 2009 emissions factors have been provided by PG&E in their *Greenhouse Gas Emission Factors Info Sheet* (2011) and the 2010 emissions factor is posted at http://www.pgecurrents.com/2012/03/26/pge-reports-lowest-greenhouse-gas-emissions/.

[3] Emissions factors with and without RPS were obtained from the SEEC Government Operations Forecast Assistant available at http://californiaseec.org/documents/forecasting-tools/seec-government-operations-forecast-assistant. SEEC obtained these values with PG&E's guidance and the use of the Energy + Environmental Economics (E3) GHG Calculator Version 3c.

[4] Ibid.

Residential and Commercial

Data Sources

The California Energy Commission (CEC) provided the estimated annual consumption growth rates of electricity and natural gas in the residential and commercial sectors in the PG&E planning area[5] (see Table 4). Along with the consumption growth rate, CEC also provided an estimated annual population growth rate[6] of 1.35% from 2010 to 2020 for the same area, which differs from the WDOF, WCS, and SCGS population growth rates of 0.71%, 1.04%, and 1.38% respectively. Furthermore, information provided by the CEC also indicates that electricity and natural gas consumption growth rates in residential and commercial sectors are somewhat slower that the population growth rate. However, according to the CEC, population growth is the primary driver of growth in electricity and natural gas consumption in residential and commercial sectors. Thus for the purposes of projecting emissions, we assumed that growth in energy consumption is proportional to population growth. In order to account for city-specific population growth and to be consistent with other sections of this report, we adjusted the CEC energy consumption growth rates based on the city population growth estimates.

Table 4: Expected Annual Utility Consumption Growth Rate 2011-2020 (R_{cec})

	Residential	Commercial
Electricity	1.80%	1.34%
Natural gas	1.11%	0.52%

The same data for residential and commercial electricity and natural gas use obtained from PG&E and used in the baseline inventory were used to estimate emissions projections. Since PG&E qualifies as an "investor owned utility," we calculated emissions using emission factors that did and did not account for RPS for 2011 to 2020, as discussed in the Renewables Portfolio Standard section. To calculate emissions in from 2005 to 2010, we used the verified electricity emission factors provided by PG&E. The natural gas CO_2 emission factors from 2003 to 2010 stayed constant as indicated by PG&E. For the emissions projection calculations, we assumed that the natural gas emissions factors for CO_2, CH_4, and N_2O remain constant from 2010 to 2020.

In addition to the RPS correcting factors, the projection accounts for Title 24, which is a regulation aimed at reducing residential utility consumption by 10% and commercial by 5% (SEEC). The CEC estimate of the energy consumption growth rate already accounts for the effects of Title 24. Therefore, we did not conduct any additional calculations to account for Title 24.

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[5] Growth rates are obtained from the California Energy Commission's California Energy Demand 2010 – 2020 Adopted Forecast (CEC-2---2009-021-CMF), issued in 2009. Values are specific to the PG&E service area from 2010 to 2010. Electricity values are from page 77 and natural gas values are from page 231.
[6] Ibid, page 84.

Methods

Adjusting consumption growth rates

Since the electricity and natural gas consumption growth rates provided by CEC are for the entire PG&E planning area, we adjusted those estimates based on the city population growth rate by assuming that consumption growth is primarily driven by population growth. We assumed that energy consumption growth is proportional to population growth as stated in Equation 7. This equation is applied to residential and commercial electricity and natural gas consumption growth rates.

$$(R_{adj} + 1) = \left(\frac{r_{pop}+1}{r_{cec}+1}\right) * (R_{cec} + 1) \qquad [7]$$

Where:

Term	Description	Value	Units
r_{pop}	WDOF, WGS, or SCGS city population growth rate presented in the population section	User input (Table 1)	%
r_{cec}	CEC provided population growth rate for PG&E service area	1.35	%
R_{cec}	Original electricity or natural gas consumption growth rate for residential or commercial sectors as provided by CEC	User input (Table 4)	%
R_{adj}	Adjusted electricity or natural gas consumption growth rate for residential or commercial sectors	Calculated Values	%

Emissions Factors

Electricity emissions factors for CO_2 are provided in Table 3 in the Renewables Portfolio Standard section. In addition to CO_2, we accounted for nitrous oxide (N_2O) and methane (CH_4) emissions. The Local Government Operation (LGO) Protocol provides statewide values for these emissions factors from 1990 to 2007 (Table 5 shows 2005 to 2007 values). However, we were unable to obtain these emissions factors beyond 2007.

Table 5: Electricity Emissions Factors[7]

Year	CO_2 (lbs/MWh)	CH_4 (lbs/MWh)	N_2O (lbs/MWh)
2005	948.28	0.0300	0.0110
2006	889.75	0.0310	0.0090
2007	919.64	0.0290	0.0100

[7] Obtained from Local Government Operations (LGO) Protocol. PG&E specific nitrous oxide and methane emissions factors were not available, so we use the California Grid average values for all three gases to obtain general statewide ratios of methane and nitrous oxide to carbon dioxide emissions.

To predict the CH_4 and N_2O emission factors, we divide the 2005 emission factors of each gas by the 2005 CO_2 emissions factor to obtain a ratio of emissions of CH_4/CO_2 and N_2O/CO_2 in California in 2005. Multiplying these ratios by the CO_2 emission factor in future years yields estimated emissions factors for CH_4 and N_2O in future years when CH_4 and N_2O emission factors are unknown.

Equations 8 to 11 provide emission factors for N_20 and CH_4 gases in any given year with and without the RPS.

$$EF_{cn_CH4} = EF_{cn} * EF_{CH4}/EF_{CO2} \quad [8]$$

$$EF_{cn_N2O} = EF_{cn} * EF_{N2O}/EF_{CO2} \quad [9]$$

$$EF_{rn_CH4} = EF_{rn} * EF_{CH4}/EF_{CO2} \quad [10]$$

$$EF_{rn_N2O} = EF_{rn} * EF_{N2O}/EF_{CO2} \quad [11]$$

Where:

Term	Description	Value	Units
EF_{cn}	Projected carbon dioxide electricity emissions factor with no RPS (constant) in year n	User Input	$MTCO_2/kWh$
EF_{rn}	Projected carbon dioxide electricity emissions factor with RPS in year n	User Input	$MTCO_2/kWh$
EF_{CH4}	2005 methane electricity emissions factor	0.0300	lbs CH_4/MWh
EF_{N2O}	2005 nitrous oxide electricity emissions factor	0.0110	lbs N_2O /MWh
EF_{CO2}	2005 carbon dioxide electricity emissions factor	948.28	lbs CO_2/MWh
EF_{cn_CH4}	Projected methane electricity emissions factor with no RPS (constant) in year n	Calculated Values	MT CH_4/kWh
EF_{cn_N2O}	Projected nitrous oxide electricity emissions factor with no RPS (constant) in year n	Calculated Values	MT N_2O /kWh
EF_{rn_CH4}	Projected methane electricity emissions factor with RPS in year n	Calculated Values	MT CH_4/kWh
EF_{rn_N2O}	Projected nitrous oxide electricity emissions factor with RPS in year n	Calculated Values	MT N_2O /kWh

As described above, we assume constant natural gas emissions factors for CO_2, CH_4, and N_2O. We obtained these emissions factors from the LGO Protocol Table G.7.

Estimating Emissions

To project emissions in a future year, we essentially multiplied the consumption in that year by the emission factor in that year. To combine electricity emissions from all greenhouse gases (GHGs) we converted the emissions of each gas to CO_{2e} emissions as shown in Equations 12 (without RPS) and 13 (with RPS).

$$EM_{cn} = [(R_{adj} + 1) * C_{n-1}] * (EF_{cn} + 21 * \mathrm{EF_{cn_CH4}} + 310 * \mathrm{EF_{cn_N2O}}) \quad [12]$$

$$EM_{rn} = [(R_{adj} + 1) * C_{n-1}] * (EF_{rn} + 21 * \mathrm{EF_{rn_CH4}} + 310 * \mathrm{EF_{rn_N2O}}) \quad [13]$$

Where:

Term	Description	Value	Units
R_{adj}	Adjusted electricity or natural gas consumption growth rate for residential or commercial sectors	Calculated Values	%
C_{n-1}	Electricity consumption in year n-1		
EF_{cn}	Projected carbon dioxide electricity emissions factor with no RPS (constant) in year n	User Input	$MTCO_2$/kWh
EF_{rn}	Projected carbon dioxide electricity emissions factor with RPS in year n	User Input	$MTCO_2$/kWh
EF_{cn_CH4}	Projected methane electricity emissions factor with no RPS (constant) in year n	User Input	$MTCH_4$/kWh
EF_{cn_N2O}	Projected nitrous oxide electricity emissions factor with no RPS (constant) in year n	User Input	MTN_2O /kWh
EF_{rn_CH4}	Projected methane electricity emissions factor with RPS in year n	User Input	$MTCH_4$/kWh
EF_{rn_N2O}	Projected nitrous oxide electricity emissions factor with RPS in year n	User Input	MTN_2O /kWh
EM_{cn}	Projected emissions from electricity with no RPS (constant) in year n	Calculated Values	$MTCO_2e$/kWh
EM_{rn}	Projected emissions from electricity RPS in year n	Calculated Values	$MTCO_2e$/kWh

Note that the full equations are used from 2011 to 2020, but for from 2005 to 2010 the bracketed portion of the equations are replaced with the energy use provided by PG&E. Estimates of natural gas emissions were derived as in Equations 12 and 13, except that natural gas emissions don't vary with the RPS, and natural gas use and emissions factors were used in place of electricity use and emissions factors.

Results

Projected emissions with the RPS from 2011 – 2020 are shown in Tables 6 to 8 while Tables 9 to 11 show emissions without the RPS. Each set of tables provides emissions projections for each population estimate: WDOF, WCS, and SCGS. Figures 1 and 2 display these projected emissions trends visually.

With RPS

Table 6. Predicted GHG Emissions in ($MTCO2_e$) with WDOF and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	3,718	4,659	2,851	944	12,172
2012	3,589	4,681	2,739	943	11,952
2013	3,459	4,703	2,628	942	11,733
2014	3,346	4,725	2,531	941	11,542
2015	3,211	4,747	2,417	940	11,315
2016	3,072	4,770	2,302	939	11,083
2017	2,930	4,792	2,186	938	10,846
2018	2,784	4,815	2,068	936	10,604
2019	2,636	4,838	1,949	935	10,357
2020	2,520	4,860	1,855	934	10,169

Table 7. Predicted GHG Emissions in ($MTCO2_e$) with WCS and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	3,730	4,674	2,860	947	12,211
2012	3,612	4,712	2,757	949	12,030
2013	3,493	4,749	2,654	951	11,848
2014	3,390	4,787	2,564	953	11,694
2015	3,263	4,826	2,457	955	11,502
2016	3,133	4,864	2,348	957	11,302
2017	2,998	4,903	2,237	959	11,097
2018	2,858	4,943	2,123	961	10,885
2019	2,714	4,982	2,007	963	10,667
2020	2,604	5,022	1,916	965	10,507

Table 8. Predicted GHG Emissions in ($MTCO2_e$) with SGCS and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	3,743	4,690	2,870	950	12,253
2012	3,637	4,743	2,776	956	12,111
2013	3,529	4,797	2,681	961	11,968
2014	3,436	4,852	2,599	966	11,852
2015	3,319	4,907	2,499	971	11,696
2016	3,197	4,963	2,396	977	11,533
2017	3,069	5,020	2,290	982	11,361
2018	2,936	5,077	2,181	987	11,182
2019	2,798	5,135	2,069	993	10,994
2020	2,693	5,194	1,982	998	10,866

Without RPS

Table 9. Predicted GHG Emissions in ($MTCO2_e$) with WDOF and (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	4,213	4,659	3,230	944	13,045
2012	4,261	4,681	3,252	943	13,138
2013	4,311	4,703	3,275	942	13,231
2014	4,361	4,725	3,298	941	13,325
2015	4,411	4,747	3,321	940	13,419
2016	4,462	4,770	3,344	939	13,515
2017	4,514	4,792	3,368	938	13,612
2018	4,566	4,815	3,391	936	13,709
2019	4,619	4,838	3,415	935	13,807
2020	4,672	4,860	3,439	934	13,906

Table 10. Predicted GHG Emissions in ($MTCO2_e$) with WCS and (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	4,226	4,674	3,240	947	13,088
2012	4,289	4,712	3,274	949	13,224
2013	4,353	4,749	3,308	951	13,361
2014	4,418	4,787	3,342	953	13,500
2015	4,484	4,826	3,376	955	13,641
2016	4,551	4,864	3,411	957	13,783
2017	4,618	4,903	3,446	959	13,927
2018	4,687	4,943	3,481	961	14,072
2019	4,757	4,982	3,517	963	14,220
2020	4,828	5,022	3,554	965	14,369

Table 11. Predicted GHG Emissions in ($MTCO2_e$) with SGCS and Constant (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	4,241	4,690	3,251	950	13,132
2012	4,318	4,743	3,296	956	13,313
2013	4,397	4,797	3,341	961	13,497
2014	4,478	4,852	3,387	966	13,683
2015	4,560	4,907	3,433	971	13,872
2016	4,643	4,963	3,480	977	14,064
2017	4,728	5,020	3,528	982	14,258
2018	4,815	5,077	3,576	987	14,456
2019	4,903	5,135	3,625	993	14,656
2020	4,993	5,194	3,675	998	14,859

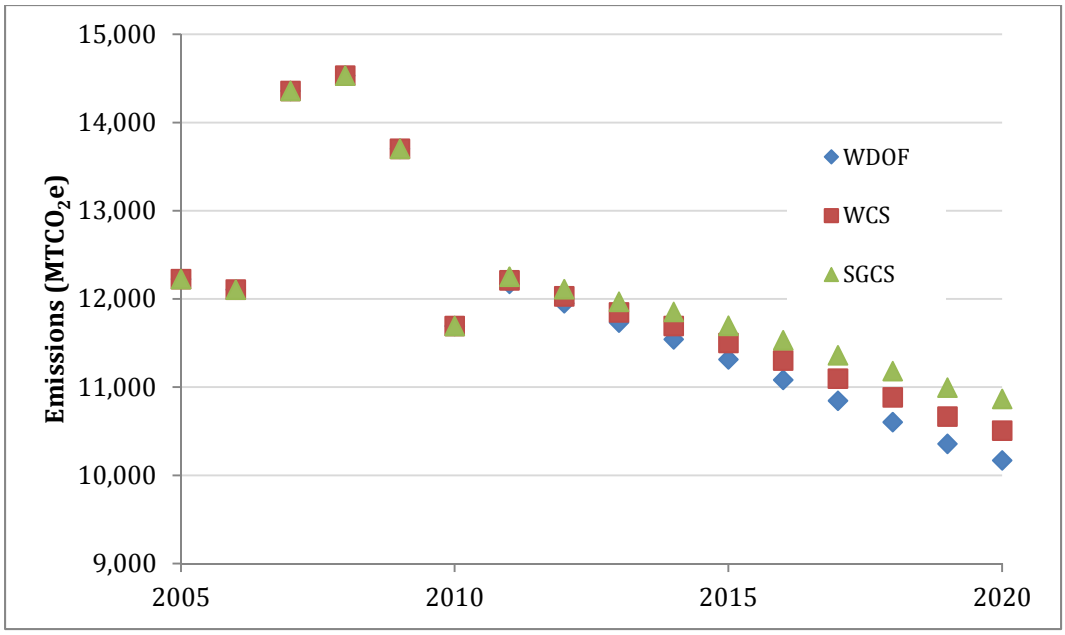

Figure 1: Residential and Commercial Electricity and Natural Gas Emissions Projections: With RPS

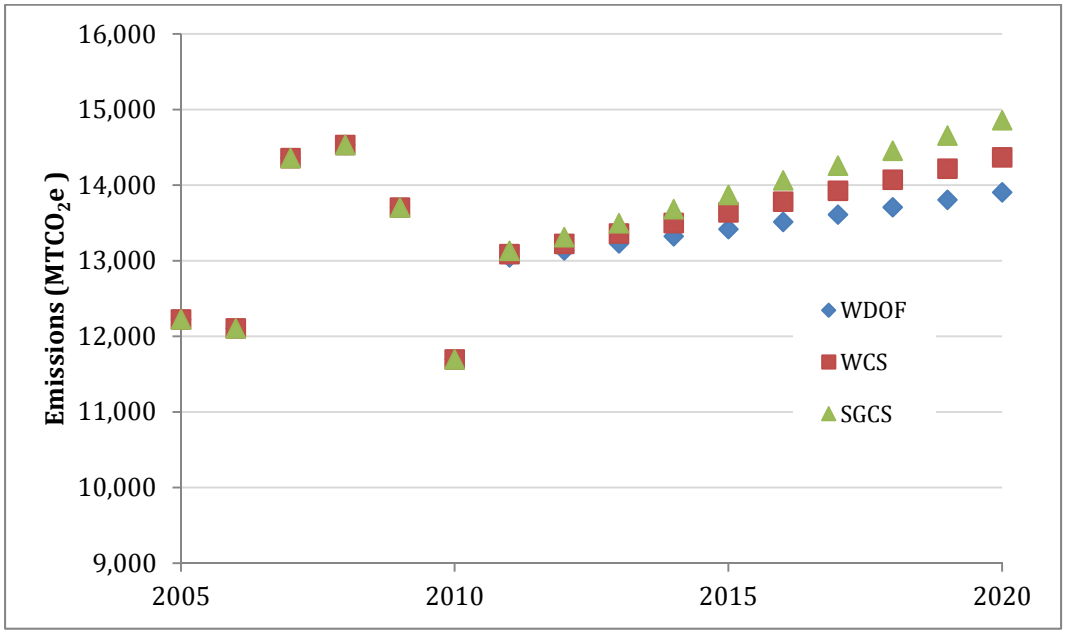

Figure 2: Residential and Commercial Electricity and Natural Gas Emissions Projections: Without RPS

Analysis

Table 12 summarizes residential and commercial emissions in Winters in 2005 and 2020 and provides emissions from the City of Piedmont in order to compare projected emissions rates.

Table 12: Emissions and population change comparison

		Winters (RPS)	Winters (No RPS)	Piedmont
Population change from baseline to 2020 (%)		5.3~8.9	5.3~8.9	7.35[8]
2005 Emissions ($MTCO_2e$)	**Residential**	8,526	8,526	24,034
	Commercial	3,700	3,700	1,389
2020 Emissions ($MTCO_2e$)	**Residential**	7,631	7,361	25,221
	Commercial	2,884	4,522	1,519
Net change from Baseline (%)	**Residential**	-10.5	16	4.9
	Commercial	-22	22	9.4

The implementation of the RPS contributes critically to reducing the GHG emissions in both the residential and commercial sectors in the BAU scenario, as shown in the net change from baseline row in the table above.

The climate action plan of Piedmont did not provide detail about the methods used to project emissions. Based on the assumption that population growth is the primary driver of GHG emissions growth, we would expect Winters to have similar growth in emissions. Piedmont blends commercial and industrial sectoral emissions.

[8] Obtained from CLR search.

Transportation

The transportation GHG emissions projections include emissions from on-road and off-road mobile sources.

Data Sources

On-Road excluding Transit Buses

The on-road data sources used were the same as those used in the 2005 baseline inventory[9], except that N_2O and CH_4 were obtained using ratios to CO_2 emissions from the 2005 inventory analysis instead of revisiting the EMissions FACtors model from 2007 (EMFAC 2007).

Transit Buses

Emissions from transit buses are calculated using updated fuel efficiency data provided by Yolobus. The vehicle miles traveled (VMT) for 2011 is estimated similarly as in the 2005 baseline inventory. The current Yolobus fleet includes forty-five compressed natural gas (CNG) buses and six diesel buses[10].

Off-Road excluding Airport and Rail Use

Projected GHG emissions data for off-road mobile sources are computed using the California Air Resources Board (ARB) "Off-Road Engine Database" in the same manner as the 2005 baseline inventory for years 2012, 2017, and 2022[11].

Aircraft Use

The data sources for aircraft emissions projections were similar to those of the 2005 baseline inventory. The aircraft emissions are estimated from i) the 2011 fuel consumption information and descriptions provided by Allied Aviation, fuel providers at the Sacramento International Airport and ii) vehicle trip data and SACOG estimates for the year 2035 in the Sacramento region[12].

Airport Ground Support Equipment

Airport Ground Support Equipment data sources are the same as the 2005 baseline inventory for years 2012, 2017, and 2022[13].

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[9] Data from EMFAC are available in the tabs titled "raw&calc.OnRoad_EMFAC 2011[2005/2020]"in the AppendixIB3_2020BAU_Transportation_WN.xlsx excel file, hereafter referred to as the Transportation Projections excel file.

[10] Data for Yolobus are shown in the "calc.Transit" tab in the Transportation Projections excel file.

[11] Data for off-road emissions are shown in the "raw.OffRoad2005", "raw.OffRoad2012", "raw.OffRoad2017", and "raw.OffRoad2022" tabs in the Transportation Projections excel file.

[12] Data for aircraft fuel use are shown in the "raw.AirportTrips2035" and "raw.AircraftFuelUse2011" tabs in the Transportation Projections excel file. Regional vehicle trip data are shown in "raw.AirportTrips2035".

[13] Data for Airport Ground Support Equipment are shown in the "calc.AirportSupportEquip2005", "calc.AirportSupportEquip2012", "calc.AirportSupportEquip2017", and "calc.AirportSupportEquip2022" tabs in the Transportation Projections excel file.

Well to Pump

Well to pump data sources are the same as those use in the 2005 baseline inventory.

Scaling Factors

The same scaling factors were used to scale emissions to city level as in 2005 baseline inventory[14].

Limitations

The same limitations apply to projected emissions as to the 2005 baseline inventory. In addition, since data are not provided specifically for each year, the data was either extrapolated or interpolated depending on the availability of the data. Finally, as with any projection of future events, projected emissions are based on projected data, which is subject to uncertainty.

Methods

The transportation GHG emissions projections for mobile sources rely on multiple sources for the emissions data, each requiring a unique methodological approach. This section is divided into six sub-sections covering each category of mobile source emissions: on-road excluding transit buses, transit buses, off-road (excluding airport and rail use emissions), aircraft use, airport ground support equipment, and well to pump emissions.

Emissions for the years 2006 to 2020 are calculated using similar methodologies to those used in the 2005 baseline inventory. Differences from 2005 baseline calculations are noted below. For a full description of 2005 baseline emissions calculation methodologies, see Appendix IA.

Emissions from on-road mobile sources excluding transit buses

Emissions:

CO_2 emissions for 2020 are calculated using the same method as in 2005 baseline inventory – using EMFAC 2011 information for Yolo County. Note that this calculation assumes that Pavley and Low Carbon Fuel Standards (LCFS) are in place, which results in significant reductions from on-road sources. The vehicle tailpipe standards established in AB 1493 (Pavley) and in the LCFS created through state executive order will reduce transportation emissions over time. Pavley reduces tailpipe GHG emissions, while also improving vehicle fuel efficiency. The LCFS reduces the carbon intensity in vehicle fuels. To estimate emissions from N_2O and CH_4, we assume that in 2020 the ratio of emissions of N_2O and CH_4 to CO_2 for each vehicle category is the same as in the baseline inventory. This greatly simplifies the projection calculations and affects a very small portion of the on-road inventory. CH_4 emissions for 2020[15] were calculated for each vehicle category using ratios as follows:

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[14] Data for Scaling Factors is shown in the "calc.ScalingFactors" tab in the Transportation Projections excel file.

[15] This calculation occurs in sheet "calc.OnRoadandW2P2005and2020" in the Transportation Projections Excel file.

$$CH_{4_{2020}} = \left(\frac{CH_{4_{2005}}}{CO_{2_{2005}}}\right) * CO_{2_{2020}} \quad [14]$$

Where:

Term	Description	Value	Units
$CO_{2_{2020}}$	CO_2 emissions in 2020	Input Values	$MTCO_2$
$CO_{2_{2005}}$	CO_2 emissions in 2005	Input Values	$MTCO_2$
$CH_{4_{2020}}$	CH_4 emissions in 2020	Input Values	$MTCH_4$
$CH_{4_{2005}}$	CH_4 emissions in 2005	Input Values	$MTCH_4$

N_2O emissions were estimated using the same method as shown in Equation 14, but with N_2O specific ratios.

Scaling factor: City Share of Yolo County Emissions

In the 2005 baseline inventory, we scale Yolo County emissions to the city level using the ratio of city to county VMT (which is based on the 2005 number of households in the city and county and VMT generated per household indicated by SACOG modeling outputs (see Appendix IA)). We assume that in 2020 the City's share of Yolo County on-road emissions does not change. While the city to county ratio of VMT is assumed the same in 2020, changes in 2020 VMT at the county level that are built into the EMFAC 2011 model are retained in the BAU scenario used in this projection.

Once 2020 emissions were calculated and scaled, we assumed a linear trend in emissions from 2005 emissions and 2020 to calculate yearly projections from 2005 to 2020 in Winters (Figure 3).

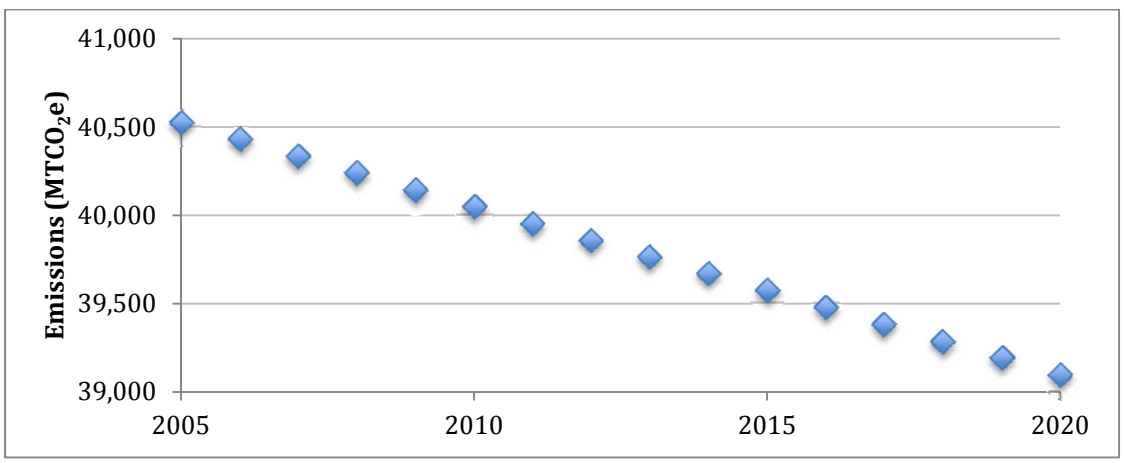

Figure 3: On-road GHG Emissions Projections from 2005 to 2020 [16]

[16] Linear extrapolation calculations are shown in the "calc.OnRoadProjections" tab in the Transportation Projections excel file.

Emissions from transit buses

Fuel efficiency data for 2011 and expected trends in future fuel use are based on information from Erik Reitz (ereitz@yrcd.org), Associate Transport Planner, Yolo County Transportation District, who noted that in 2007 the transit bus fleet changed to include some diesel buses in addition to CNG buses. Emissions for 2011 are calculated[17] using the same method as in the 2005 baseline inventory based on i) the updated fleet, ii) 2011 route information and iii) the assumption that transit bus emissions factors for each vehicle fuel type are the same as those used in the 2005 inventory). To estimate emissions for each year through 2020, a linear relationship was assumed, extrapolating from 2005 to 2011 out to 2020 (Figure 4).

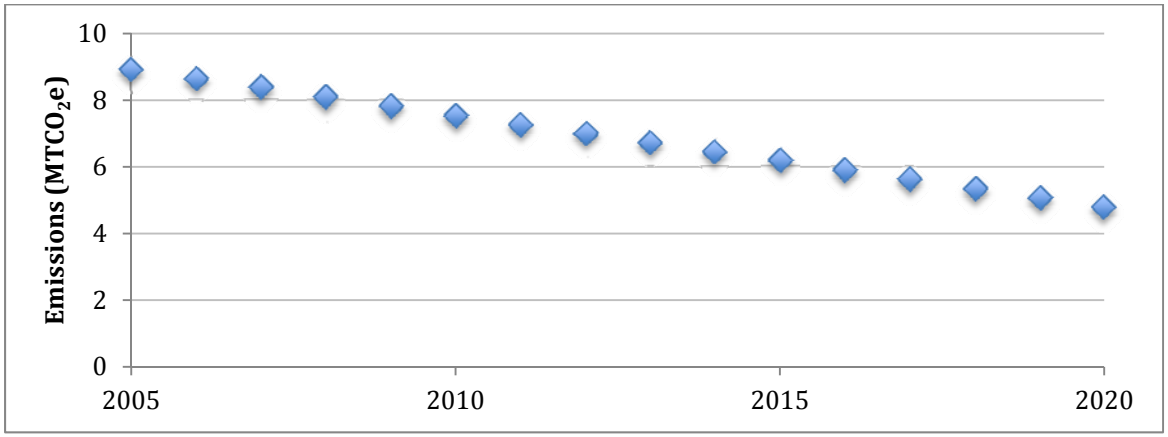

Figure 4: Transit bus GHG Emissions Projections from 2005 to 2020[18]

Emissions from off-road mobile sources excluding airport (aircraft and airport ground support)

Emissions for 2012, 2017, and 2022 from off-road mobile sources were calculated using the same methodology as in the 2005 baseline inventory using a version of the Off-Road model for each year. A linear trend was fit between 2005 and 2012 to calculate emissions for 2006-2011, a linear trend between 2012 and 2017 was used to calculate emissions for 2013-2016, and a linear trend between 2017 and 2022 was used to calculate emissions for 2018-2020 (Figure 5). Note that according to the Off-Road model, changes in agricultural activities were minor. This is reflected in the stable levels of agricultural emissions shown in Table 13.

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[17] The "calc.Transit" sheet in the Transportation Projections Excel file shows the transit bus emissions estimates for 2005 and 2020.

[18] Linear interpolation and extrapolation of transit emissions are calculated in the "Calc.TransitProjections" tab of the Transportation Projections Excel file.

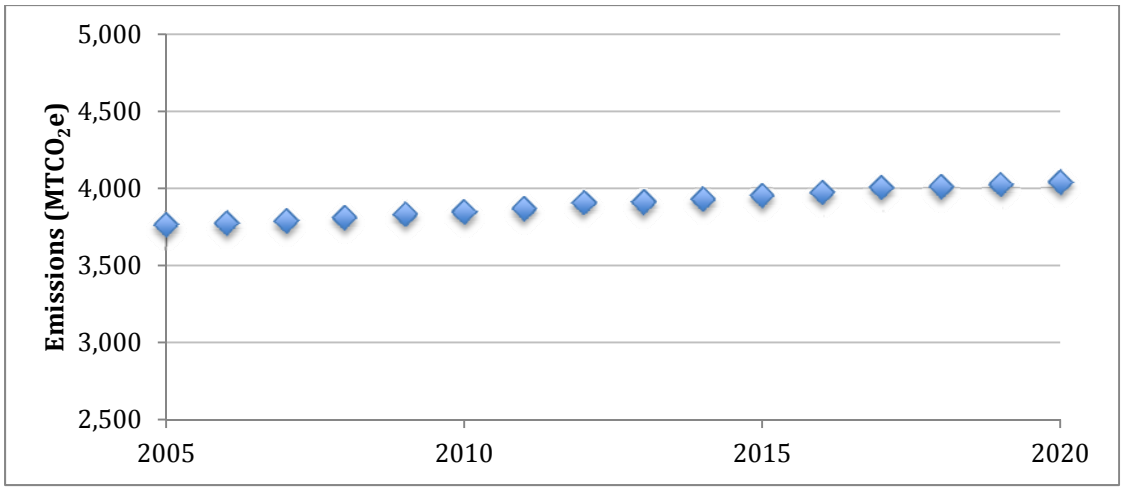

Figure 5: Off-road GHG Emissions Projections from 2005 to 2020 [19]

Emissions from aircraft use

Airport fuel use:

The 2011 aircraft emissions at the Sacramento Municipal Airport were estimated using the same methodology used in the 2005 baseline inventory, using 2011 fuel data instead of 2005 fuel use data. A linear trend was fit between 2005 emissions and 2011 emissions to calculate emissions for the years 2006 to 2010. From 2012 through 2014, fuel use is estimated to increase at a rate of 1% per year. From 2015 through 2020, an increase of 3% per year is assumed.[20]

Scaling Factor: City to region airport trips

The city to region airport trip ratio for 2035 (the year for which regional trip estimates were available) was calculated using the same methodology as in the 2005 baseline inventory. We then linearly interpolated the trip ratio for the years 2006 to 2020 based on the 2005 and 2035 trip ratios.[21] Each year's aircraft emissions at the Sacramento Airport were scaled to the City's share using the corresponding year's trip ratio, as in the 2005 baseline inventory (Figure 6).

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[19] Calculations for off-road projections are shown in the "calc.OffRoad2005", "calc.OffRoad2005" , "calc.OffRoad2005" , and "calc.OffRoad2005" tabs and summarized in the "calc.OffRoadProjections" in the Transportation Projections excel file.

[20] John Cormier of Allied Aviation, aviation fuel provider at the Sacramento International Airport, indicated in an e-mail conversation on April 24, 2012 that the decline in fuel usage shown occurred in 2008 when the economy declined. The rates of increase used in future years were also recommended by John Cormier. John Cormier can be reach at John.Cormier@alliedaviation.com. 2005 and 2011 fuel use are shown in the "calc.AircraftFuelUse" tab of the Transportation Projection Excel file.

[21] 2035 trips are estimated from "raw.AirportTrips2035" and interpolated in "calc. AirportTripRatioProjections" in the Transportation Projections Excel file.

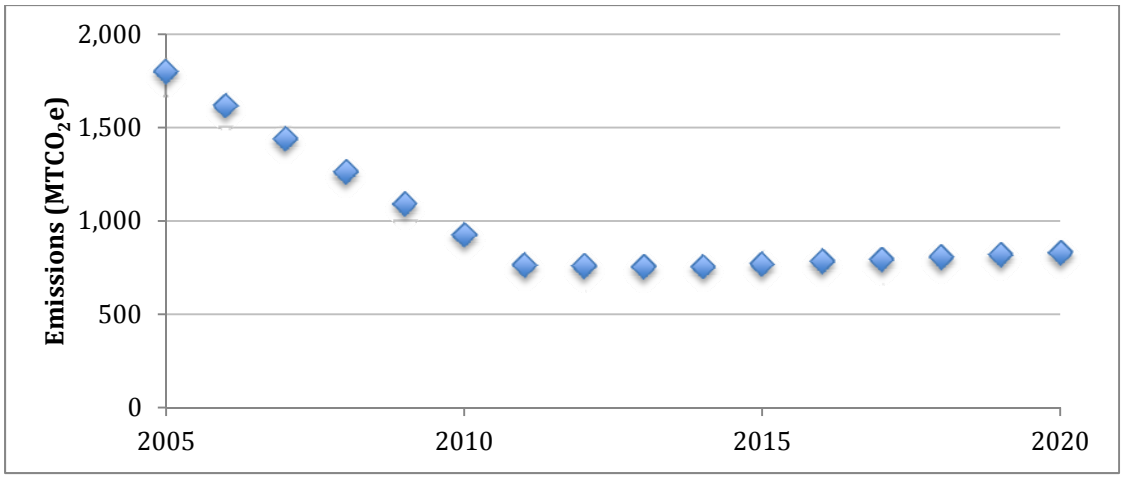

Figure 6: Airplane GHG Emissions Projections from 2005 to 2020 [22]

Emissions from airport ground support equipment

The emissions for ground support equipment are calculated using the same methods as in the 2005 baseline inventory (Figure 7). The emissions were obtained from the same off-road data sources as noted above in the off-road emissions section and the trip ratio factors (used to scale emissions from the airport to the city) were obtained from the calculations used to estimate aircraft emissions (above).

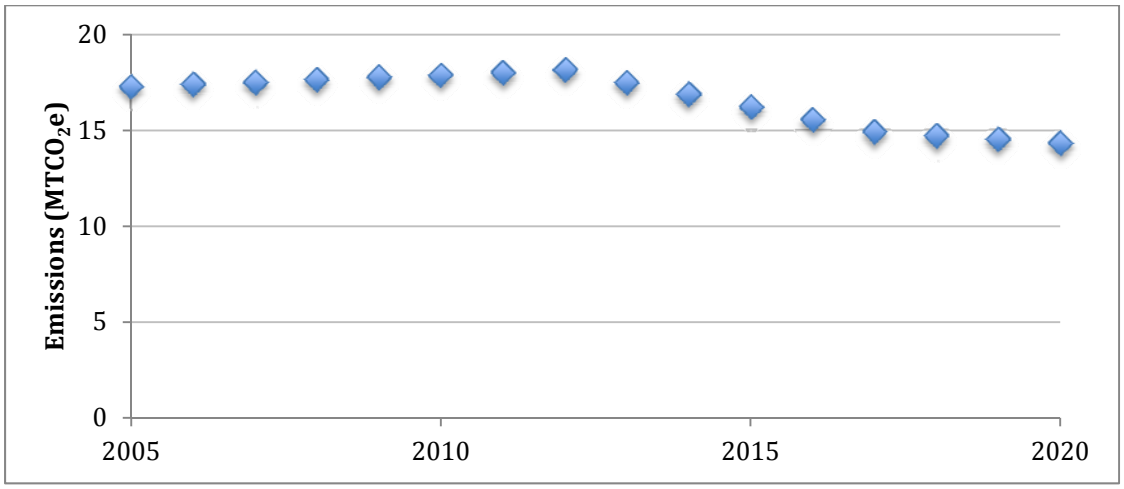

Figure 7: Ground Support GHG Emissions Projected from 2005 to 2020[23]

[22] Calculations for aircraft projections are shown in the "calc.AircraftProjections" in the Transportation Projections excel file.

[23] Calculations for airport ground support projections are shown in the "calc.AirportSupportEquip[2005/2012/2017/2022]" tabs and are summarized in the "calc.AirportSupEquipProjections" tab in the Transportation Projections excel file.

Well to Pump Emissions

Well to pump (W2P) emissions were calculated using the same methods as in the 2005 baseline inventory, which excluded W2P emissions from the CNG transit buses. We assumed a linear trend between 2005 and 2020 to interpolate emissions from 2006 to 2019 (Figure 8).

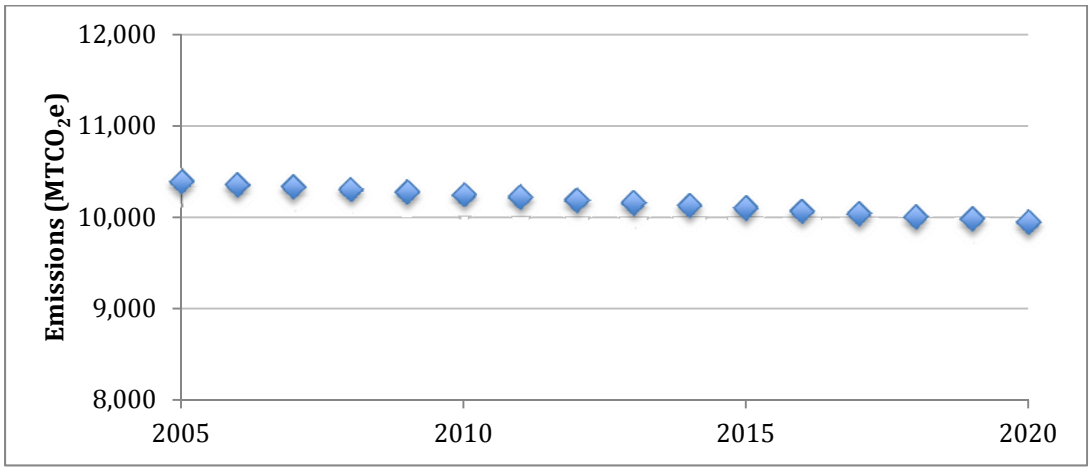

Figure 8: Well to Pump GHG Emissions Projected from 2005 to 2020[24]

Results

The GHG transportation emissions projections are presented in Table 13 (Scope 1 direct emissions), Table 14 (Scope 3 indirect emissions) and in Figure 9 (total emissions). The CO_2 equivalent metric tons ($MTCO_2e$) are calculated as in the 2005 baseline inventory.

[24] Calculations for well to pump projections are shown in the "calc.OnRoadandW2P2005and2020" tab and summarized in the "calc.WelltoPumpProjections" in the Transportation Projections excel file

Table 13: Scope 1 Direct Transportation $MTCO_2e$ Emissions Projections by Sector

Year	On-Road P2W						Off-Road P2W				Total Scope 1
	Passenger Vehicles	Light-duty Trucks	Motorcycles	Heavy-duty Trucks	Non-Transit Buses	Transit Buses	Agricultural Equipment	Construction and Other Commercial Equipment	Lawn and Garden Equipment	Recreational Equipment	
2005	12,385	15,858	64	11,989	227	9	146	3,243	206	156	44,282
2006	12,313	15,744	68	12,074	228	9	146	3,256	209	160	44,206
2007	12,242	15,630	72	12,159	228	8	146	3,268	211	165	44,130
2008	12,171	15,516	77	12,245	229	8	146	3,281	214	169	44,054
2009	12,100	15,402	81	12,330	229	8	146	3,293	216	174	43,978
2010	12,029	15,288	85	12,415	230	8	146	3,306	219	178	43,902
2011	11,957	15,174	89	12,500	230	7	146	3,318	221	183	43,826
2012	11,886	15,061	94	12,585	231	7	146	3,331	223	187	43,750
2013	11,815	14,947	98	12,670	231	7	146	3,346	226	191	43,677
2014	11,744	14,833	102	12,755	232	6	146	3,361	229	194	43,603
2015	11,673	14,719	106	12,840	232	6	146	3,376	231	198	43,529
2016	11,602	14,605	111	12,926	233	6	146	3,391	234	202	43,455
2017	11,530	14,491	115	13,011	233	6	146	3,407	236	206	43,381
2018	11,459	14,378	119	13,096	234	5	146	3,417	238	208	43,299
2019	11,388	14,264	124	13,181	234	5	146	3,427	239	211	43,218
2020	11,317	14,150	128	13,266	235	5	146	3,437	241	213	43,136

Table 14: Scope 3 Indirect Transportation $MTCO_2e$ Emissions Projections by Sector

Year	Off-Road P2W		On Road W2P	Total Scope 3
	Aircraft Use	Airport Ground Support Equipment	On-road W2P (non-transit)	
2005	1,799	17	10,388	12,205
2006	1,617	17	10,359	11,993
2007	1,438	18	10,329	11,785
2008	1,262	18	10,300	11,580
2009	1,091	18	10,271	11,379
2010	923	18	10,242	11,182
2011	759	18	10,213	10,989
2012	757	18	10,183	10,958
2013	755	17	10,154	10,927
2014	753	17	10,125	10,895
2015	766	16	10,096	10,878
2016	779	16	10,066	10,861
2017	792	15	10,037	10,844
2018	805	15	10,008	10,827
2019	818	15	9,979	10,811
2020	831	14	9,949	10,795

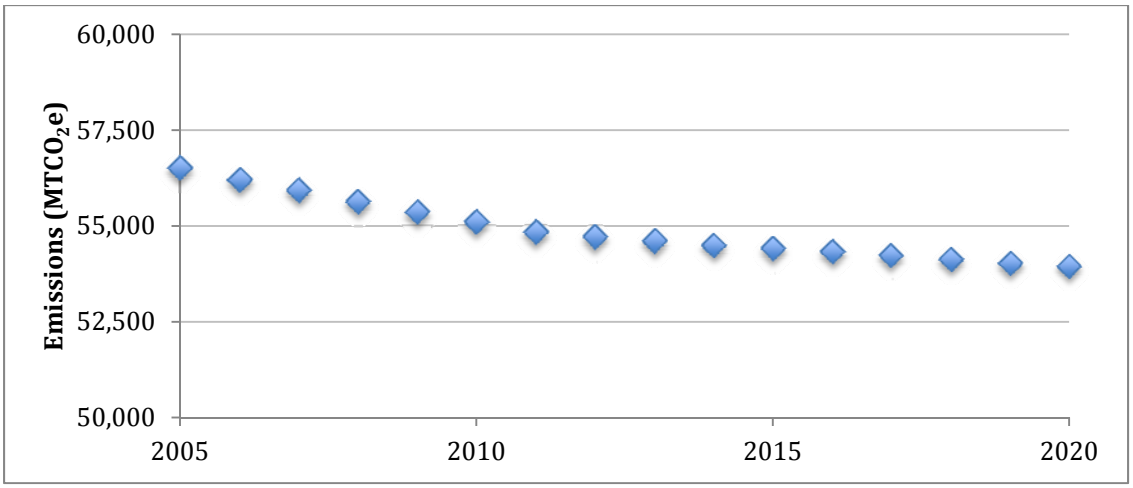

Figure 9: GHG Emissions Projection from Transportation Sources from 2005 to 2020[25]

[25] The transportation GHG emissions summary is presented in the "Summary Projections" tab in the Transportation Projections excel file.

Municipal Inventory

Municipal Energy Use (excluding water and water treatment)

Data Sources

To project municipal emissions we assumed that municipal energy consumption will grow at a rate similar to local population. Local population growth rates were determined as described in the population section above.

Municipal electricity and natural gas use was provided by PG&E. For the raw electricity and gas usage data we used the summed electricity and gas usage consumption values that were calculated in the baseline inventory, based on the data for 2005 to 2010 provided by PG&E. Since PG&E qualifies as an "investor owned utility," calculations were completed with emissions factors that either accounted for RPS or did not for the years 2010 to 2020, as discussed in the Renewables Portfolio Standard section above. For the years 2005 to 2009 we used the verified electricity emissions factors provided by PG&E. To project municipal emissions from natural gas we assumed that the natural gas emissions factor will remain constant through 2020 because the factor provided by PG&E value remained constant for 2003-2010 and natural gas emissions factors were projected to remain constant by SEEC.

Methods

Assumptions

We assumed that fleet mileage and municipal energy use will change in proportion to population.

Emissions factors

We assumed that the emissions factors for the municipal vehicle fleet remain constant from 2005 to 2020 because it is unlikely that there will be any significant changes to the vehicle fleet in the next 15 years. We used the CO_2, CH_4 and N_2O electricity and natural gas emissions factors developed in the Residential and Commercial and the RPS sections of this report.

Energy Use

We used known energy use values for the years 2005 to 2010. To project the energy use for the years 2011 to 2020, three separate projections were estimated, one using each population projection (WDOF, WCS, and SCGS). We assumed that municipal energy use per capita remains constant, so we simply scaled the municipal energy using the annual population growth estimates based on the WDOF, WCS, and SGCS population estimates. Equation 15 shows the calculations for electricity use estimates. Natural gas use estimates were estimated in the same manner, except they rely on natural gas in the previous year rather than electricity use in the previous year.

$$K_{n,m} = K_{n-1} + (K_{n-1} * P_m) \qquad [15]$$

Where:

Term	Description	Value	Units
$K_{n,m}$	Electricity use for year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	kWh
K_{n-1}	Electricity use for year n-1	Input Value	kWh
P_m	Growth rate for population estimate m (WDOF, WCS, or SCGS)	Input Value (Table 1)	%

Emissions

Electricity and natural gas emissions from 2005 to 2010 are calculated in the baseline inventory (Appendix IA). To estimate electricity emissions with RPS from 2011 to 2020, we use Equation 16. Electricity emissions without the RPS were estimated as in Equation 16 by substituting the constant (no RPS) emissions factors for each gas. Natural gas emissions were estimated as in Equation 16 by substituting natural gas use and emissions factors for electricity use and emissions factors.

$$E_{n,m} = (K_{n,m} * RPS_n) + (K_{n,m} * A * RPS_{CH4}) + (K_{n,m} * B * RPS_{N20}) \qquad [16]$$

Where:

Term	Description	Value	Units
$E_{n,m}$	Total emissions generated in year n from electricity usage for population estimate m (WDOF, WCS, or SCGS) with RPS	Calculated Values	$MTCO_2$
$K_{n,m}$	Yearly kilowatt hour for year n-1 for population estimate m (WDOF, WCS, or SCGS)	Input Value	kWh
RPS_n	RPS emissions factor for year n	Input Value	$MTCO_2/kWh$
A	Conversion factor	21	$MTCO_2e/MTCH_4$
RPS_{CH4}	CH_4 RPS emissions factor for year n	Input Value	$MTCH_4/kWh$
B	Conversion factor	310	$MTCO_2e/MTN_2O$
RPS_{N2O}	N_20 RPS emissions factor for year n	Input Value	MTN_2O/kWh

To determine emissions from the vehicle fleet we scaled the baseline inventory emissions by the population for the years 2006 to 2020 as shown in Equation 17 based on our assumption that fleet mileage changes in proportion to population and fleet emissions factors remain the same as in the baseline inventory. Population estimates are obtained from the population section of this report.

$$VF_{n,m} = (P_{n,m}/P_m) * VF_b \qquad [17]$$

Where:

Term	Description	Value	Units
$VF_{n,m}$	Vehicle fleet emissions for year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	$MTCO_2e$
$P_{N,m}$	Population for year n from population estimate m (WDOF, WCS, or SCGS)	Input Values	people
P_m	2005 Baseline population from population estimate m (WDOF, WCS, or SCGS)	52,474	people
VF_b	Vehicle fleet emissions for baseline year (2005)	Input Values	$MTCO_2e$

Results

The projected municipal emissions for 2011-2020 are provided in Table 15.

Table 15. Projected municipal fleet and energy use emissions for 2011-2020 ($MTCO_2$)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
With RPS:										
WDOF	204	201	198	196	194	193	193	194	195	199
WCS	205	202	201	200	201	203	206	210	217	227
SGCS	188	183	179	176	174	173	173	175	178	183
Without RPS:										
WDOF	216	216	218	219	222	225	229	234	240	248
WCS	217	218	221	224	229	235	243	252	263	277
SGCS	199	198	199	200	203	206	211	218	226	235

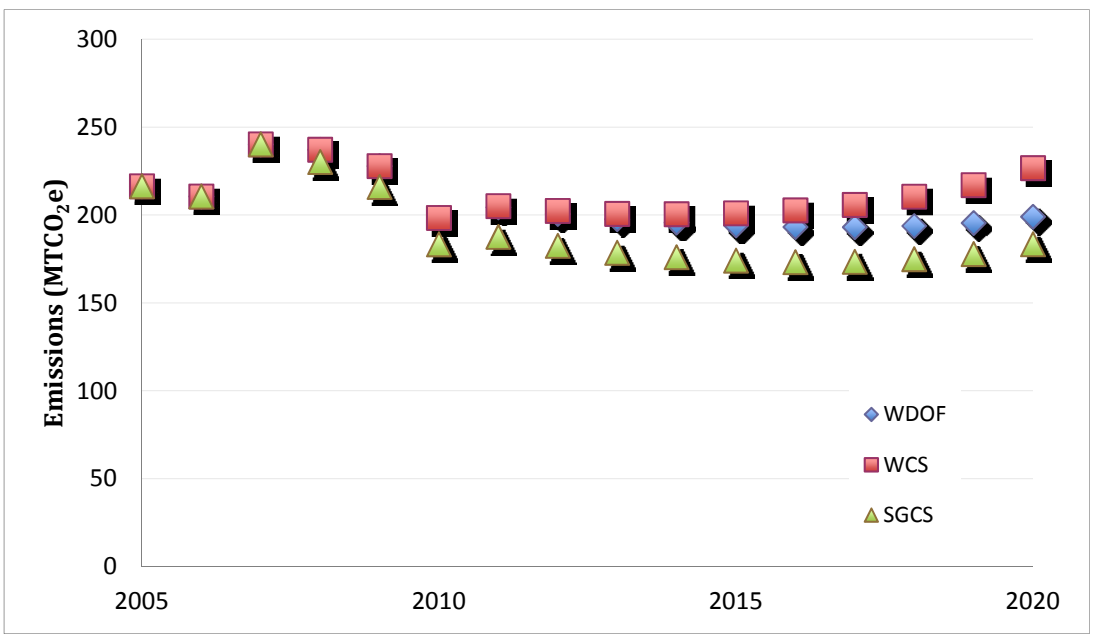

Figure 10: Projected municipal fleet and energy use emissions from 2005 to 2020 with RPS

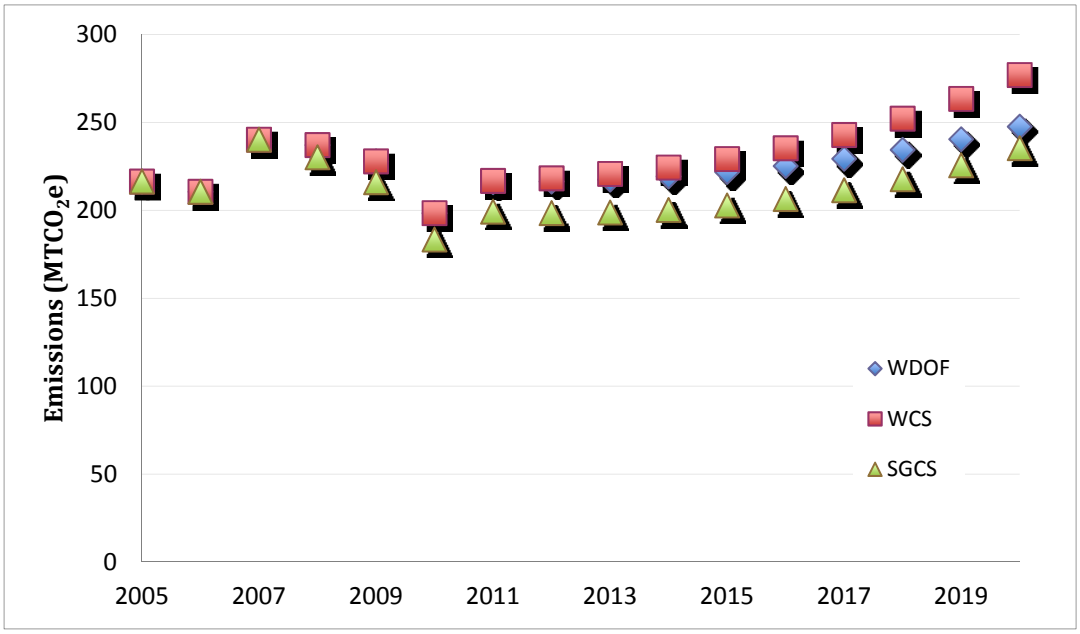

Figure 11: Projected municipal fleet and energy use emissions from 2005 to 2020 without RPS

Analysis

The resulting emissions for Winters appear to be consistent and there are no extreme outliers in the data. Table 16 shows the percentage decrease and increase calculated for each projection method.

Table 16: Percentage increase or decrease in municipal emissions from 2005 to 2020

Projection Method	Percentage Decrease or Increase in emissions from 2005 to 2020 (%)[26]
WDOF with RPS	-8.7
WCS with RPS	4.5
SGCS with RPS	-18.0
WDOF without RPS	12.6
WCS without RPS	21.9
SGCS without RPS	8.1

[26] Values in parentheses indicate a decrease in emissions.

Municipal Water and Wastewater

Data Sources

To project municipal water and wastewater emissions we assume that potable water supply (PWS) and wastewater treatment (WWT) consumption will grow in proportion to local population. Local population growth rates were determined as outlined in the Population section. All historical electricity and gas usage data was provided by PG&E, as shown in the baseline calculations in Appendix IA. The process N_2O emissions from the 2005 baseline were used to project the WWT emissions, as described in the baseline. Carol Scianna from the city of Winters provided the solar panel array data.

Methods

For the years 2010 to 2020 we estimated three separate projections, using WDOF, WCS, and SGCS population growth rate estimates, as described in the population section above.

Assumptions

We assumed that there will be no significant changes to the current WWT or PWS processes through 2020[27]. We also assumed that all process N_2O emissions are proportionate to population growth because N-load increases proportionately to population. Solar panels were installed at the waste water treatment plant in May of 2010. An annual amount of solar energy consumed for wastewater treatment was assumed to remain constant from 2011 and 2020 and was provided by Carol Scianna. The annual GHG emissions associated with solar power generation was assumed to be negligible.

Emissions factors

We used the CO_2, CH_4 and N_2O electricity and natural gas emissions factors developed in the Residential and Commercial and the RPS sections of this report.

Energy Use (PWS and WWT)

We used known energy use values for the years 2005 to 2010. To project the energy use for the years 2011 to 2020, three separate projections were estimated, one using each population projection (WDOF, WCS, and SCGS). We assumed that PWS and WWT energy use per capita remain constant, so we simply scaled the energy using the annual population growth estimates based on the WDOF, WCS, and SGCS population estimates. Equation 18 shows the calculations for electricity use estimates for PWS for 2011 to 2020.

$$K_{PWS_n,m} = K_{n-1} + (K_{n-1} * P_m) \qquad [18]$$

Where:

Term	Description	Value	Units
$K_{PWS_n,m}$	Electricity use from the grid for PWS in year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	kWh

[27] It is unlikely that there will be any significant changes to PWS and WWT because there are no projects planned at the current time to occur before 2020.

K_{n-1}	Electricity use for PWS for year n-1	Input Values	kWh
P_m	Growth rate for population estimate m (WDOF, WCS, or SCGS)	Input Values (Table 1)	none

For WWT, Equation 19 was used to provide an estimate of annual emissions associated with the consumption of energy from the grid from 2011 to 2020. The grid energy use value is the total energy use less the electricity generated by the WWT solar panel array.

$$K_{WWT_n,m} = K_{n-1} + (K_{n-1} * P_m) - SA \qquad [19]$$

Where:

Term	Description	Value	Units
$K_{WWT_n,m}$	Electricity use from the grid for WWT in year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	kWh
K_{n-1}	Electricity use for WWT for year n-1	Input Values	kWh
P_m	Growth rate for population estimate m (WDOF, WCS, or SCGS)	Input Values (Table 1)	none
SA	Yearly electricity generated by the WWT solar panels	310,225[28]	kWh

Emissions (PWS and WWT)

PWS and WWT emissions from 2005 to 2010 are calculated in the baseline inventory (Appendix IA). To estimate electricity emissions with RPS from 2011 to 2020, we use Equation 19. Electricity emissions without the RPS were estimated as in Equation 20 by substituting the constant (no RPS) emissions factors for each gas.

$$E_{j,n,m} = (K_{j,n,m} * RPS_n) + (K_{j,n,m} * A * RPS_{CH4}) + (K_{j,n,m} * B * RPS_{N20}) \qquad [20]$$

Where:

Term	Description	Value	Units
$E_{j,n,m}$	Total emissions generated for process j (PWS or WWT) in year n from electricity usage for population estimate m (WDOF, WCS, or SCGS) with RPS	Calculated Values	$MTCO_2$
$K_{j,n,,m}$	Electricity use from the grid for process j (PWS or WWT) in year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	kWh
RPS_n	RPS emissions factor for year n	Input Values	$MTCO_2/kWh$
A	Conversion factor	21	$MTCO_2e/MTCH_4$
RPS_{CH4}	CH_4 RPS emissions factor for year n	Input Values	$MTCH_4/kWh$
B	Conversion factor	310	$MTCO_2e/MTN_2O$
RPS_{N2O}	N_20 RPS emissions factor for year n	Input Values	MTN_2O/kWh

[28] Provided by Carol Scianna at the City of Winters.

To determine emissions from N_2O from wastewater treatment plant processes and aquatic discharge, we simply scaled the baseline inventory emissions by the population for the years 2006 to 2020 as shown in Equation 21. Population estimates are obtained from the population section of this report.

$$NE_{n,m} = (P_{n,m}/P_m) * NE_b \quad [21]$$

Where:

Term	Description	Value	Units
$NE_{n,m}$	N_2O emissions for year n for population estimate m (WDOF, WCS, or SCGS)	Calculated Values	$MTCO_2e$
$P_{n,m}$	Population for year n from population estimate m (WDOF, WCS, or SCGS)	Input Values	people
P_m	2005 Baseline population from population estimate m (WDOF, WCS, or SCGS)	6,753	people
NE_b	N_2O emissions for baseline year (2005) for process emissions of aquatic discharge	Input Values	$MTCO_2e$

Results

Water and wastewater treatment emissions projections for 2011-2020 for Winters are provided in Tables 17 through 22 and in Figures 12 and 13.

Table 17*:* Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using WDOF with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	108	65	38	37	36	35	33	32	30	29
PWS Electricity Use	164	158	151	146	139	133	126	119	112	107
WWT Process N_2O	8	8	8	8	8	8	8	8	8	8
WWT Effluent Discharge into Aquatic Environments N_2O	159	160	161	163	164	165	166	167	168	170
Total	439	391	359	354	347	340	333	326	319	314

Table 18: Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using WCS with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	108	66	39	38	37	36	35	34	32	31
PWS Electricity Use	165	159	153	148	142	135	129	122	116	110
WWT Process N_2O	8	8	8	8	8	8	8	9	9	9
WWT Effluent Discharge into Aquatic Environments N_2O	160	161	163	165	166	168	170	172	174	175
Total	440	394	363	359	354	348	342	336	330	326

Table 19: Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using SGCS with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	108	67	40	40	39	38	37	36	35	34
PWS Electricity Use	165	160	154	150	144	138	132	126	119	114
WWT Process N_2O	8	8	8	8	8	8	8	8	9	9
WWT Effluent Discharge into Aquatic Environments N_2O	154	156	159	161	163	165	167	170	172	174
Total	435	391	361	358	354	349	345	340	335	331

Table 20: Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using WDOF without RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	122	78	48	48	49	50	51	52	53	54
PWS Electricity Use	186	187	189	190	191	193	194	195	197	198
WWT Process N_2O	8	8	8	8	8	8	8	8	8	8
WWT Effluent Discharge into Aquatic Environments N_2O	159	160	161	163	164	165	166	167	168	170
Total	475	433	406	409	412	416	419	423	426	430

Table 21: Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using WCS without RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	122	78	49	50	51	53	54	56	57	58
PWS Electricity Use	187	188	190	192	194	196	199	201	203	205
WWT Process N_2O	8	8	8	8	8	8	8	9	9	9
WWT Effluent Discharge into Aquatic Environments N_2O	160	161	163	165	166	168	170	172	174	175
Total	476	436	410	416	421	426	431	436	442	447

Table 22: Projected Water and Wastewater Treatment Emissions ($MTCO_2e$) using SGCS without RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	123	79	50	52	54	55	57	59	61	63
PWS Electricity Use	187	190	192	195	198	200	203	206	209	212
WWT Process N_2O	8	8	8	8	8	8	8	8	9	9
WWT Effluent Discharge into Aquatic Environments N_2O	154	156	159	161	163	165	167	170	172	174
Total	472	433	409	415	422	429	436	443	450	458

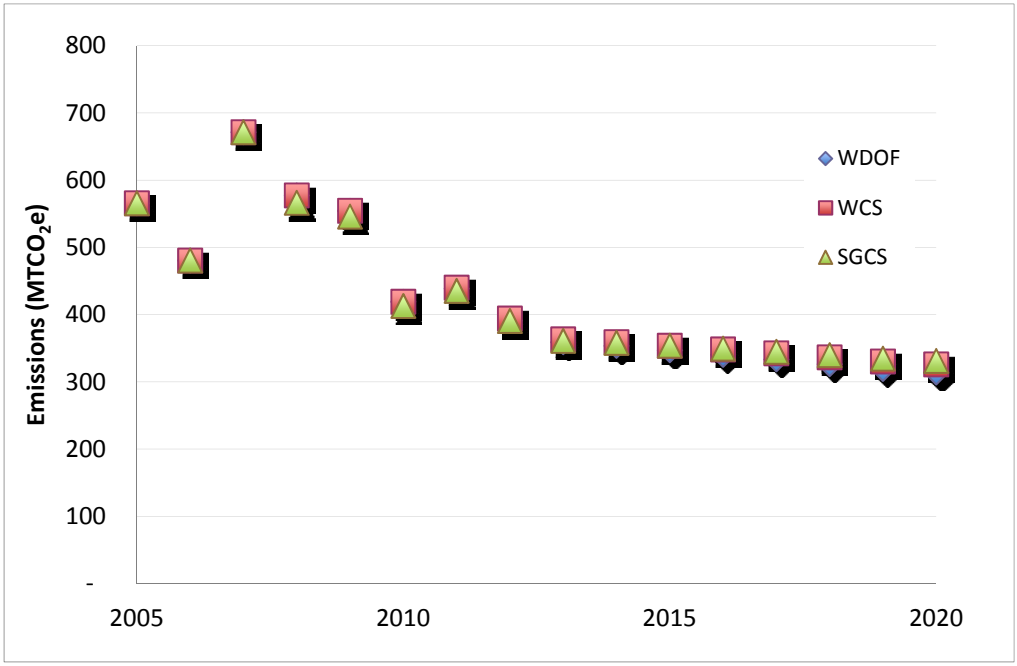

Figure 12: PWS and WWT projected emissions with RPS for 2005 to 2020

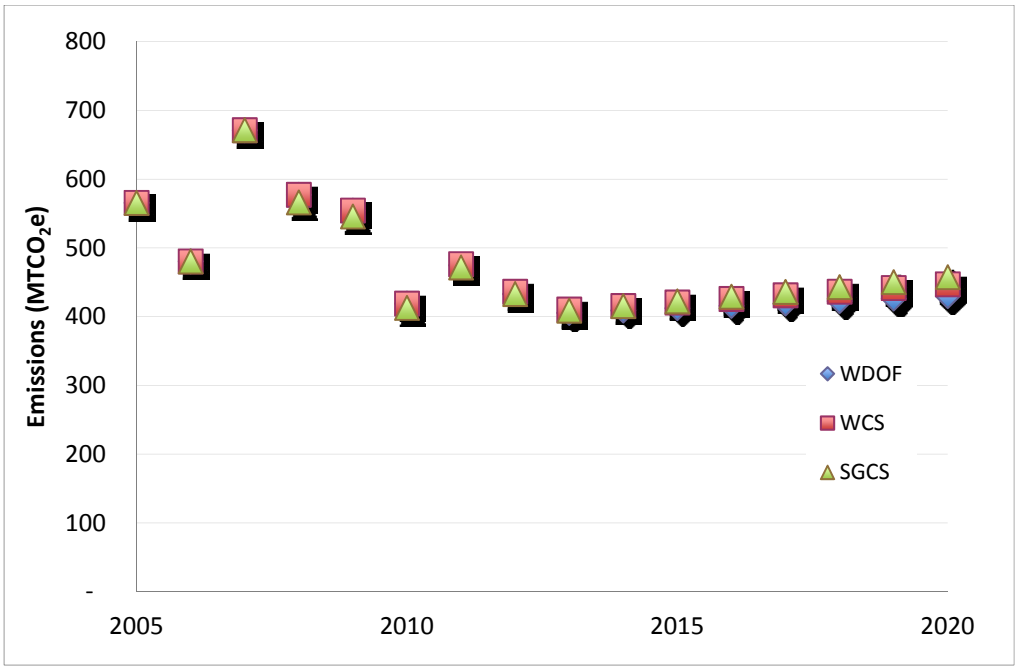

Figure 13: PWS and WWT projected emissions without RPS for 2005 to 2020

Analysis

The resulting PWS and WWT emissions for Winters appear to be consistent and there are no extreme outliers in the data. Table 23 shows the percentage decrease or increase in emissions using each projection method.

Table 23: Percentage decrease or increase in PWS and WWT emissions from 2005 to 2020

Projection Method	Percent Decrease or Increase from 2005 to 2020[29]
WDOF with RPS	(80.2)
WCS with RPS	(73.5)
SGCS with RPS	(70.8)
WDOF without RPS	(31.6)
WCS without RPS	(26.5)
SGCS without RPS	(23.6)

[29] Values in parentheses indicate a decrease in emissions over the 2005 to 2020 time interval.

Total Projections

Adding the yearly projected emissions totals for each subsection together we obtained total city emissions as shown below in Table 25 and Figures 15 and 16. Table 26 provides the emissions totals for Scopes 1 and 2 only.

Table 25: Total Yearly Projected City Emissions in $MTCO_2e$

Year	Total $MTCO_2e$ Emissions					
	With RPS			Without RPS		
	WDOF	WCS	SGCS	WDOF	WCS	SGCS
2005	69,495	69,495	69,495	69,495	69,495	69,495
2006	68,996	68,996	68,996	68,996	68,996	68,996
2007	71,185	71,185	71,185	71,185	71,185	71,185
2008	70,987	70,987	70,969	70,987	70,987	70,969
2009	69,845	69,845	69,825	69,845	69,845	69,825
2010	67,392	67,392	67,371	67,392	67,392	67,371
2011	67,630	68,596	67,690	68,551	68,840	68,618
2012	67,252	68,586	67,392	68,495	68,787	68,653
2013	66,893	68,596	67,112	68,458	68,769	68,708
2014	66,590	68,638	66,885	68,451	68,814	68,797
2015	66,263	68,698	66,631	68,461	68,877	68,904
2016	65,932	68,760	66,371	68,472	68,945	69,015
2017	65,597	68,826	66,104	68,485	69,016	69,131
2018	65,250	68,887	65,822	68,492	69,083	69,243
2019	64,901	68,954	65,536	68,503	69,157	69,361
2020	64,613	69,024	65,312	68,515	69,235	69,483

Table 26: Scope 1 and 2 Yearly Projected City Emissions in $MTCO_2e$

Year	Scope 1 and 2 $MTCO_2e$ Emissions					
	With RPS			Without RPS		
	WDOF	WCS	SGCS	WDOF	WCS	SGCS
2005	57,290	57,290	57,290	57,290	57,290	57,290
2006	57,003	57,003	57,003	57,003	57,003	57,003
2007	59,400	59,400	59,400	59,400	59,400	59,400
2008	59,407	59,407	59,389	59,407	59,407	59,389
2009	58,466	58,466	58,446	58,466	58,466	58,446
2010	56,210	56,210	56,189	56,210	56,210	56,189
2011	56,641	57,607	56,701	57,562	57,851	57,629
2012	56,294	57,628	56,434	57,537	57,829	57,695
2013	55,966	57,669	56,185	57,531	57,842	57,781
2014	55,695	57,743	55,990	57,556	57,919	57,902
2015	55,385	57,820	55,753	57,583	57,999	58,026
2016	55,071	57,899	55,510	57,611	58,084	58,154
2017	54,753	57,982	55,260	57,641	58,172	58,287
2018	54,423	58,060	54,995	57,665	58,256	58,416
2019	54,090	58,143	54,725	57,692	58,346	58,550
2020	53,818	58,229	54,517	57,720	58,440	58,688

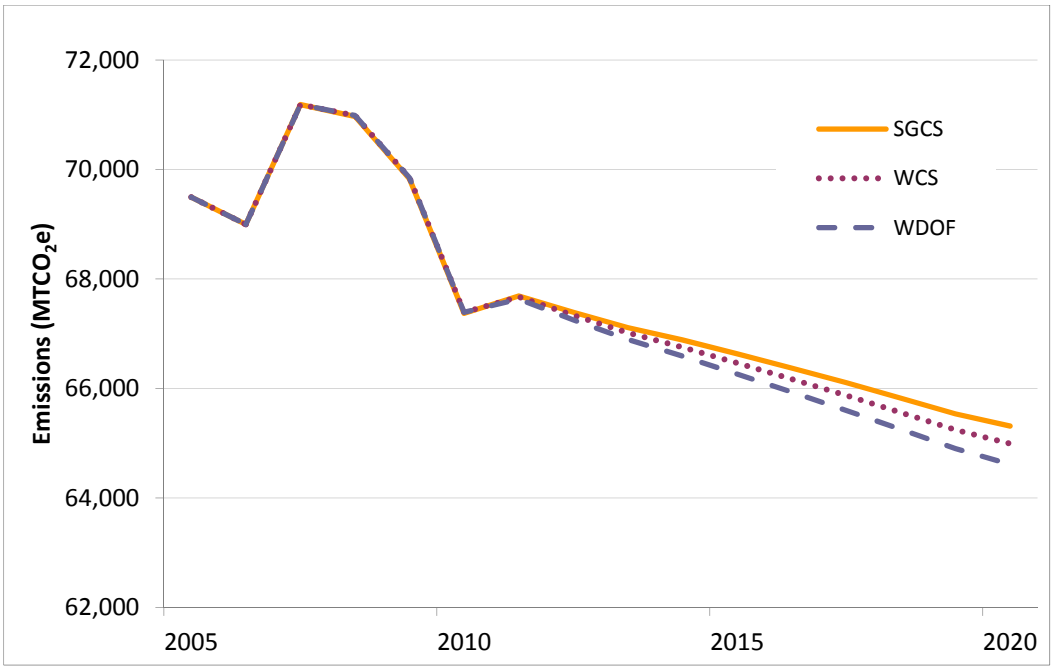

Figure 15: Total Emissions Projections Per Year (with RPS)

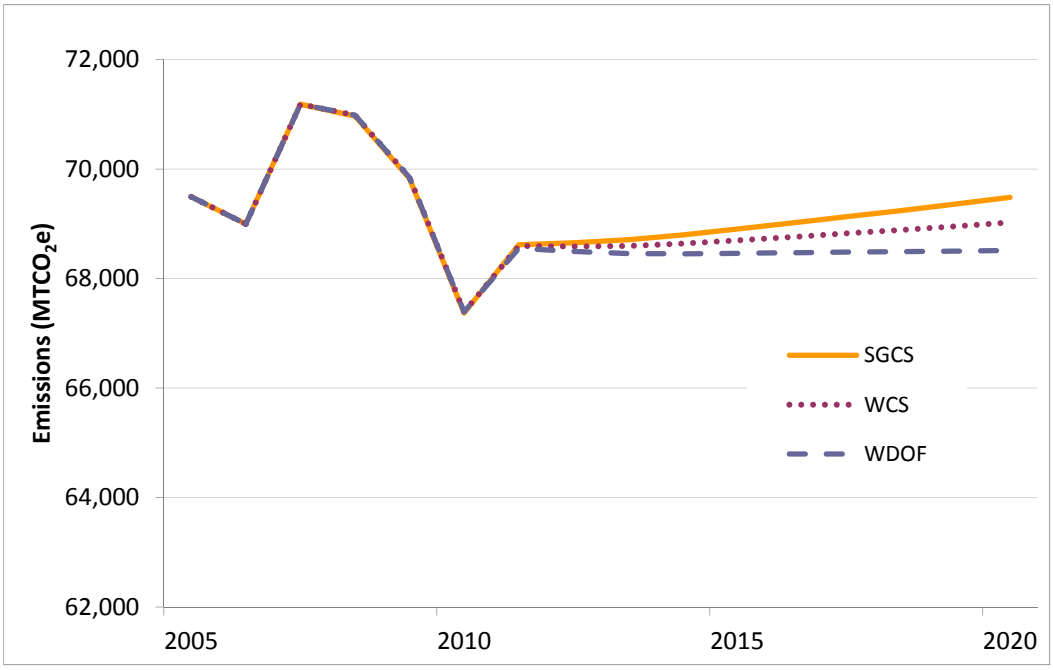

Figure 16: Total Emissions Projections Per Year (without RPS)

Not applying RPS factors yields total 2020 emissions estimates that are 6.0% higher than RPS estimates using WDOF, 6.2% higher than RPS estimates using WCS, and 6.4% higher than RPS estimates using SGCS in the year 2020.

In Tables 26 and 27 we show the total emissions estimates for each emissions source by the emissions scope for the estimates that use the SCGS population projection.

Table 26: Summary of projections for 2020 with RPS using the SGCS population projection

Emissions Source	Emissions ($MTCO_2e$) Scope 1	Scope 2	Scope 1&2	Scope 3
Community				
Electricity-Residential	0	2,693	2,693	0
Electricity-Commercial	0	1,982	1,982	0
Natural Gas-Residential	5,194	0	5,194	0
Natural Gas-Commercial	998	0	998	0
Transportation	43,136	0	43,136	10,795
Municipal				
Electricity	0	61	61	0
Natural Gas	18	0	18	0
Vehicle Use	104	0	104	0
PWS	0	114	114	0
WWT	183	34	217	0
Total	**49,633**	**4,884**	**54,517**	**10,795**

Table 27: Summary of projections for 2020 without RPS using the SGCS population projection

Emissions Source	Emissions ($MTCO_2e$) Scope 1	Scope 2	Scope 1&2	Scope 3
Community				
Electricity-Residential	0	4,993	4,993	0
Electricity-Commercial	0	3,675	3,675	0
Natural Gas-Residential	5,194	0	5194	0
Natural Gas-Commercial	998	0	998	0
Transportation	43,136	0	43,136	10,795
Municipal				
Electricity	0	113	113	0
Natural Gas	18	0	18	0
Vehicle Use	104	0	104	0
PWS	0	212	212	0
WWT	183	63	246	0
Total	**49,633**	**9,056**	**58,689**	**10,795**

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Technical Appendix II: Reduction Strategies Summaries

Community Reduction Strategies

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
Bundle 1A: Buildings - Lighting (Residential and Commercial Energy)								**3.9**
1A-1	Encourage Community Members to Use CFL Bulbs and/or Fixtures	Encourage community members to switch to CFLs by: holding promotional free CFL giveaway days, or subsidizing the cost of the bulbs, or raising awareness about available state and federal subsidies	# of light bulbs replaced with CFLs	2.58	4.35	0.6	0.015	**4.0**
1A-2	Encourage Installment of LED Exit Signs	Encourage the replacement or initial installment of old exit signs with LED exit signs; LED exit signs last much longer, and fail less frequently, reducing maintenance costs	Exit signs replaced with LED exit signs	U	26.87	2.1	0.093	**4.2**
1A-3	Encourage Installment of Occupancy Sensors	Encourage commercial sectors to install motion sensors in buildings to automatically turn the lights on and off	Square feet installed with occupancy sensors	0.06	0.236	0.2	0.00082	**3.7**
1A-4	Encourage the Installment of Solar Tubes	Encourage the installment of solar tubes in buildings; Solar tubes add natural light and reduce the need for artificial lighting	NA	340	U	U	U	**U**
1A-5	Encourage Commercial Lighting Fixture Upgrades	Encourage the replacement of older fixtures with magnetic ballasts and T-12 size fluorescent tubes with T-8 size tubes; Local government can subsidize the disposal and/ or replacement cost	Square feet of facilities retrofitted with efficient lighting	0.06	0.203	0.3	0.0007	**3.7**
1A-6	LED Holiday Light Exchange	Encourage community members to use LED holiday lights instead of traditional strings of incandescent bulbs by offering an exchange or subsidizing the cost	Strings of lights replaced with LED lights	7.5	1.48	5.1	0.00514	**4.0**
1A-7	Halogen Torchiere Lamp Exchange	Encourage community members to replace halogen torchieres with fluorescent torchieres by offering an exchange or other incentives; In addition to energy benefits, fluorescent torchieres are cooler and safer to operate compared to halogen torchieres	# of halogen torchieres replaced with fluorescent torchieres	46	16.2	2.8	0.056	**3.7**
1A-8	Institute a Lights-out-at-night Policy	Develop ordinance that requires businesses to turn off lights throughout commercial buildings at the end of the work day	Square feet with Lights Out at Night policy	0.06	0.236	0.2	0.00082	**3.8**
Bundle 1B: Buildings - Appliances (Residential and Commercial Energy)								**4.0**
1B-1	ENERGY STAR Computer Replacements	Encourage the replacement of computers with ENERGY STAR rated models	# of computers replaced with ENERGY STAR computers	0	19.86	0	0.069	**4.3**
1B-2	ENERGY STAR Monitor Replacements	Encourage the replacement of computer monitors with ENERGY STAR rated models	# of monitors replaced with ENERGY STAR monitors	0	6.03	0	0.021	**3.8**
1B-3	ENERGY STAR Printer Replacements	Encourage the replacement of printers with ENERGY STAR rated models; Research shows that new ENERGY STAR qualified printers are 37% more energy efficient on average than conventional ones; Newer models can also reduce paper consumption by printing double sided	# of printers replaced with ENERGY STAR printers	10	36.63	0.27	0.127	**4.2**
1B-4	ENERGY STAR Copier Replacements	Encourage the replacement of copy machines with ENERGY STAR rated models	# of copiers replaced with ENERGY STAR copiers	10	74.22	0.13	0.258	**4.2**
1B-5	ENERGY STAR Refrigerator Replacements	Encourage the replacement of computer monitors with ENERGY STAR rated models; New ENERGY STAR qualified refrigerators are found to use half the energy of refrigerators made prior to 1993, 40% less than those from 2001, and 15% less than required in 2007	# of refrigerators replaced with ENERGY STAR refrigerators	30	45.843	0.7	0.159	**4.0**
1B-6	ENERGY STAR Dishwasher Replacements	Encourage the replacement of dishwashers with ENERGY STAR rated models	# of dish washers replaced with ENERGY STAR dish washers	0	22.01	0	0.078	**4.3**
1B-7	ENERGY STAR Clothes Washer Replacements	Encourage the replacement of clothes washers with ENERGY STAR rated models; This replacement helps to save water, energy, and detergent as well as increase durability of clothes	# of clothes washers replaced with ENERGY STAR clothes washers	150	14.68	10.2	0.052	**3.7**
1B-8	ENERGY STAR Water Cooler Replacements	Encourage the replacement of water coolers with ENERGY STAR rated models; ENERGY STAR coolers that produce both hot and cold water offer more potential for savings, as much as $35 in extra annual cost savings per cooler	# of water coolers replaced with ENERGY STAR water coolers	0	20.16	0	0.07	**4.3**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
1B-9	High Efficiency Water Heater Replacements	Encourage the replacement of water heaters with ENERGY STAR rated models	# of water heaters replaced with high efficiency water heaters	910 for electric, 1150 for natural gas	187.42	5.6	0.66	**3.7**
1B-10	ENERGY STAR Vending Machine Replacements	Encourage the replacement of vending machines with ENERGY STAR rated models; Local government can negotiate contracts that include more energy efficient machines that will reduce GHG emissions and cost less to operate	# of vending machines replaced with ENERGY STAR vending machines	0	163.91	0	0.569	**4.3**
1B-11	Water and Energy Efficient Model Homes	Use water and energy efficient equipment in model homes	# of model homes equipped with energy efficient equipment	Mixed results depending on the type of equipment. See previous for information about specific energy efficient equipment.				**3.0**
Bundle 1C: Buildings - Comprehensive Improvements (Residential and Commercial Energy)								**3.3**
1C-1	Retro Commissioning for Energy Efficiency Performance	Evaluate the performance of various systems in existing buildings and analyze how building components work together	Square feet of facilities retro-commissioned	U	0.229	U	0.00081	**3.7**
1C-2	Enable Smart meter Data Availability	Encourage PG&E to make smart meter data available to customers	NA	U	U	U	U	**U**
1C-3	Promote Energy Conservation Through Campaigns Targeted at Residents	Outreach and education programs that offer information about and encourage conservation measures; Offer incentives and prizes to increase interest in conservation through programs similar to City of Davis's Davis Cool Initiative, Low Carbon Diet Pilot Program, or Carbon Neutral Design Competition	# of targeted or participating households	1000	192.83	5.2	0.678	**3.2**
1C-4	Promote Energy Conservation Through Campaigns Targeted at Businesses	Educate public on free energy-efficiency programs such as PG&E commercial and industrial energy efficiency/demand response program; Promote water production and storage policies to reduce the energy requirements and GHG emissions associated with these activities, including construction of low embedded energy and low energy use water towers instead of on-ground tanks; Offer incentives and prizes to increase interest in conservation through programs similar to Davis Cool Initiative or Carbon Neutral Design Competition	# of participating businesses	1000	1525.22	0.7	6	**3.2**
1C-5	Promote Green Building Practices Through a Local Green Building Assistance Program or Creating Incentives	1) Participate in Yolo Energy Watch program 2) Develop policy to evaluate and incentivize carbon-neutral development projects; Incentives could include: green building permit preference (move quickly through permit process based on Title 24 analysis), fee incentives, and improved planning process 3) Require the implementation and construction of lowest possible carbon impact public works and infrastructure projects	Square feet of green building construction	U	0.478	U	0.001827	**3.3**
1C-6	Perform Energy Efficiency Retrofits of Existing Facilities	Provide and encourage residential and commercial energy audits and retrofits, such as free energy audits provided by PG&E; Leverage existing rebates or add additional rebates for energy efficient retrofits	Square foot of facilities retrofitted	1.5	0.208	7.2	0.00073	**2.7**
1C-7	Require Energy Upgrades of Facilities at Time Of Sale	Require prescriptive energy efficiency measures (EE checklist) during title transfer stage based on sale price; Checklists could include measures such as: using efficient light bulbs and fixtures, replacing appliances with more efficient alternatives, increasing insulation, replacing windows, and upgrading HVAC systems	# of homes sold that implemented energy efficient measures	600	227.41	2.6	0.8262	**2.7**
1C-8	Require New Homes to be Solar Ready	Create regulations requiring new homes to be solar-ready; Solar-ready features include orientation and infrastructure requirements	NA	U	U	U	U	**4.5**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
1C-9	Adopt a High Performance Local Energy Code (Including a Green Building Ordinance) for New Construction and Renovation of Community Facilities	Update building code to mandate higher building performance in commercial and residential buildings; Mandate achievement of CALGreen Tier 1 energy performance or even LEED silver/ gold status; Seek to harmonize with regional green building ordinances; Establish neighborhood design standards to maximize GHG reductions from urban design including: street layout, building orientation, landscaping to accommodate passive and active solar energy systems and to capture natural cooling and heating opportunities	Square foot of new construction and renovation meeting the Local Energy Ordinance	0	0.52	0	0.0018	**2.8**
1C-10	Adopt a Strict Commercial Energy Code	Green building design looks at buildings as a complete system to maximize health, comfort, and productivity of occupants while minimizing resource use for construction and operation; Adopt GHG thresholds and standards for new residential and commercial buildings including credit for zero net energy	Square foot of new construction and renovation meeting the Energy Code	U	0.19	7.9	0.00073	**2.8**
1C-11	Adopt Strict Residential Energy Code Requirements	Green building design looks at buildings as a complete system to maximize health, comfort, and productivity of occupants while minimizing resource use for construction and operation; Adopt GHG thresholds and standards for new residential and commercial buildings including credit for zero net energy	# of newly constructed homes meeting the Energy Code	5000	193.27	25.9	0.6352	**2.5**
1C-12	Create Carbon Tax	Create a city carbon tax to function as a funding mechanism to support city programs to reduce GHG emissions in addition to federal level carbon taxes, mechanisms include: 1) Utility bill checkbox "green fund" similar to PG&E climate smart, & resulting program implementation; 2) Green-fee on building permits (e.g., $0.50 per $1k), and resulting programs; 3) General Plan fee on projects (to support staffing, GP updates & amendments), and resulting activities; and 4) tax builders of new homes based on the projected (lifetime) carbon emissions resulting from the home	NA	U	U	U	U	**U**
1C-13	Implement New Energy-efficient Public/Affordable Housing Projects	Build and/ or promote energy efficient affordable homes; These projects can function as pilot or demonstration projects to promoting Green Building standards and regulations to the general building community, as well as, serve as a public education program	# of energy efficient housing units built	3000	483.53	6.2	1.589	**2.8**
1C-14	Funding for Energy Efficiency and Renewable Energy Projects	Establish a financing district for energy efficient projects including solar energy production upgrades of residential and commercial properties (AB 811); Funding sources could include: funding from energy efficiency and conservation block grant programs, state energy programs, and California-FIRST's PACE funds	# of participating homes	5000	97.93	51.1	0.3664	**2.3**
1C-15	Energy Efficient Weatherization of Low-Income Housing Program	Create a program to help low-income households acquire weatherization, including: sealing cracks, adding insulation, and (sometimes) replacing inefficient appliances; This will help low-income households save money on their bills and improve their quality of life, as well as stimulate the local economy	# of homes weatherized	2913	259.98	11	0.995	**2.8**
1C-16	Green Lease Program	Improve energy efficiency of multifamily rental (MFR) housing by either working with landlords to obtain energy efficiency and water conservation, or moving facilities to locations that are supported by renewable systems (such as solar) and close to infrastructure, such as transportation; Participating MFRs could then advertise themselves as a "Green Property"	Square feet of commercial space participating in the program	U	U	U	0.000315	**4.1**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
1C-17	"Green Business/Developer" Recognition Program	Encourage businesses to go beyond operations regulations and to conduct business in a environmental friendly manner (Such as: contracting with companies which adopt energy efficient, low carbon practices, and using non-toxic and fragrance-free products) via incentives and disincentives; Green business programs usually provide assistance to participating businesses in pollution reduction, energy savings, recycling, and waste reduction; This is helpful to small businesses that cannot afford to hire environmental consulting services; These programs can focus on a type of business of particular concern or large potential for impact; Participation in a local green business program can be promoted by allowing participating businesses to brand themselves as "green businesses" once they meet certain requirements	# of participating businesses	100	1525.22	0.1	5.997	**3.2**
1C-18	Create Volunteer-based Energy Auditing/Maintenance Program	Encourage the creation of voluntary programs through public–private partnerships such as Acterra's Green@Home Program in Palo Alto, a partnership among the city, neighborhood associations, utilities and environmentalists; In this program, trained volunteers would conduct home visits, install CFLs, turn down thermostats on hot water heaters, install electronic thermostats, and go through a 20-point checklist on ways homeowner can increase water and energy efficiency	NA	U	U	U	U	**U**
Bundle 1D: Buildings - Temperature Control (Residential and Commercial Energy)								**3.6**
1D-1	HVAC Temperature Control	Encourage the community to dial down (in winter) or up (in summer) thermometers [~4oF in occupied areas, more in infrequently occupied areas]; reduce outside air volume circulated; fine-tune boiler burners [from >200% to 130% excess air]	NA	U	U	U	U	**U**
1D-2	ENERGY STAR Window Air Conditioner Replacements	Encourage the replacement of window air conditioners with ENERGY STAR rated models	# of window air conditioners replaced with ENERGY STAR window air conditioners	10	9.39	1.1	0.033	**4.2**
1D-3	EPA Certified Wood Stoves Replacements	Encourage the replacement of non-certified older stoves with EPA certified wood stoves; Using wood waste as a fuel may help reduce the waste sent to landfills and thereby reduce methane production from a landfill's anaerobic decomposition of organic waste	# of non-certified wood stoves replaced with certified wood stoves	500	U	U	0	**3.5**
1D-4	Energy Efficient Boiler Replacements	Encourage the replacement of any over-sized boiler with appropriately sized boilers	Square feet of facilities upgraded with efficient boilers	0.36	0.0149	24.2	0.000054	**3.5**
1D-5	Energy Efficient Chiller Replacements	Encourage the replacement of any over-sized chillers with appropriately sized chillers	Square feet of facilities upgraded with efficient chillers	0.36	0.085	4.2	0.000294	**3.7**
1D-6	HVAC Fan Upgrades	Encourage replacement of older fans with energy-efficient fans and insulate leaking ducts	Square feet of facilities upgraded with efficient fans	0.02	0.0387	0.4	0.000134	**3.8**
1D-7	Electric to Natural Gas Heating Conversion	Encourage the replacement of electricity based heating equipment with natural gas based units	# of homes switched from electric to natural gas heat	1350	50.8	26.6	0.164	**3.2**
1D-8	Install Reflective Roofing	Encourage the installation of reflective roofing; Reflective roofs reduce electricity use by reducing the heat entering the building through the roof, which ultimately translates into energy bill savings; Reflective roofs yield the largest energy savings in hot, sunny climates, and will only save energy on a building with air conditioners, although it will keep non air conditioned buildings cooler; Reflective roofs may help mitigate the urban heat island effect if implemented on a large enough scale	Square feet of reflective roof installed	0.25	0.086	2.9	0.000307	**3.7**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
1D-9	Install Green Roofing	Encourage the installation of green roofing; Green roofs use a soil medium and plants on top of an impermeable membrane roof; They reduce building energy use by insulating the roof, and by cooling it through shading and evapotranspiration (the process by which plants draw water from the soil and release it into the air); Green roofs yield the largest energy savings in hot, sunny climates, and will only save energy on a building with air conditioner, although it will keep non air conditioned buildings cooler; Green roofs also help with reducing storm water runoff by holding up to 70-90% of water from summer storms, and 25-40% of winter storm water; Additionally, they delay runoff and filter the water which can help avoid expensive expansions to wastewater treatment plants that handle storm water; Green roofs also cool the air around surrounding buildings, and can contribute towards reducing urban heat island effect if implemented on a large enough scale; Lastly, these spaces can also be used to grow food or provide a recreational space	Square feet of green roof installed	7	0.0441	153.1	0.00076	**3.0**
Bundle 2: Renewable Energy Generation and Procurement (Residential and Commercial Energy)								**3.0**
2-1	Encourage Installment of Geothermal Heat Pumps	Encourage the use of Geothermal Heat Pumps (GHPs) for heating and cooling; GHPs are more efficient than traditional air-conditioning or heat pumps because they use the stable underground temperatures; GHPs also reduce maintenance costs and last longer than traditional heating and air conditioning equipment	# of homes that installed GHPs	12380	156.75	79	0.544	**3.0**
2-2	Encourage R&C Solar Photovoltaic (PV) Panels	Encourage the installment of solar (PV) panels in residential and commercial buildings	kW of PV installed	9000	144.248	62	0.5	**3.0**
2-3	Encourage R&C Solar Water Heaters	Encourage the installment of solar water heaters in residential and commercial buildings	Homes installing solar hot water heater	3000	20.413	15	0.72	**3.0**
2-4	Encourage Commercial Wind Turbines Installation	Encourage the installment of wind turbines at businesses for commercial energy production	Capacity size (kW)	1540	150.176	10.3	0.5209	**3.2**
2-5	Purchase Green Electricity Via the Grid from Solar, Geothermal, Wind or Hydroelectric Sources	Purchase green electricity via the grid from solar, geothermal, wind, or hydroelectric sources	kWh of electricity purchased green	0.022	-91575	U	0.000343	**2.8**
2-6	Purchase Green tags / Renewable Energy Certificates	Encourage community members to purchase Renewable Energy Certificates (RECs); RECs allow an institution or a home to offset their energy consumption from non-renewable sources by investing in utilities that rely on renewable energy sources for energy production without being directly connected to the utility for its energy needs	kWh of electricity purchased green	0.019	-241300	U	0.000343	**2.8**
2-7	Create Community Solar Facilities	Create community solar facilities that allow businesses, apartment residents, and other residents who can not have their own PV panels to utilize solar power	NA	U	U	U	U	**U**
Bundle 3: Waste Diversion and Reduction (Solid Waste Disposal - Residential and Commercial)								**2.7**
3-1	Encourage Sustainable Action in Schools	Encourage schools to improve recycling, energy conservation, and product lifecycle awareness	NA	U	U	U	U	**4.5**
3-2	Encourage Reuse or Recycling of Construction and Demolition Materials	Create a program to encourage reuse/recycling of materials used in construction and demolition to divert landfill waste	Waste diverted from landfill (lbs/ square feet of construction)	U	U	U	0.00000533	**2.3**
3-3	Implement "Pay-As-You-Throw" Program	Provide financial incentives for people to reduce the amount of waste they generate; Encourage recycling, reuse of items, and source reductions, where people may choose items with less packaging, knowing they will have to pay for the disposal of that packaging	Waste diverted from landfill (lbs/ person/ year)	U	U	U	2.144E-06	**2.7**
3-4	Create Sustainable Vendor Ordinance for Public Events	Require recycling at major public events (of cardboard, paper, containers, and food/organics); Require compostable/recyclable silverware and food take out packaging	Waste diverted from landfill (lbs/ person/ year)	U	U	U	0.299	**3.6**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/y	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
3-5	Cooperative Purchasing program	Create a bulk and/or cooperative purchasing system for businesses within the city to implement climate friendly, rapidly renewable, and recycled-content products purchasing policies	# of participating businesses	U	U	U	U	**U**
3-6	Establish/Expand Curbside Organics Composting Program	Establish/expand curbside organics composting program to be conducted in the same manner as garbage collection to divert waste from landfills; When organic matter like wood, paper, food, and yard waste is placed in landfills, it decomposes producing methane, a GHG 21 times as powerful as carbon dioxide; Collecting and composting this organic waste prevents the emissions the waste would have produced in the landfill	Waste diverted from landfill (lbs/ person/ year)	U	U	U	1.2E-06	**2.0**
3-7	Establish/Expand Curbside Recycling Programs	Establish/expand curbside recycling program to be conducted in the same manner as garbage collection to divert waste from landfills; Set higher diversion rate goal for existing programs to increase waste recovery of recyclable goods	Waste diverted from landfill (lbs/ person/ year)	U	U	U	0.00001285	**2.2**
3-8	Establish/Expand Business Recycling Programs	Set up recycling programs for businesses in the community to reduce landfill waste; Recycling consumes less energy than producing products from raw materials; Set higher diversion rate goals for existing programs to increase waste recovery of recyclable goods	Waste diverted from landfill (lbs/ person/ year)	U	U	U	0.00001285	**2.2**
3-9	Create Yard Waste Collection and Composting Program	Create a curbside collection program for composting of yard waste only; Adopt an ordinance for landscape maintenance businesses to compost/divert yard waste	Waste diverted from landfill (lbs/ person/ year)	U	U	U	6.59E-07	**2.2**
3-10	Reuse Facilities/ Programs to Foster Solid Waste Reduction	Create a program to encourage reuse of items, which is less energy intensive than recycling and recreating products; Create a city salvage yard for the city to promote reuse of goods and reduce consumption	Waste prevented (lbs/ person/ year)	U	U	U	1.368E-06	**2.7**
Bundle 4: Urban Forestry (R&C Energy; Carbon Sequestration - not in Inventory)								**3.6**
4-1	Low Maintenance Gardens in New Development Model Homes	Encourage the installation of low maintenance gardens in new development for model homes	NA	U	U	U	U	**4.5**
4-2	Tree Planting to Shade Buildings	Encourage tress planting to shade buildings, thereby, reducing energy required to heat or cool the buildings; Trees also help reduce storm water runoff, create a more attractive environment and increase property values	# of trees planted to shade buildings	224	20.16	11.1	0.07	**3.2**
4-3	Develop Policies to Encourage Community-Based Farms	Develop policies to encourage community-based farms including demonstration projects	NA	U	U	U	U	**U**
4-4	Tree Planting for Carbon Storage & Heat Island	Plant trees on a broad scale to reduce the urban heat island effect, as well as for carbon storage	# of trees planted	U	0.692	324	0.252	**3.2**
Bundle 5: Transportation Miscellaneous (Transportation)								**3.3**
5-1	Encourage Telecommunicating	Encourage telecommunicating; Encourage the use of video and cellular communication methods rather than in-person meetings that require travel to an office workspace	Employees offered telecommuting incentives	U	48.244	U	0.172	**3.3**
5-2	Encourage Consumption of Local Food, Produce, and Goods	Encourage consumption of local foods, produce, and goods; Conduct a community education campaign on the carbon consequences of food choices, with special focus on protein sources such as meat, fish, grains and vegetables	NA	U	U	U	U	**U**
5-3	Gasoline Lawnmower Replacement	Encourage gasoline lawnmower replacement through exchange programs or other incentives; Lawnmowers pollute disproportionately, replacing yard equipment with electric models may reduce GHG emissions	# of lawnmowers replaced	60	U	U	0	**3.3**
Bundle 6: Transportation Infrastructure (Transportation)								**2.8**
6-1	Use Non-asphalt Pavements	Encourage the commercial use of non-asphalt pavements; Alternatives can reduce the urban heat island effect, reducing energy use for cooling	Acres of non-asphalt pavement converted	10000	U	U	0	**2.8**
6-2	Traffic Light Synchronization	Synchronize traffic lights to minimize stopping and idling and reduce GHG emission reductions	NA	U	U	U	U	**U**
6-3	Increase Number of Roundabouts	Increase the number of traffic circles in place of traffic lights and retrofit old intersections	NA	20000	U	U	U	**U**

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Bundle 7: Transportation Fuels (Transportation)								**2.8**
7-1	Develop a Neighborhood Electric Vehicle Program	Research the development of infrastructure for NEV vehicles; These vehicles are highly energy efficient and to be used for short trips within the city; As an example, the City of Lincoln has produced a NEV Transportation Plan	NA	U	U	U	U	**U**
7-2	Convert to Compressed Natural Gas (CNG)	Encourage conversion to compressed natural gas (CNG); CNG is a clean burning fuel with low carbon footprint compared to diesel or gasoline; CNGs are ideal for taxis and buses because they usually have centralized fueling stations, have high VMT, and operate in high density population areas	# of CNG vehicles	3000	U	U	1.551	**2.5**
7-3	Conversion to Electric Vehicles (EVs)	Encourage R&C to convert gasoline operated vehicles to EVs; Neighborhood Electric Vehicles (NEVs; max speed 25 mph) are suitable in-town transportation and small deliveries, have no tailpipe emissions, and lower operating cost	# of EVs	10000	1613.32	6.2	5.75	**3.2**
7-4	Local Bio-Fuel Production	Develop a plan for local bio-fuel production, distribution and use by working with local farmers of Yolo and Solano Counties, UCD, State, and Federal partners; Co-benefits to local agricultural industry include disposal of crop residues, availability of an alternative fuel source for farm equipment, and improved air quality	NA	U	U	U	U	**U**
Bundle 8: Transportation Equipment and Operations (Transportation)								**4.4**
8-1	Limit Idling of Heavy Equipment Vehicles	Educate the public and any businesses that use heavy equipment vehicles on the effectiveness of limiting the idling for GHG emission reduction	# of vehicles affected	U	669.6	U	2.29	**4.3**
8-2	Limit Idling of Local Transit Buses and School Buses	Educate local transit and school bus management officials on the effectiveness of reducing idling for GHG emission reduction	# of vehicles affected	U	251.1	U	0.86	**4.5**
Bundle 9: Transit and Bike/Ped (Transportation)								**3.0**
9-1	Provide Low-Carbon Transportation Education	Provide low-carbon transportation education; Promote a variety of transportation options to help people find car-free transportation methods (example: provide multi-modal guides)	# of households targeted	29	223.518	0.1	0.797	**3.0**
9-2	Increase Mass Transit Ridership	Encourage more people to use mass transit options, such as rail travel	# of additional daily transit passengers	U	U	U	1.339	**3.7**
9-3	Increase Bus Ridership	Encourage people to ride buses	# of additional daily bus passengers	U	U	U	0.556	**3.7**
9-4	Encourage a Change in Transit Policy Allowing Bicycles on Trains/Buses	Encourage transit systems to reverse policies which discourage or prohibit having bicycles on buses or trains by implementing bicycle-friendly policies in transit stations and trains/ buses	# of additional daily bike/ transit trips replacing car trips	U	U	U	0.926	**4.0**
9-5	Transportation Demand management	Require that new developments mitigate their transportation impacts by requiring funds to supplement the need for additional buses or shuttles	NA	U	U	U	U	**U**
9-6	Provide High School Students with Free Bus Passes	Provide high school students with free bus passes; This measure will reduce the number of cars on the road; High school students may be less inclined to drive their own car or get rides if provided with this pass	# of students given bus passes	U	U	U	0.7	**2.8**
9-7	Provide Bicycles for Daily Trips	Create bicycle lending or rental program for the community	# of bicycles available	250	489.14	0.5	1.74	**3.3**
9-8	Create a "Safe Routes to School" Program	Create raised pedestrian walks to encourage children to walk and bike; Provide a safe route map to families to encourage biking and walking	# of students covered by Safe Routes to School Program	U	18.96	U	0.068	**3.3**
9-9	Expand Bus Service in Range and/or Frequency	Expand bus service in range and/or frequency; Increased frequency over busy routes will make bus transit more convenient and appealing	# of additional daily bus passengers	U	U	U	0.35	**2.0**
9-10	Improve / Expand Pedestrian Infrastructure	Provide safer environments for pedestrians by slowing traffic by using speed bumps, widening sidewalks or creating pedestrian only zones; Prioritize pedestrian needs in planning	# of weekly trips switched from car to walk	U	6.969	U	0.025	**2.3**
9-11	Create Community Programs to Encourage Bicycle Riding and Recycling	Encourage bicycle recycling and riding through informational and repair workshops that engage the community	NA	U	U	U	U	**U**

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9-12	Implement Bus Rapid Transit (BRT) or Shuttle Programs	Implement Bus Rapid Transit (BRT) or shuttle programs; BRT replicates the advantages of rail transit at a lower cost; To implement, separate bus lanes may be created or traffic priorities may be granted to buses by installing signals that detect arriving buses and hold a green lights; Methods can be developed to speed up the boarding process by creating pre-boarding payment options by providing passes or smartcards	# of new daily transit passengers	U	U	U	2.184	**2.0**
9-13	Create/Expand Bicycling Infrastructure	Improve existing/construct new dedicated bike paths and/or bicycle lanes with well maintained surfaces, good lighting, bicycle-specific crossing signals, and other features that ensure the safety of bicyclists; Local employers can promote a larger bicycling community by providing bike lockers and showering facility; Also, establish/expand bicycle parking downtown and in other commercial areas	# of weekly trips switching from car to bike	U	27.874	U	0.099	**2.8**
Bundle 10: Parking Policies (Transportation)								**3.4**
10-1	Implement Parking Cash-out Program	Offer cash incentives to employees to give up their parking spots	# of employees offered parking cash-out program	U	126.08	U	0.45	**3.8**
10-2	Create Parking Policies to Encourage Walking, Bicycling, and Using Public Transit	Establish parking policies to increase use of walking, public transit, and bicycling	Percent increase in on-street parking prices	U	U	U	0.00000055	**4.0**
10-3	Create Fuel-Efficient Vehicle Preferred Parking policies	Provide parking spots for fuel efficient vehicles (e.g. permit system)	# of hybrid vehicles purchased	2530	922.64	2.7	3.29	**2.8**
10-4	Increase Park-n-Ride Lots	Change parking infrastructure to allow commuters who do not live within walking distance of public transport depots to drive to the train/bus station and then continue the remainder of their commute via public transport	NA	U	U	U	U	**U**
10-5	Develop Parking Infrastructure to Support Emerging EV Transportation System	Construct parking spaces in large parking structures that are reserved for EVs and have a charging station	# of EV charging spaces	U	630.216	U	2.247	**3.0**
Bundle 11: Land Use (Transportation)								**2.5**
11-1	Promote Transit-oriented Development	Promote transit-oriented development (TOD)	Residential units in Transit Oriented Development	U	1649.21	U	5.88	**2.8**
11-2	Research the use of "Smart Growth" in Future Development	Research and promote high density, mixed use development (residential/commercial) in and outside downtown to provide essential services to all residents with minimal required travel; Include incentives for commercial development; This type of development prevents urban sprawl and increases useful purposing of land in densely populated areas	Percent increase in housing or jobs per acre	U	U	U	0.00000035	**2.4**
11-3	Participate in Regional Planning	Participate in regional planning to reduce commuting and GHG emissions through SACOG as part of SB 375	NA	U	U	U	U	**U**
11-4	Walkable/Bikeable Street Landscape	Establish/reevaluate neighborhood design standards to minimize GHG emissions from transportation; Measures include locating homes within walking/ biking distance of essential services; Also, implement “Complete Streets”/Greenstreets plan to new streets; The Complete Streets planning approach incorporates features that encourage waking and biking in conjunction with vehicle traffic; Features primarily focus on improving the safety and overall experience of pedestrians and bicyclists; Example features include: sidewalks with a parallel row of trees or bushes separating traffic from pedestrians to minimize pedestrian exposure to traffic, designated bikes lanes, and visible crosswalk markings	NA	U	U	U	U	**2.3**

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Bundle 12: Carpool and Carshare (Transportation)								**2.3**
12-1	Increase Ride-Sharing	Increase Ride-Sharing (e.g., carpools); Local governments can create low interest or interest free loans for businesses setting up vanpool programs; Toll booths can also provide toll free or reduced toll for such vehicles; Research the possibility of implementing a Guaranteed Ride Home Program for carpool participants, which guarantees employees a ride home - by taxi or company car - in case an emergency comes up and they need to get home quickly	# of employees offered ride-sharing programs	U	52.32	U	0.187	**3.3**
12-2	Establish A Car Sharing Program	Establish a car sharing program; Place shared cars in areas with high amounts of pedestrian traffic (such as university campuses, transit stations, etc) for use at a per-mile or hourly charge; Look into the Zipcar sharing program that is already implemented in the City of Davis	# of car-share participants	U	324.88	U	1.158	**1.3**
12-3	Create High-Occupancy Vehicle (HOV) Lanes	Promote carpool and/or vanpool by designating special traffic lanes; high-efficiency or alternative fuel vehicles can also be allowed to use these lanes	Percent reduction in VMT per person using lanes	U	10.83		0.0386	**2.3**
Bundle 13: Vehicle Efficiency (Transportation)								**2.7**
13-1	Encourage Retirement of Old Vehicles	Work with local vehicle dealerships to promote local participation in any State and/or Federal programs established to encourage the purchase of high efficiency vehicles and the retirement of inefficient vehicles	NA	U	U	U	U	**U**
13-2	Encourage Procurement of Hybrid Vehicles	Encourage procurement of hybrid vehicles	# of hybrid vehicles used	2530	922.64	2.7	3.29	**2.7**
13-3	Develop Local "Cash-for-Clunkers" Program	Create local incentives and financing opportunities for the purchase of high efficiency vehicles and the retirement of inefficient vehicles by creating a local "Cash-for-Clunkers" program	NA	U	U	U	U	**U**

Notes: 1. Incremental costs listed are overall costs to implement the measure. The City's share of this cost may vary depending on how the implement the measure.
2. Annual Cost Savings are annual unless otherwise noted. Unless otherwise noted, energy costs for electricity, natural gas, and gasoline replaced by natural gas, and water are assumed to be $0.0988/kWh, $1.55/therm, $1.86/gallon, and $0.0025/gal respectively. Gasoline/Fuel Oil costs are assumed to vary by fuel type: cost of Gasoline = $2.64/gallon, diesel = $2.79/gallon, biodiesel = $2.88/gallon, fuel oil (No.2 Distilled Oil) = $2.59/gallon, E85 = $2.27/gallon. Annual Cost Savings are net annual cost savings (savings - implementation costs) when implementation cost is not listed.
3. Simple payback period is incremental cost divided by annual cost: no discounting is applied.
4. GHG emissions savings estimated from CAPPA assume WECC California utility region (CAMX).
5. The Average Potential for Successful Implementation Score is designed to indicate generally desirable actions with a high score - thus a high scores indicate 'low hanging fruit'. It calculated as the sum of the measures. The Potential for Successful Implementation of each action may vary by City.
6. "U" indicates unknown values. Negative values indicates energy use increase rather than energy savings.

Municipal Reduction Strategies

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/yr	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
Bundle 14: Municipal Miscellaneous								**4.1**
14-1	Energy Conservation Education	Educate city employees on energy conservation efforts as well as the life cycle of products	NA	U	U	U	U	**5.0**
14-2	Update General Plan	Incorporate climate change goals, policies, and actions for greenhouse gas reduction and energy efficiency into the General Plan; Consider including a "Climate Change Element" in the General Plan	NA	U	U	U	U	**4.5**
14-3	Favor Contracts with Sustainable Companies	Implement City policies that favor contracting with companies which adopt energy efficient, low carbon practices, and use non-toxic and fragrance free products	NA	U	U	U	U	**U**
14-4	Plant Trees to Increase Building Shade	Plant trees to shade buildings, thereby, reducing energy required to heat or cool the buildings. Trees also help reduce storm water runoff, create a more attractive environment and increase property values	Number of trees planted to shade buildings	224	20.16	11.1	0.07	**2.8**
14-5	Hire Energy/Climate Specialist	Hire full time energy/climate specialist to provide insight and solutions for implementing renewable energy sources and reducing GHG emissions	NA	U	U	U	U	**U**
Bundle 15A: Facilities - Lighting (Municipal Energy)								**4.4**
15A-1	Decrease Average Daily Time Street Lights Are On	Make sure streetlights are turned off when they are not needed to save energy and reduce emissions	Number of daily cut-back hours/ street lamp	U	6.909	U	0.0237	**4.8**
15A-2	Institute a Lights-Out-at-Night Policy	Turn off lights throughout the buildings at the end of the work day	Square feet with Lights Out at Night policy	0.06	0.236	0.2	0.00082	**4.5**
15A-3	Install LED Exit Signs	Install and/or replace old exit signs with LED exit signs; LED exit signs last much longer and fail less frequently reducing maintenance costs	Exit signs replaced with LED exit signs	U	26.87	2.1	0.093	**4.5**
15A-4	Install LED Street Lights	Replace streetlights, signal lights, parks and parking lot lighting with LED Street Lights; LEDs are highly efficient, and their light is directional, making it easy to focus them on roads, avoiding ambient light pollution and energy waste	Street lights replaced with LED street lights	U	37.542	0.2	0.13	**3.5**
15A-5	Install Other Non-LED energy Efficient Street Lights	Replace streetlights, signal lights, parks and parking lot lighting with non-LED energy efficient street lights (i.e. High Pressure Sodium); Metal halide and high pressure sodium lamps use about 35% less energy than mercury vapor lamps.	Number of mercury vapor lamps replaced with sodium or metal halide lamps	85	33.987	2.5	0.118	**4.0**
15A-6	Install LED Lighting at Schools and Parks	Replace and or install school and park lighting with LEDs	NA	U	U	U	U	**U**
15A-7	Installment of Occupancy Sensors	Install occupancy sensors in city facilities to automatically turn the lights on and off, saving energy	Square feet installed with occupancy sensors	0.06	0.236	0.2	0.00082	**4.5**
15A-8	Install Solar Tubes	Install solar tubes in buildings; Installing solar tubes in buildings adds natural light and reduces the need for artificial lighting	NA	340	U	U	U	**U**
15A-9	LED Holiday Lights	Use LED holiday lights instead of traditional strings of incandescent bulbs at government facilities	Strings of lights replaced with LED lights	7.5	1.48	5.1	0.00514	**4.7**
15A-10	Efficient Lighting Retrofits	Replace older fixtures with magnetic ballasts and T-12 size fluorescent tubes with T-8 size tubes at government facilities	Square foot of facilities retrofitted with efficient lighting	0.06	0.203	0.3	0.0007	**4.3**
Bundle 15B: Facilities - Appliances (Municipal Energy)								**4.8**
15B-1	Use ENERGY STAR Water Coolers	Replace water coolers with ENERGY STAR rated models; ENERGY STAR coolers that produce both hot and cold water offer more potential for savings	Number of water coolers replaced with ENERGY STAR water coolers	0	20.16	0	0.07	**5.0**
15B-2	Use ENERGY STAR Copiers	Replace copy machines with ENERGY STAR rated models	Number of copiers replaced with ENERGY STAR copiers	10	74.22	0.13	0.258	**4.8**

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15B-3	Use of ENERGY STAR Refrigerators	Replace Refrigerators with ENERGY STAR rated models; New ENERGY STAR qualified refrigerators are found to use half the energy of refrigerators made prior to 1993, 40% less than those from 2001, and 15% less than required in 2007	Number of refrigerators replaced with ENERGY STAR refrigerators	30	45.843	0.7	0.159	**4.8**
15B-4	Use ENERGY STAR Vending Machines	Replace vending machines with ENERGY STAR rated models. Local government can negotiate contracts that include more energy efficient machines, reducing GHG emissions and operation costs	Number of vending machines replaced with ENERGY STAR vending machines	0	163.91	0	0.569	**5.0**
15B-5	Use ENERGY STAR Printers	Replace printers with ENERGY STAR rated models; Research shows that new ENERGY STAR qualified printers are 37% more energy efficient on average than conventional ones; Newer models can also reduce paper consumption by printing double sided	Number of printers replaced with ENERGY STAR printers	10	36.63	0.27	0.127	**4.8**
15B-6	Use ENERGY STAR monitors	Replace computer monitors with ENERGY STAR rated models	Number of monitors replaced with ENERGY STAR monitors	0	6.03	0	0.021	**4.8**
15B-7	Use ENERGY STAR Computers	Replace computers with ENERGY STAR rated models	Number of computers replaced with ENERGY STAR computers	0	19.86	0	0.069	**5.0**
15B-8	Use High Efficiency Water Heaters	Replace old water heaters with high efficiency water heaters	Number of water heaters replaced with high efficiency water heaters	910 for elec, 1150 for nat. gas	187.42	5.6	0.66	**4.7**
15B-9	Use Energy Efficient Boilers	Replace any over-sized boiler with appropriately sized boilers	Square feet of facilities upgraded with efficient boilers	0.36	0.0149	24.2	0.000054	**4.2**
Bundle 15C: Facilities - Comprehensive Improvements (Municipal Energy)								**4.1**
15C-1	Adopt a High Performance Local Energy Code (including a Green Building Ordinance) for New Construction and Renovation of Municipal Facilities	Update facility code to mandate higher municipal facility performance; Mandate achievement of CALGreen Tier 1 energy performance or even LEED silver/ gold status; Seek to harmonize with regional Green Building Ordinances; Establish facility design standards to maximize GHG reductions	Square foot of new construction and renovation meeting the Local Energy Ordinance	0	0.52	0	0.0018	**3.8**
15C-2	Purchase Carbon Credits	Purchase carbon credits; Purchasing these credits allows the city to offset GHG emissions of municipal activities by paying for projects that reduce GHG emissions somewhere else	Tons of offsets purchased	19.79	U	U	U	**3.7**
15C-3	Perform Energy Efficiency Retrofits of Existing Facilities	Perform energy audits and retrofits (such as free energy audits provided by PG&E) of municipal facilities; Utilize existing rebates	Square foot of facilities retrofitted	1.5	0.208	7.2	0.00073	**4.0**
15C-4	Retro Commission for Energy Efficiency	Evaluate the performance of various systems in municipal buildings and analyze how the building's components work together	Square feet of facilities retro-commissioned	U	0.229	U	0.00081	**4.8**
Bundle 15D: Buildings - Temperature Control (Municipal Energy)								**4.2**
15D-1	HVAC Energy Conservation	Encourage facility personnel to dial down (in winter) or up (in summer) thermometers [~4oF in occupied areas; more infrequently in unoccupied areas]; reduce outside air volume circulated; fine-tune boiler burners [from >200% to 130% excess air]	NA	0	U	U	U	**U**
15D-2	HVAC Fan Upgrade	Switch to energy efficient fans and insulate leaking ducts	Square feet of facilities upgraded with efficient fans	0.02	0.0387	0.4	0.000134	**4.7**

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15D-3	Use Energy Efficient Chillers	Replace any over-sized chillers with appropriately sized chillers	Square feet of facilities upgraded with efficient chillers	0.36	0.085	4.2	0.000294	**4.3**
15D-4	Switch Electric Heat to Natural Gas	Replace electricity based heating equipment with natural gas based heating equipment	Square feet of buildings switched from electric to natural gas heat	0.54	0.3	1.8	0.00097	**5.0**
15D-5	Install Reflective Roofing	Install reflective roofing; Reflective roofs reduce electricity use by reducing the heat entering the building through the roof, which ultimately translates into energy bill savings; Reflective roofs yield the largest energy savings in hot, sunny climates, and will only save energy on a building with air conditioners, although it will keep non air conditioned buildings cooler; Reflective roofs may help mitigate the urban heat island effect if implemented on a large enough scale	Square feet of reflective roof installed	0.25	0.086	2.9	0.000307	**4.2**
15D-6	Install Green Roofing	Install green roofing; Green roofs use a soil medium and plants on top of an impermeable membrane roof; They reduce building energy use by insulating the roof, and by cooling it through shading and evapotranspiration (the process by which plants draw water from the soil and release it into the air); Green roofs yield the largest energy savings in hot, sunny climates, and will only save energy on a building with air conditioner, although it will keep non air conditioned buildings cooler; Green roofs also help with reducing storm water runoff by holding up to 70-90% of water from summer storms, and 25-40% of winter storm water; Additionally, they delay runoff and filter the water which can help avoid expensive expansions to wastewater treatment plants that handle storm water; Green roofs also cool the air around surrounding buildings, and can contribute towards reducing urban heat island effect if implemented on a large enough scale; Lastly, these spaces can also be used to grow food or provide a recreational space	Square feet of green roof installed	7	0.0441	153.1	0.00076	**2.8**
Bundle 16: Renewable Energy Generation and Procurement (Municipal Energy)								**3.4**
16-1	Funding for Energy Efficiency and Renewable Energy	Establish a local financing district for municipal solar energy production (AB 811); Funding sources could include funding from energy efficiency and conservation block grant program, state energy program, and California-FIRST's PACE funds	NA	U	U	U	U	**3.2**
16-2	Purchase Electricity from Renewable Energy Sources from the Grid	Purchase green electricity via the grid from solar, geothermal, wind, or hydroelectric sources	kWh of electricity purchased green	0.022	-11000	U	0.000343	**3.5**
16-3	Purchase Green Tags / Renewable Energy Certificates	Purchase Renewable Energy Certificates (RECs) for a percentage of government operations. RECs allow an institution or a home to offset their energy consumption from non-renewable sources by investing in utilities that rely on renewable energy sources for energy production without being directly connected to the utility for its energy needs	kWh of electricity purchased green	0.019	-9500	U	0.000343	**3.5**
16-4	Install Solar Water Heaters	Install solar water heaters in municipal buildings	Gallons of hot water heated per day heated with solar water heater	60	2.916	21	0.01	**4.0**
16-5	Install Solar Water Heaters at Swimming Pools	Install solar water heaters at swimming pools. By substituting solar powered for fossil fuel run heating systems, pools can be heated without producing GHG emissions	Square feet of pools retrofitted with solar water heater	9.5	1.936	5	0.007	**3.8**
16-6	Install Solar (PV) Panels on Municipal Facilities	Install Solar (PV) Panels on municipal facilities when feasible	NA	U	U	U	U	**U**
16-7	Install Wind Turbines	Installment of wind turbines for energy production.	Capacity size (kW)	1540	150.176	10.3	0.5209	**3.0**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/yr	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
16-8	Use Geothermal Heat Pumps at Government Facilities	Use Geothermal Heat Pumps (GHPs) for heating and cooling. GHPs are more efficient than traditional air-conditioning or heat pumps because they use the stable underground temperatures. GHPs also reduce maintenance costs and last longer than traditional heating and air conditioning equipment	Square feet of buildings using geothermal heat pumps	9.6	0.477	20.1	0.00165	**3.2**
16-9	Implement Methane Flaring at WWTP	Current aerobic wastewater treatment plant may be substituted for an anaerobic treatment system with methane recovery and combustion	Population served by the Wastewater Treatment Plant	U	U	U	0.3285	**3.0**
Bundle 17: Waste Diversion and Reduction (Solid waste disposal - not in inventory)								**3.2**
17-1	Encourage City Employees to Recycle	Encourage increased recycling in general for government employees	Waste diverted from landfill (lbs/ employee/ year)	U	U	U	0.001286	**4.0**
17-2	Encourage Organics Composting by City Employees	Encourage increased composting in general for government employees; When organic matter like wood, paper, food, and yard waste is placed in landfills, it decomposes producing methane, a GHG 21 times as powerful as carbon dioxide. Collecting and composting this organic waste prevents the emissions it would have produced in the landfill. Strategy here is to collect organic waste in the same manner as garbage is collected and divert it from landfills	Waste diverted from landfill (lbs/ person/ year)	U	U	U	0.000001223	**2.0**
17-3	Encourage Reuse or Recycling of Construction and Demolition Materials	Encourage Reuse/recycling of materials used in municipal construction to divert landfill waste	Waste diverted from landfill (lbs/ square feet of construction)	U	U	U	0.00000533	**3.5**
Bundle 18: Transportation Fuels (Transportation)								**3.4**
18-1	Fleet Conversion to Electric Vehicles (EVs)	Convert gasoline operated vehicle fleet to EVs; Neighborhood Electric Vehicles (NEVs; max speed 25 mpg) suitable for parking enforcement and small deliveries; no tailpipe emissions, and lower operating cost	Number of EVs	10000	1613.32	6.2	5.75	**3.0**
18-2	Fleet Conversion to Ethanol (E85)	Use E85 (85% ethanol and 15% gasoline blend) instead of diesel or gasoline in the vehicle fleet	Number of E85 vehicles	313.45	U	U	4.89	**4.0**
18-3	Convert to Compressed Natural Gas (CNG)	CNG is a clean burning fuel with low carbon footprint compared to diesel or gasoline; ideal for taxis and buses because they usually have concentrated fueling station, have higher VMT, and operate high density population areas	Number of CNG vehicles	3000	416.96	U	1.551	**2.8**
18-4	Fleet Conversion to Bio-Diesel (B20)	Switch garbage trucks, fire trucks, maintenance vehicles, and transit buses from 100% diesel to B20 (20% bio-diesel and 80% petroleum diesel)	Number of vehicles switching from diesel to biodiesel	82.968	U	U	5.43	**3.5**
18-5	Fleet Conversion to Bio-Diesel (B100)	Switch garbage trucks, fire trucks, maintenance vehicles, and transit buses from 100% diesel to B100 (100% bio-diesel)	Number of vehicles switching from diesel to biodiesel	163.47	U	U	6.81	**3.5**
Bundle 19: Transportation Equipment and Operations (Transportation)								**4.9**
19-1	Limit Idling of Government Operations Vehicles	Educate local government management officials on the effectiveness towards GHG reduction by reducing the idling of such vehicles	Number of vehicles affected by the idling policy	U	16.79	U	0.061	**5.0**
19-2	Limit Idling of Heavy Equipment Vehicles	Educate city employees that use heavy equipment vehicles on the effectiveness towards GHG reduction of limiting the idling of such vehicles	Number of vehicles affected by the idling policy	U	669.6	U	2.29	**4.8**
Bundle 20: Transit and Bike/Ped (Transportation)								**3.7**
20-1	Implement a Police on Bicycle Program	Switch police cars with bicycles for patrolling in high density areas	Number of police officers patrolling on bicycles instead of cars	1000	6800	U	7.08	**3.5**
20-2	Bicycle Lending Program	Implement bicycle lending program for city employees to use daily when traveling short distances within the city	Number of employees enrolled in this program	25	12.86	1.9	0.046	**3.8**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/yr	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
Bundle 21: Vehicle Efficiency (Transportation)								**4.3**
21-1	Reduce Municipal Fleet Mileage	Reduce vehicle miles by replacing face to face meetings with video conferencing, or by encouraging/ incentivizing employees to carpool, walk, ride a bike, or a take a transit by making bicycles available for employees during the day, and reimbursing for work-related bicycles travel	Annual vehicle miles eliminated	U	0.134	U	0.000478	**4.2**
21-2	Utilize Fuel-Efficient Vehicles For Parking Enforcement	Utilize/purchase fuel-efficient vehicles for parking enforcement	Number of fuel efficient scooters	U	1611.37	U	5.75	**4.2**
21-3	Procurement of Smaller Fleet Vehicles	Purchase smaller more fuel efficient vehicles to replace current fleet	Number of smaller vehicles used	U	517.51	U	1.85	**4.7**
21-4	Procurement of Hybrid Vehicles	Purchase hybrid vehicles to replace current fleet	Number of hybrid vehicles used	2530	922.64	2.7	3.29	**4.0**
Bundle 22: Transportation Miscellaneous (Transportation)								**3.5**
22-1	Encourage Telecommunicating	Encourage telecommunicating; Encourage the use of video and cellular communication methods rather than in-person meetings that require travel to an office workspace	Employees offered telecommuting incentives	U	48.244	U	0.172	**4.0**
22-2	Use Non-Asphalt Pavements	Use non-asphalt pavements for city construction projects. Alternatives can help reduce the urban heat island effect, reducing energy use for cooling	Acres of non-asphalt pavement per year	10000	U	U	U	**3.0**
Bundle 23: Water Conservation								**4.1**
23-1	Adopt Water Conservation Ordinance	Establish a baseline energy use for water production, use, and processing (kWh/gallon) and develop specific actions to move toward a zero energy use water system; Also, consider adopting Bay Area Water supply and Conservation Agency Indoor Ordinance (or outdoor) if haven't already done so; See BAWSCA	Percent household savings under ordinance	U	1.238	U	92	**4.0**
23-2	Install Low Flow Faucets	Install low flow faucets to conserve water and reduce energy usage	Number of faucets replaced	8	3.99	1.9	0.012	**4.5**
23-3	Install Low Flow Shower Heads	Install low flow shower heads to conserve water and reduce energy usage; Additionally this reduces hot water usage, saving natural gas	Number of showerheads replaced	29	39.753	0.7	0.116	**4.7**
23-4	Install High Efficiency Toilets	Install toilets that satisfy current state standards of 1.3 gallons per flush or less, compared to federal standards of 1.6 gallons per flush (See Comment)	Number of toilets or urinals replaced	448	14.339	31.2	0.007	**3.7**
23-5	Install Central Lawn Irrigation	Install central lawn irrigation; Central lawn irrigation can control water usage through soil moisture or weather sensors; This will increase water conservation	Acres of lawns installed with central irrigation sensors	50	423.8	0.203	0.20333	**4.0**
23-6	Use Low-Maintenance Landscaping	Use low-maintenance landscaping; Landscaping with local native plants can greatly reduce or eliminate the need for irrigation, pesticides, and gasoline powered maintenance equipment	Acres of low maintenance landscaping	U	U	U	0.857	**4.3**
23-7	Funding for Municipal Water Conservation Projects	Establish a local financing district for water conservation (AB 811); Funding sources could include funding from Energy Efficiency and Conservation Block Grant Program, State Energy Program, and California-FIRST's PACE funds	NA	U	U	U	U	**U**
23-8	Low Impact Development	For new developments and retrofits, manage storm water runoff to mimic natural hydrology (i.e., infiltration rates) by encouraging aquifer recharge that will offset the need to pump and treat imported water	NA	U	U	U	U	**U**
23-9	Water Efficient Model Homes	Install water efficient appliances, toilets, shower heads, and other technologies that will promote water conservation in homes	NA	Mixed results depending on the type of equipment. See previous for information about specific energy efficient equipment.				**4.5**
23-10	Improve Water Pumping Energy Efficiency	Improve water pumping energy efficiency; Many water systems have old, inefficient pumps that can be upgraded with short payback times from energy savings	Improvement in the pumping efficiency	200000	13.631	1.5	0.0473	**3.5**
23-11	Water Leak Detection and Repair	Identify water losses at the retail water agency level, find the leaks, and fix them	NA	U	U	U	U	**U**

ID #	New Reduction Strategy	Strategy Description	Definition of Unit	Incremental Cost[1,6] $/unit	Annual Cost Saving[2,6] $/unit/yr	Simple Payback Period[3,6] yrs	GHG reductions[4,6] mtCO2e/unit/yr	Potential for Successful Implementation[5,6] 1 - 5; 5 = Desirable
Bundle 24: Wastewater Management								**2.7**
24-1	Install Sludge Incinerators at WWTP	Install sludge incinerators at the WWTP ; Sludge incinerators at waste water treatment plants can run turbines to produce energy	NA	U	U	U	U	**U**
24-2	Install Anaerobic Digester at WWTP	Install anaerobic digester at the WWTP; Digesters are used to breakdown the "sludge" that results from wastewater treatment. Reduces the volume of solids by about half	Population served by the Wastewater Treatment Plant	103	2.402	42.9	0.008333	**2.7**
24-3	Upgrade Anaerobic Digester to Allow Co-Digestion of High-Strength Organic Waste at WWTP	Aggressive collection of food scraps (fats, oils and grease) from restaurants, groceries, wineries and food-processing factories, and waste from animal-processing plants could make digesters much more productive	NA	U	U	U	U	**U**
24-4	Reuse Wastewater	Use gray water and/or tertiary treated water. Replace imported potable water with treated municipal wastewater in appropriate applications such as irrigation and industrial uses	NA	U	U	U	U	**U**
24-5	Secondary Aeration System Retrofit	Replace mechanical mixers in ponds with alternative systems using wind energy, solar energy or bubblers	NA	U	U	U	U	**U**
24-6	Install Hydroelectric Turbine in Wastewater Pipeline	Install a mini turbine in Winters' sewer main at the creek side sump	NA	U	U	U	U	**U**

Notes
1. Incremental costs listed are overall costs to implement the measure. The City's share of this cost may vary depending on how the implement the measure.
2. Annual Cost Savings are annual unless otherwise noted. Unless otherwise noted, energy costs for electricity, natural gas, and gasoline replaced by natural gas, and water are assumed to be $0.0988/kWh, $1.55/therm, $1.86/gallon, and $0.0025/gal respectively. Gasoline/Fuel Oil costs are assumed to vary by fuel type: cost of Gasoline = $2.64/gallon, diesel = $2.79/gallon, biodiesel = $2.88/gallon, fuel oil (No.2 Distilled Oil) = $2.59/gallon, E85 = $2.27/gallon. Annual Cost Savings are net annual cost savings (savings - implementation costs) when implementation cost is not listed.
3. Simple payback period is incremental cost divided by annual cost: no discounting is applied.
4. GHG emissions savings estimated from CAPPA assume WECC California utility region (CAMX).
5. The Average Potential for Successful Implementation Score is designed to indicate generally desirable actions with a high score - thus a high scores indicate 'low hangin fruit'. It calculated as the sum of the measures. The Potential for Successful Implementation of each action may vary by City.
6. "U" indicates unknown values. Negative values indicates energy use increase rather than energy savings.

Technical Appendix IIIA: Bundle Summaries

How to Read Bundle Summaries

3: Waste Diversion & Reduction

Emissions Source: Residential & Commercial

GHG Reduction Potential: Low (per unit basis)
High Scalability

Ease of Implementation:
- Education/Outreach
- Incentive/Rebate
- Regulatory/Policy
- Municipal Action/Service

Objective

Create programs to reduce waste-creation and divert waste from residential and commercial operations that would otherwise end up in landfill for reuse. This can occur via educational and incentive programs.

Tracking Options

Reduction Strategy	Incentive/Regulation Tracking: Weight of Waste Diverted Per Sq ft of Construction	Incentive/Regulation Tracking: Per Capita Weight Waste Reduced Per Year	Self-Reporting Survey: Per Capita Weight Diverted Waste Per Year	Applicable Incentive #
3-2. Encourage Reuse or Recycling of Construction and Demolition Materials	X		X	11-B
3-3. Implement "Pay-As-You-Throw" Program		X		NA

Recommended Tracking Method

Strategy 3-2 consists of programs to encourage the reuse and/or recycling of construction materials. CAPPA provides emissions factors using the weight of waste diverted per square foot of construction. If this action is implemented as an incentive program, this value could be obtained through incentive tracking. If this action is implemented as an educational program then a self-reporting survey could be used.

Strategy 3-3 would require new regulations. Emissions reductions can be quantified by applying a CAPPA emissions factor using the per capita amount of waste reduced. Since these regulations would be enforced directly by the city, the city can obtain these values using data from the regulation/enforcement process.

Alternative Tracking Methods

Action 3.2 allows for the possibility of self-reporting surveys. However, as mentioned above, self-reporting surveys can be unreliable and subject to large margins of estimation/tracking error. Moreover, surveys can be expensive and timely to create, collect, and compile.

Effectiveness and Ease of Implementation

Action 3-2 would require funding and City staff time to determine incentive eligibility and distribute awards. This item has a low per-unit GHG emissions reduction potential, with units of pounds of waste per square foot of construction, which is moderately expandable since many pounds of waste can potentially be diverted but item only applies only to construction projects in the city, which are limited.

Action 3-3 requires enforcement, which may make implementation time-intensive. Per-unit reduction potential for 3-3 is moderate, while expandability is moderately high since the average person generates many pounds of trash per year. Thus, the amount of trash generated has good potential for reduction.

Education/Outreach

Educational programs would be necessary in conjunction with the advent of any new waste-reuse collection programs. These programs would need to teach participators how to sort trash appropriately and about the importance of trash reduction and diversion.

Additional Notes

The bundle 3 Waste Diversion & Reduction strategies aim to prevent GHG emissions that are generated when trash is disposed of at a landfill. These emissions were not included in the baseline inventory.

Bundle Summary:
Bundle name and emissions source and GHG reduction potential, defined as:
- Low, Medium, High overall potential for reductions per unit, where the unit is defined for each reduction strategy in Chapter 3 and Appendix II.
- Expandability or reductions refers to how many units could be affected in the City.

3. **Ease of implementing** the bundle for the various implementation approaches.
- = Easy
- = Moderate
- = Challenging

Objective: Overview of the bundles' objective and the means with which it can be implemented.

Tracking Options: This table shows:
1. The reduction strategies included in the bundle. Details about these strategies are included in Appendix II.
2. The means of tracking each reduction strategy. The metric that we recommend (if possible) is highlighted in green.
3. Applicable incentives. This column lists any rebates/incentives that apply to the reduction strategy, corresponding to rebates listed in the Appendix. This columns is only included in bundles with at least one reduction strategy that has an applicable rebate.

Recommended Tracking Method: describes the tracking method highlighted in green in the "Tracking Options" chart.

Alternative Tracking Methods: Description of tracking methods that might be used to monitor the progress of each reduction strategy in lieu of or in addition to the recommended method. Includes description of why the alternative methods are considered 'second best'.

Effectiveness and Ease of Implementation: Describes easily achieved reduction measures, resources needed to implement strategies for the various implementation approaches, and identifies challenges to implementing each reduction strategy.

Education/Outreach: Discusses the challenges and opportunities associated with educating the community about the reduction strategies in this bundle.

Additional notes: Describes any additional information about this bundle and its implementation.

1A: Buildings – Lighting

Emissions Source: **Residential & Commercial (Community)**

GHG Reduction: Potential **Low (per unit basis)**
High Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Encourage residents and businesses to install high efficiency lighting and reduce the amount of time artificial lighting is used. This can occur via educational programs, promotion of existing incentive programs, or the creation of new incentive programs and sponsored exchanges.

Tracking Options

Reduction Strategy	PG&E Data and Reports		Self-Reporting Survey		Incentives/Rebate Tracking		Applicable Incentives
	Aggregate Energy Used (kWh)	Energy Savings (kWh)	Units installed or Replaced (#)	Area Affected (Sq. Ft.)	Units installed or Replaced (#)	Area Affected (Sq. Ft.)	
1A-1. Encourage Community Members to Use CFL Bulbs and/or Fixtures	X	X	X		X		L1-L5, C1
1A-2. Encourage Installment of LED Exit Signs	X	X	X		X		L16
1A-3. Encourage Installment of Occupancy Sensors		X	X	X	X	X	L17
1A-4. Encourage the Installment of Solar Tubes	Benefits Unknown						
1A-5. Encourage Commercial Lighting Fixture Upgrades	X	X	X	X	X	X	L2-L5, L13
1A-6. LED Holiday Light Exchange	X		X		X		
1A-7. Halogen Torchiere Lamp Exchange	X		X		X		
1A-8. Institute a Lights-Out-at-Night Policy	X			X		X	L17, L18

Recommended Tracking Method

The most accurate metric for individualized lighting upgrades is the number of units replaced or installed, which can be tracked by the City. This could be quantified through rebate records or by the number exchanged through a program or at an event and/or survey correspondence. As shown above these metrics are preferred for incentive based strategies 1A-1, 1A-2 and program creation strategies 1A-6 and 1A-7. CAPPA has devised a GHG emission factor (Appendix II) associated with the replacement of each unit, which should be used in conjunction with the metric data to estimate the overall GHG reductions.

Strategy 1A-3 and 1A-4 involves installations that reduce the need for artificial lighting. Strategy 1A-3 can be tracked indirectly by the area affected. 1A-5 can similarly be tracked by the area of facilities retrofitted with

efficient lighting using the corresponding CAPPA emissions factor (Appendix II).

Strategy 1A-8 involves the creation of an ordinance related to the use of commercial lighting. This strategy can be best tracked by the area of commercial buildings that are affected by the ordinance using the CAPPA emissions factor devised for this strategy (Appendix II). Participation for this strategy may be difficult to acquire especially when lighting is used for advertisement purposes (i.e. window shopping). For complete participation and accurate tracking measurements, the commercial buildings participating may need to be monitored.

Alternative Tracking Methods

Strategies 1A-1 – 1A-2 and 1A-5 through 1A-8 can also be tracked by analyzing the change in the aggregate energy savings for lighting from PG&E's annual savings reports. This method is recommended for use only in conjunction with the preferred metric because these records can only provide aggregate measurement of the effects of strategies.

Commercial PG&E rebates exist for Strategies 1A-1 through 1A-3, 1A-5 and 1A-8; therefore aggregated energy savings data found in PG&E's savings report can be used as an additional (albeit aggregate) tracking method. A Residential rebate for strategy 1A-1 also exists and can be tracked in the aggregate with the savings reports.

Effectiveness and Ease of Implementation

The effectiveness of strategies 1A-1, 1A-2, 1A-3 and 1A-5 depends on the level effort invested in encouraging the community but overall has a very high potential for GHG reductions due to the high level of expandability. Educating the community on lighting efficiency is a relatively low cost effort while incentivizing the replacement of the lights can have higher costs. These strategies each have moderate implementation costs, short payback periods (0-2 years), and can result in substantial electricity savings. Strategy 1A-3 has the highest estimated annual savings per unit for this bundle.

Strategies 1A-6 and 1A-7 will require city staff to set up and run the exchange. The effectiveness may be increased if the City subsidizes the light bulbs exchanged unless PG&E sponsorship or federal grants are available. If funding is limited, it may be desirable to target low-income communities first to ensure that funds go to replacements that recipients may not have invested in otherwise due to their income constraints. Both strategies have moderate implementation costs and moderate payback periods (3-5 years).

Strategy 1A-8 can greatly reduce the energy used by businesses but may have a high implementation cost. The ordinance will most likely require incentives for the commercial sector as well as staff time to enforce the lighting restrictions. This strategy has a high implementation cost but a minimal payback period.

Education/Outreach

Utility companies have advertised the usage of new and efficient lighting to the general public for some time. Education should consist of informing residents about potential energy and cost savings related to the improvement of lighting. Increasing public awareness of current energy efficiency package rebates PG&E offers for multifamily housing can also ease implementation efforts for lighting upgrades. Educating the community on the positive psychological and health effects that comes from natural lighting can also decrease the use of artificial lighting and increase the number of natural lighting upgrades such as solar tubes.

There is potential for a large impact on community participation by targeting parts of the community that may not have seen as many advertisements before or have avoided participation in the past.

Several other PG&E incentives for commercial lighting exist, including lamps and other fixtures not listed in the strategy descriptions. Promoting these incentives would inform the commercial sector about a large array of options of high efficiency lighting.

Additional Notes

The benefits of measure 1A-4 have not been quantified.

1B: Buildings – Appliances

Emissions Source: Residential & Commercial (Community)

GHG Reduction Potential: Low (per unit basis) High Expandability

Ease of Implementation: Education/Outreach, Incentive/Rebate, Municipal Action/Service

Objective

The City can encourage residents and businesses to install energy efficient appliances in their homes or offices. These strategies can be implemented through educational programs, promotion of existing rebates and by the creation of new incentive and rebate programs.

Tracking Options

Reduction Strategy	PG&E Data and Reports		Self-Reporting Survey		Incentive /Rebate Tracking	Applicable Incentives
	Aggregate Energy Used (kWh or therms)	Energy Savings (kWh or therms)	Units installed or Replaced (#)	Model Homes Retrofitted (#)	Units Installed or Replaced (#)	
1B-1. ENERGY STAR Computer Replacements	X		X		X	
1B-2. ENERGY STAR Monitor Replacements	X		X		X	
1B-3. ENERGY STAR Printer Replacements	X		X		X	
1B-4. ENERGY STAR Copier Replacements	X		X		X	
1B-5. ENERGY STAR Refrigerator Replacements	X	X	X		X	A1-A7, C1, C6
1B-6. ENERGY STAR Dishwasher Replacements	X		X		X	
1B-7. ENERGY STAR Clothes Washer Replacements	X	X	X		X	A34-A35
1B-8. ENERGY STAR Water Cooler Replacements	X		X		X	
1B-9. High Efficiency Water Heater Replacements	X	X	X		X	A29-A31, C1, R2
1B-10. ENERGY STAR Vending Machine Replacements	X		X		X	A28
1B-11. Water and Energy Efficient Model Homes				X		

Recommended Tracking Method

Strategies 1B-1 through 1B-10 involves the replacement of home and office appliances. Using the devised CAPPA emissions factor (Appendix II) these strategies would be best tracked by incentive/rebate records for the number of high efficiency appliance replacements or installations. If rebates or incentives are not applicable or if data are unavailable, tracking can be done via surveys of existing residents and businesses.

Strategy 1B-11 involves the replacement of current equipment in model homes with more energy and water efficient models. This strategy does not have a known emissions factor. This strategy would best be tracked by a self-reporting survey sent to developers.

Alternative Tracking Methods

In conjunction with using the number of appliances replaced/installed for Strategies 1B-1 – 1B-10, it may be desirable to analyze the total annual residential and commercial electricity and natural gas usage. This can be used to crosscheck the total estimated energy reduced from switching appliances.

Strategies 1B-5, 1B-7, 1B-9, and 1B-10 have corresponding PG&E rebates, which enables tracking via the PG&E savings reports. These savings will be part of the total electricity savings under the appliances section for both residential and non-residential categories.

Effectiveness and Ease of Implementation

The effectiveness of Strategies 1B-1 through 1B-10 depends on the level effort invested into encouraging the community but overall these strategies have a high potential for GHG reductions. Educating the community on the use of energy efficient appliances and the incentives that currently exist is a relatively low cost effort that can have a large impact on energy savings over time. For the replacement strategies that do not currently have incentives, it may be desirable for the City to create their own incentives. The implementation costs of these strategies were estimated to be moderate with short payback periods (0-10 years).

Incentives would be the most effective way to maximize the number of energy and water efficient retrofits for strategy 1B-11. Working with local contractors to create subsidized retrofit packages for home owners and businesses can reduce costs and also support local jobs and ‘green’ expertise. Strategy 1B-11 has a moderate implementation cost and an unknown payback period.

Education/Outreach

Education should consist of informing residents on potential energy and cost savings related to the improvement of appliances. Increasing public awareness of current appliance rebates shown in Appendix IIIB will help to encourage replacement.

Additional Notes

NA

1C: Buildings – Comprehensive Improvements

Emissions Source: Residential & Commercial (Community)

GHG Reduction: Potential: Medium (per unit basis) Moderate Expandability

Ease of Implementation:
- Education/Outreach
- Incentive/Rebate
- Regulatory/Policy
- Municipal Action/Service

Objective

The City can encourage and regulate residents and businesses to increase levels of building energy efficiency through the comprehensive improvements. This can be accomplished by creating programs to promote energy efficient retrofits for residential and commercial buildings. Higher levels of building energy efficiency can be required of new and existing buildings by analyzing the community's current building energy efficiency levels and then adopting new and stricter building codes.

Tracking Options

Reduction Strategy	PG&E Data and Reports	City Operations Tracking			Rebates/ Incentives Tracking		Self-Reporting Survey		Applicable Incentives
	Energy Savings (kWh)	Homes Built that Meet Standards (#)	Targeted/ Participating Households (#)	Affected Building Area (Sq Ft)	Participating Households or Businesses (#)	Affected Building Area (Sq Ft)	Participating Households or Businesses (#)	Affected Building Area (Sq Ft)	
1C-1. Retro Commissioning for Energy Efficiency Performance						X		X	
1C-2. Enable Smart meter Data Availability	Benefits Unknown								
1C-3. Promote Energy Conservation Through Campaigns Targeted at Residents					X		X		C2
1C-4. Promote Energy Conservation Through Campaigns Targeted at Businesses					X		X		
1C-5. Promote Green Building Practices Through a Local Green Building Assistance Program or Creating Incentives						X		X	
1C-6. Perform Energy Efficiency Retrofits of Existing Facilities	X					X		X	A1-A36, C1-C3, C5, C6, L1-L18, R3, R4, TC1-TC17

1C-7. Require Energy Upgrades of Facilities at Time Of Sale	X	X							A1-A36, C1-C3, C5, C6, L1-L18, R3, R4, TC1-TC17
1C-8. Require New Homes to be Solar Ready	Benefits Unknown								R3-R5
1C-9. Adopt a High Performance Local Energy Code (Including a Green Building Ordinance) for New Construction and Renovation of Community Facilities				X					C4, R5-R7
1C-10. Adopt a Strict Commercial Energy Code				X					
1C-11. Adopt Strict Residential Energy Code Requirements		X							
1C-12. Create Carbon Tax	Benefits Unknown								
1C-13. Implement New Energy-efficient Public/Affordable Housing Projects		X							C4, R5-R7
1C-14. Funding for Energy Efficiency and Renewable Energy Projects			X						
1C-15. Energy Efficient Weatherization of Low-Income Housing Program	X		X						C1, C5
1C-16. Green Lease Program	X					X		X	C3
1C-17. "Green Business/Developer" Recognition Program					X				
1C-18. Create Volunteer-based Energy Auditing/Maintenance Program	Benefits Unknown								

Recommended Tracking Method

Strategies 1C-1, 1C-6, and 1C-9 are best tracked by the square feet of facilities retro-commissioned, retrofitted, or renovated using the CAPPA emissions factor (Appendix II). It may be desirable to analyze the specific retrofits taking place and try to weigh them according to the amount of GHG reduction potential for more accurate tracking. Assuming the retrofits consist mostly of the strategies listed in the building bundles, the GHG reduction per unit given for each strategy could be used for this weighting process. This tracking would best take place via city records or incentive/rebate records if applicable; otherwise a self-reporting survey of residents and businesses could be used.

Strategies 1C-3 through 1C-5, and 1C-17 involve the promotion of energy conservation and green building practices for both residents and businesses. Strategy 1C-3 should be tracked using the number of households that have agreed to participate in energy conservation and Strategy 1C-4 should similarly be tracked using the number of business that have also agreed to participate. The number of businesses participating can also be used for Strategy 1C-17 since this strategy is the recognition of businesses that commit to energy conservation. Strategy 1C-5 can most accurately be tracked by the square feet of buildings that implemented green building construction. CAPPA emissions factors are available for these strategies and should be used in conjunction with

the suggested metric. These strategies would be best tracked through an incentive/rebate program or a self-reporting survey if a strategy is only implemented as an educational program.

Strategies 1C-7 through 1C-11 involve the adoption of energy codes that require energy conservation efforts during the construction of new buildings and renovation of current buildings. Strategy 1C-7 can best be tracked using the number of homes sold that implemented the energy efficiency measures from city records (if available). Strategies 1C-9 and 1C-10 both depend on the extent of renovation or construction and should therefore be tracked using city records of the square feet of buildings constructed or renovated under the energy codes. 1C-11 similarly involves the construction of new residential homes and would be best tracked using city records of the number of homes constructed under the energy code. CAPPA emission factors are available for each strategy and should be used in conjunction with the suggested metric. Since these strategies rely on regulation, they would best be tracked directly by permit records and with information from the city staff enforcing the codes.

Strategy 1C-13 and 1C-14 involve the implementation and funding of new energy efficient projects. Strategy 1C-13 would best be tracked using the number of energy efficient households created. Strategy 1C-14 involves the funding of renewable energy projects but should be tracked with the product of the funding; therefore the number of households upgraded through these projects is the preferred metric. The preferred method for tracking is by the city or contracted staff that implements the projects.

Strategy 1C-15 involves the weatherization of low-income housing. The actions undertaken under this strategy can vary from replacing inefficient appliances to sealing cracks. It should be tracked using the number of households that participate in this program in conjunction with the CAPPA emission factor. Similar to retrofits, for more accurate tracking the effectiveness of each weatherization project could be weighed using the GHG reduction potential for each individual upgrade. The best method of tracking would be through the city staff that implements the program.

Strategy 1C-16 involves the creation of a green lease program that works with landlords to improve their multifamily housing in order to increase energy efficiency and water conservation. This strategy would best be tracked using the square feet of housing participating in the housing. RICAPS provides a GHG emissions factor to be used with the suggested metric in order to find the net GHG reduction. Tracking this strategy would best be implemented through incentive/rebate records if applicable or through a survey sent to the landlords of the green multifamily residences.

Alternative Tracking Methods

Strategies 1C-6, 1C-7, 1C-15, and 1C-16 each involve the improvement of buildings via appliance replacements and HVAC system upgrades. Many of these building improvements have corresponding PG&E rebates that could be taken advantage of. If these rebates are used, the estimated amount of electricity saved could then be tracked using PG&E's electricity savings reports in the residential and non-residential categories. However the savings reports only track the aggregate amount of electricity per rebate program so this method should only be used in conjunction with the preferred tracking method.

Effectiveness and Ease of Implementation

Strategy 1C-1 would complement many of the community retrofit strategies. This strategy would ease the

implementation and effectiveness of other retrofitting strategies by analyzing the buildings in need of retrofits at a relatively low cost.

Strategy 1C-2 could have minimal costs and may be very effective at increasing the community's awareness of electricity consumption. Enabling the community to see their own electricity and natural gas usage may give them more knowledge about how they use energy and motivation to reduce energy use through other strategies.

Strategies 1C-3 through 1C-5 can have variable costs depending on the extent of the campaigns and have potential to greatly reduce GHG emissions. The payback period is estimated to have an intermediate length. The main costs associated with these campaigns would be staff time and other optional costs including incentives and prizes for increasing interest in conservation. These campaigns have the ability to promote all strategies suggested in the implementation section. Additionally they can increase community involvement in energy conservation efforts.

Strategy 1C-6 would best be promoted via existing or newly created incentives and educational programs that provide detail on retrofit options. The implementation cost is estimated to be high with an intermediate payback period length, however the cost of this strategy can be greatly reduced by taking advantage of existing incentives. PG&E offers customized retrofit packages for both residential and non-residential buildings at a subsidized cost. PG&E rebates also exist for many of the building components upgraded within retrofits, which may result in more savings than the customized retrofit programs offered.

Strategies 1C-7 through 1C-11 can greatly reduce GHG emissions but can also be very costly to residents if standards are too stringent. It may be desirable to only require incremental improvements over time in order to ease the implementation of such efforts for residents and businesses. Many of these improvements yield annual savings, which may be one of the selling points for these strategies. The cost of implementing these strategies and their payback periods vary widely.

Strategy 1C-12 offers a potentially cost effective approach to reducing GHG emissions through a carbon tax. This strategy could focus on businesses and local manufacturers. It may be desirable to implement this strategy slowly since it may be seen as a radical approach to the community. More research is required to understand the dynamic of implementation and the overall effect of this strategy, especially with regard to potential economic leakage.

Strategy 1C-13 requires a large initial investment to construct affordable energy efficient homes. However, these homes have an intermediate payback period (estimated at 6 yrs) and offer annual cost savings. These houses are to be used as a pilot to promote development of similar housing structures and therefore have potential to reduce larger amounts of GHG emissions.

Strategy 1C-14 would require a large amount of funding to initiate, however funding may be available from state energy programs and energy efficiency grants. This strategy could aid in the creation of many renewable energy and energy efficiency projects.

Strategy 1C-15 would also require a large amount of funding and has an estimated payback period of around

50 years; however this strategy has a high GHG reduction potential. This strategy is only suggested for low-income housing where residents may not have funds for weatherization upgrades. However the weatherization of low-income housing could be contracted locally to provide local jobs and increase local 'green' retrofit expertise, which would make such upgrades more accessible to others in the community.

Strategy 1C-16 requires minimal funding by working with landlords of multifamily rental housing (MFRs) to increase the water and energy conservation of the buildings. The City can then work to designate the title "Green Property" to the building, which could be used for advertising purposes by the landlord.

Strategy 1C-17 can potentially reduce a large sum of GHG emissions if citywide participation is acquired. This strategy is estimated to have a high implementation cost but can have a minimal payback period. To increase the overall number of businesses that participate in performing "green actions", incentives and disincentives could be established. Competition between businesses could also be incorporated into this strategy to increase levels of effort. Extra funding may be used to assist businesses in finding ways to make operations more environmentally friendly.

Strategy 1C-18 involves the creation of volunteer based energy auditing and maintenance programs. This strategy is a community recommendation and the implementation costs and effectiveness are unknown. This strategy could complement and lower the implementation costs of other strategies in this bundle.

Education/Outreach

Education should consist of informing residents and businesses about potential energy and cost savings related to comprehensive building improvements. Education efforts should also focus on increasing the public awareness about retrofit programs and incentives.

Additional Notes

Many of the strategies listed in the comprehensive buildings bundle overlap with and complement strategies from the lighting, appliances, and temperature control bundles.

1D: Buildings – Temperature Control

Emissions Source: Residential & Commercial (Community)

GHG Reduction: Potential: Low (per unit basis) High Expandability

Ease of Implementation:
- Education/Outreach
- Incentive/Rebate
- Municipal Action/Service

Objective

The City can encourage residents and businesses to make comprehensive HVAC system improvements to improve building energy efficiency. This can occur via educational programs, promotion of existing incentive programs, or the creation of new incentive programs.

Tracking Options

Reduction Strategy	PG&E Data and Reports	Self-Reporting Survey			Incentive/Rebate Tracking			Applicable Incentives
	Energy Savings (kWh)	Units Installed/ Replaced (#)	Homes Converted (#)	Area of Facilities Upgraded or Installed (Sq Ft)	Homes Converted (#)	Units Installed/ Replaced (#)	Area of Facilities Upgraded or Installed (Sq Ft)	
1D-1.HVAC Temperature Control	Benefits Unknown							
1D-2. ENERGY STAR Window Air Conditioner Replacements	X	X				X		C6, TC7
1D-3. EPA Certified Wood Stoves Replacements		X				X		
1D-4. Energy Efficient Boiler Replacements				X			X	TC13-TC15
1D-5. Energy Efficient Chiller Replacements				X			X	
1D-6. HVAC Fan Upgrades				X			X	TC6, TC8
1D-7. Electric to Natural Gas Heating Conversion			X		X			TC11, TC12
1D-8. Install Reflective Roofing				X			X	TC4
1D-9. Install Green Roofing				X			X	

Recommended Tracking Method

Strategies 1D-2 and 1D-3 both consist of replacing HVAC units with energy efficient units and the number of units installed or replaced would best track this strategy using the CAPPA emissions factor (Appendix II) for these strategies. Tracking the number of units replaced can occur via rebate/incentive programs (if applicable) or through surveys sent to residents and businesses.

Strategies 1D-4 through 1D-6 and 1D-8 through 1D-9 similarly involve the installation or replacement of HVAC units or related components with highly energy efficient components. These strategies can be best tracked using the area of installation or replacement and the corresponding CAPPA emissions factors. This can be done via surveys for existing homes/commercial units and by monitoring the types of HVAC components installed in new housing and commercial developments via rebate/incentive programs if applicable. The city may also be able to collect the total square feet data from local contractors who do these installations.

Strategy 1D-7 involves the promotion of replacing electricity based heating systems with natural gas based systems. This strategy is best tracked using the number of homes switched and the corresponding CAPPA emissions factor. Rebates/incentive based programs would be the ideal method for tracking although if rebates or incentives are unavailable, the strategy can be tracking using a self-reporting survey of residents and businesses.

Alternative Tracking Methods

Strategy 1D-2 is covered under PG&E rebates, which enables tracking via the PG&E savings reports. However these savings will be part of the total electricity savings under the appliances section for both residential and non-residential.

Effectiveness and Ease of Implementation

Strategy 1D-1 would have minimal costs and would primarily occur through promotion and educational programs. This strategy may be especially effective when implemented in commercial facilities through the adjustment of boilers and chillers.

Strategy 1D-2 consists of replacing window air conditioner units with energy efficient models and has a moderate amount of GHG reduction potential per replacement. The overall effectiveness of this strategy depends on the number of replacements. This strategy can be promoted through educational programs as well as through incentive programs. This strategy is estimated to have a low implementation cost and a short payback period.

Strategy 1D-3 consists of replacing older stoves with EPA-certified wood stoves and can be promoted through the creation of educational or incentive programs. While it has not been show that this measure will reduce the GHG emissions for the city, stove upgrades may reduce the need for other heating fuels in homes using better stoves and in general the use of wood waste for heating reduces the wood waste sent to the landfill. The primary benefit would likely be an improvement in local air quality.

Strategies 1D-4 and 1D-5 apply primarily to commercial buildings and consist of replacing over-sized boilers and chillers with appropriately sized units. Depending on how inefficient the current boiler or chiller is, the GHG reduction potential can vary from low to moderate per unit replaced. These strategies can have high initial costs

but can moderately reduce operational costs for businesses and have intermediate payback periods. Educating the commercial sector on potential savings and providing incentives to reduce their implementation costs can help to increase participation.

Strategy 1D-6 consists of upgrading the fan on HVAC systems to a high efficiency model. Fans are responsible for the majority of electricity drawn from HVAC systems and energy efficient models have low replacement costs and minimal payback periods. The potential GHG reduction per unit has been classified as low, however this strategy is highly expandable because it can be applied to a large number of buildings.

Strategy 1D-7 can have a substantial implementation cost and has an estimated payback period of 25 yrs. Promotion of this strategy should focus on long term home owners who would most likely benefit from this payback. Promotion can be done through educational programs which detail home owners on their possible options and also working with the service providers to incentivize the switch. Additional education of home-buyers about the lower costs of natural gas heating may affect housing costs, potentially allowing shorter term homeowners to benefit from making this upgrade when they sell their home.

Strategies 1D-8 and 1D-9 both involve promoting the replacement of current roofing with green or reflective roofing. Although the GHG reductions from these strategies are classified as low, large-scale projects can help to reduce GHG emissions through other means. Reflective roof can potentially reduce the urban heat island effect and green roofing can be used to sequester GHG emissions through plants. These strategies have moderate implementation costs and reflective roofing can have a short payback period although green roofing does not. These strategies can be promoted through educational and incentive programs.

Education/Outreach

Education should consist of informing residents and business owners of the potential savings from replacing HVAC systems with higher efficiency systems. It may be the most beneficial to target those who are already looking to replace roofing or retrofit their homes. Increasing awareness of incentive/rebate programs will likely enhance the effectiveness of outreach efforts.

Additional Notes

There are additional related PG&E rebates not included in the applicable incentives column above for both residential and commercial buildings. These rebates include whole house fans and insulation.

2: Renewable Energy Generation and Procurement

Emissions Source: **Residential & Commercial (Community)**

GHG Reduction: Potential **Medium (per unit basis)**
Moderate Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebates**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Encourage residents and businesses to install renewable energy generation infrastructure and/or to procure renewable energy. This can be accomplished via educational programs, promotion of existing incentive programs, the creation of new city-run incentive programs or possibly even the creation of solar facilities that are city-run that can be purchased by the community.

Tracking Options

Reduction Strategy	PG&E Data and Reports	City Operations Tracking		Incentive/ Rebate Tracking		Self-Reporting Survey			Applicable Incentives
	Total Increase in Solar Capacity (kWh)	Energy Generated (kWh)	Capacity Installed (kWh)	New Capacity Installed (kWh)	Installed Renewable Items (# facilities)	New Capacity Installed (kWh)	Installed Renewable Items (# facilities)	Total Electricity Purchased (kWh)	
2-1. Encourage Installment of Geothermal Heat Pumps					X		X		R1
2-2. Encourage R&C Solar Photovoltaic (PV) Panels	X			X		X			R1,R3-R7
2-3. Encourage R&C Solar Water Heaters					X		X		R2,R6
2-4. Encourage Commercial Wind Turbines Installation				X		X			R1
2-5. Purchase Green Electricity Via the Grid from Solar, Geothermal, Wind or Hydroelectric Sources								X	
2-6. Purchase Green tags / Renewable Energy Certificates								X	
2-7. Create Community Solar Facilities		X	X						R1

Recommended Tracking Method

Strategies 2-1 through 2-4 involve education about installing renewable energy sources, possibly in conjunction with the creation and promotion of incentive programs targeting renewable installations. If incentive programs are city-run, participation records can be used in conjunction with provided CAPPA emissions factors (Appendix

II). If the strategy is strictly educational or incentive program records are unavailable, a self-reporting survey can be used with the CAPPA emission factors.

Strategies 2-5 and 2-6 involve purchasing the rights to renewable energy that has been third-party generated. CAPPA provides GHG emissions factors that can be applied to kWh of renewable electricity that has been purchased to determine associated net GHG reductions. The most feasible tracking option for these strategies would be a self-reporting survey. This data may be more easily collected from the commercial sector than the residential sector, since businesses have greater motivation for the public to be aware of their sustainable practices.

Alternative Tracking Methods

Strategies 2-1 through 2-4 also allow for the possibility of using self-reporting surveys. However, self-reporting surveys can be unreliable and subject to large margins of estimation/tracking error. Moreover, surveys have better response rates when they are shorter, so is the City invests time and effort into a self-reporting survey to measure other actions it should be used for strategies that cannot be reliably tracked in other ways.

Effectiveness and Ease of Implementation

If the city implemented incentive programs, strategies 2-1 through 2-4 would require funding as well as a continued time investment to determine potential participants' incentive eligibility and to distribute awards. However, tracking progress would be relatively easy since city records from the incentive program would be available. If incentive programs were not implemented or were not city-run, the city implementation burden would only consist of promotion. Thus, less funding and administrative effort would be required by the city to implement. However, tracking the effect of such strategies directly could be difficult due to lack of record availability, and if no incentive program was implemented, the effect of an educational program would be much smaller. These strategies provide medium to high GHG emissions reduction potential per unit - the units used in the reduction strategies table in Appendix II for 2-2 and 2-4 are kW, so these strategies are highly expandable since demand for electricity is high relative to the current use of renewables. Strategies 2-1 and 2-3, which have GHG reductions per household yin Appendix II, are moderately expandable because the can occur at every household (although they may be less feasible because they require individual homes to make costly new installations). Strategies 2-1 and 2-2 have longer payback periods (60-80 years). Strategies 2-3 and 2-4 have smaller, but still lengthy, payback periods (10-15 years).

Strategies 2-5 and 2-6 can increase the feasibility of obtaining renewable energy in the residential and commercial sector since these strategies eliminate start-up infrastructure and administrative costs associated with obtaining renewable energy. As a result, a resident could purchase solar energy in any increment depending on their financial resources. The per unit GHG emissions reduction potential is relatively low. However, this strategy is highly expandable since the percent of electricity purchased from green sources could conceivably reach one hundred percent. The payback period for these strategies is undefined.

Education/Outreach

One potential educational hurdle would be overcoming the notion that obtaining renewable energy is too expensive on a small scale.

Additional Notes

Tracking methods were not explored for Strategy 2-7, which involves the creation of a new municipal solar energy resource that the residential and commercial sector could use. Since this project involves the creation

of a new ongoing city service, the strategy would require large initial and continued financial and administrative investments. However, these facilities could potentially result in large GHG emission reductions. More research would need to be conducted to determine the feasibility of such a project.

3: Waste Diversion & Reduction

Emissions Source: Solid Waste (not in inventory)

GHG Reduction Potential: Low (per unit basis)
High Expandability

Ease of Implementation:

- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Create programs to reduce residential and commercial waste-creation and divert waste that would otherwise end up in a landfill for reuse. This can occur via educational and incentive programs, increased regulations and requirements placed on local businesses' trash disposal, and the creation of new/expanded city compost and recycling collection programs.

Tracking Options

Reduction Strategy	Incentive/Rebate Tracking		City Operations Tracking			Self-Reporting Survey	
	Waste Diverted (Weight / Area of Construction)	Waste Reduced (Weight / year/ capita)	Waste Diverted (Weight / year/ capita)	Waste Reduced (Weight / year/ capita)	Participating Businesses (#)	Waste Diverted (Weight / year/ capita)	Waste Reduced (Weight / year/ capita)
3-1. Encourage Sustainable Action in Schools	Benefits Unknown						
3-2. Encourage Reuse or Recycling of Construction and Demolition Materials	X					X	
3-3. Implement "Pay-As-You-Throw" Program		X		X			
3-4. Create Sustainable Vendor Ordinance for Public Events					X	X	
3-5. Cooperative Purchasing program	Benefits Unknown						
3-6. Establish/Expand Curbside Organics Composting Program			X				
3-7. Establish/Expand Curbside Recycling Programs			X				
3-8. Establish/Expand Business Recycling Programs			X		X		
3-9. Create Yard Waste Collection and Composting Program			X		X		
3-10. Reuse Facilities/ Programs to Foster Solid Waste Reduction		X		X			X

Recommended Tracking Method

Strategy 3-2 consists of programs to encourage the reuse and/or recycling of construction materials. CAPPA provides emissions factors (Appendix II), using the weight of waste diverted per square foot of construction. If this strategy was implemented as an incentive program, this value could be obtained through incentive tracking. If this strategy was implemented as an educational program then a self-reporting survey could be used to obtain this value.

Strategies 3-3 and 3-4 would require new regulations to be created and enforced. Emissions reductions associated with implementing strategy 3-3 can be quantified by applying a CAPPA emissions factor using the per capita amount of waste reduced. Emissions reductions associated with implementing strategy 3-4 can be quantified by applying a RICAP emissions factor (Appendix II) using the number of businesses that are regulated. Since both regulations would be enforced directly by the city, the city can obtain these values using data from the regulation/enforcement process.

Strategies 3-6 through 3-9 involve the creation of new/expanded city waste-collection programs. Emissions reductions associated with implementing strategies 3-6 through 3-9 can be quantified by applying a CAPPA emissions factor using the per capita amount of waste diverted. The emissions factor using the per capita amount of waste reduced can also be used for strategy 3-10. Since these waste-collection programs would be city-run, the most direct measure of waste diversion/reduction would be the total amount of each type of waste collected for diversion as recorded by the city.

Alternative Tracking Methods

Strategies 3-4, 3-9, and 3-10 also allow for the possibility of self-reporting surveys when more reliable data collection methods are not possible.

Strategies 3-8 and 3-9 involve the creation of new ordinances for businesses. Thus, the number of businesses that would be required to participate could be used to track emissions reductions using an average-waste-diverted-per-business value. Depending on the record keeping formats of the waste-collection data, this could be a superior tracking method, although in general the average-per-business value is an approximation and is more likely to be less accurate than measures of diverted waste.

Effectiveness and Ease of Implementation

If Strategy 3-2 is implemented as an incentive program, it would require funding as well as a continued time investment to determine participant incentive eligibility and to distribute awards. This strategy has a low per-unit GHG emissions reduction potential. The unit is pounds of waste per square foot of construction, which is very expandable since many pounds of waste can potentially be diverted. However, actual expandability is only moderate since this strategy only applies only to construction projects in the city, which produce just a portion of share of waste.

Strategies 3-3 and 3-4 require continued regulation enforcement, which may make implementation of these strategies time-intensive. Per-unit reduction potential for strategies 3-3 and 3-4 are moderate. Expandability for strategy 3-4 is low since the number of businesses in the city is relatively small. Expandability for strategy 3-3 is moderately high since the average person generates many pounds of trash per year. Thus, the amount of trash generated has good potential for reduction.

Strategies 3-6 through 3-9 would require large financial investment and extensive continued operation and labor costs. Per-unit GHG emissions reduction potential for these strategies is relatively low. However,

expandability of strategies 3-6, 3-7, 3-8, and 3-9 is again relatively large since the average person generates many pounds of trash per year.

Strategy 3-10 has substantial implementation costs with large operations costs but only moderate required staff time investment. Per-unit GHG emissions reduction potential for these strategies is relatively low. Expandability is moderate since the market for reused goods may be limited.

Education/Outreach

Educational programs would be necessary in conjunction with the advent of any new waste-reuse collection programs. These programs would need to teach participators how identify what items can be reused or recycled and how to sort trash appropriately.

Additional Notes

Tracking methods for strategy 3-1 were not explored. This strategy involves the creation of a school-based educational program. Costs associated with this strategy would be minimal because education programs are relatively inexpensive, especially when conducted in conjunction with other sustainability oriented school-based educational programs. Direct benefits from these programs may be infeasible to track. However, it would be possible to conduct a survey of participating schools asking schools to quantify some of the impacts of the waste education program.

Tracking methods for strategy 3-5 were also not explored. This strategy would require new regulations to be created and enforced. These regulations would be enforced by the city, thus participation could be tracked by the city. However, this metric would be an indirect measure of the strategy's effectiveness unless the City found a way to estimate the relationship between participation and GHG emissions.

The bundle 3 Waste Diversion & Reduction strategies aim to prevent GHG emissions that are generated when trash is disposed of at a landfill. These emissions were not included in the baseline inventory, but are a potential source of emissions reductions.

4: Urban Forestry

Emissions Source: Residential & Commercial Energy Use (Community)

GHG Reduction: Potential: Medium (per unit basis) High Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

The City can work to increase and improve current urban forestry efforts to increase carbon storage, provide shade and reduce cooling energy use, and reduce watering and maintenance requirements. These strategies primarily require direct action from municipal staff although some strategies can be promoted in the community.

Tracking Options

Reduction Strategy	City Operations Tracking	Incentive/ Rebate Tracking
	Trees Planted (#)	Trees Planted (#)
4-1. Low Maintenance Gardens in New Development Model Homes	Benefits Unknown	
4-2. Tree Planting to Shade Buildings	X	X
4-3. Develop Policies to Encourage Community-Based Farms	Benefits Unknown	
4-4. Tree Planting for Carbon Storage & Heat Island	X	X

Recommended Tracking Method

Strategies 4-2 and 4-4 both involve the planting of trees in order to increase shade, carbon storage, and reduce the heat island effect near residential and commercial buildings. These strategies can be encouraged in the community by promoting and/or expanding tree planting rebate programs. If a large-scale planting effort is desired, the city may be able to subsidize the cost of particularly low maintenance trees. The recommended metric for both strategies is to track the number of trees planted, which can occur via rebate tracking as applicable. Strategy 4-2 depends on the number of trees planted for shading purposes while the metric for strategy 4-4 is the total amount of trees planted.

Alternative Tracking Methods

If the City wishes to plant trees directly both strategies 4-2 and 4-4 would best be tracked by the municipal staff or by requesting information from businesses contracted to plant trees.

Effectiveness and Ease of Implementation

Strategy 4-1 involves the replacement of model home landscaping with low maintenance gardens. The cost of this strategy can vary between model homes. The cost of making upgrades will generally be low and the effectiveness of this strategy can vary depending on the landscaping popularity, cost, and the scale of upgrades made.

The implementation cost of strategies 4-2 and 4-4 is estimated to be high with a lengthy payback period, however the costs can vary depending on the type of trees planted. Trees that are native and have low water and maintenance requirements should be prioritized in order to minimize associated emissions and long-term costs. In order to maximize the benefits of these strategies, it may be desirable to shade the majority of a

building before moving on to the next, especially in buildings that do not have HVAC zones. This would help to mitigate the use of air-conditioning most effectively by covering the whole area instead of just a section.

Strategy 4-3 can be implemented via educational programs, incentive programs, and regulatory changes and therefore the implementation cost of this strategy can vary. More research is required in order to estimate the costs and benefits of this strategy.

Education/Outreach

Education about this bundle consists of informing residents and business owners about the potential monetary savings and GHG reductions caused by planting trees for shade. A list of trees and native plants as well as an estimated amount of required maintenance should be made available to the public and at local nurseries.

Additional Notes

NA

5: Transportation Miscellaneous (Community)

Emissions Source: Transportation (Community)

GHG Reduction: Potential: Low (per unit basis) Moderate Expandability

Ease of Implementation: **Education** **Incentives** **Municipal Strategy/Service**

Objective

Encourage telecommuting in the commercial sector, encourage the consumption of local food, produce and goods, and gasoline lawnmower replacement.

Tracking Options

Reduction Strategy	City Operations Tracking		Self-Reporting Survey		Applicable Incentives
	Units Installed or Replaced (#)	Employees Offered Telecommuting Incentives (#)	Units Installed or Replaced (#)	Employees Offered Telecommuting Incentives (#)	
5-1. Encourage Telecommunicating		X		X	
5-2. Encourage Consumption of Local Food, Produce, and Goods	Benefits Unknown				
5-3. Gasoline Lawnmower Replacement	X				T12

Recommended Tracking Method

Strategy 5-1 consists of encouraging employees from the commercial sector to telecommute by providing incentives and/or educational programs to companies within the city. CAPPA has devised an emissions factor using the number of employees offered telecommuting incentives (Appendix II). This value can be tracked by having beneficiaries self-report how many employees they have offered a telecommuting option.

Alternative Tracking Methods

Depending on the information provided in the permitting process, strategy 5-1 could also be tracked using business permits to determine the number of employees at participating companies. However, this metric may lead to an overestimate since not all employees at participating companies may be offered telecommuting options.

Effectiveness and Ease of Implementation

If strategy 5-1 includes city-run incentive programs, ongoing award and administrative costs would be required. This strategy has moderate per unit GHG emission reduction potential and is moderately expandable since the unit could potentially encompass most commercial employees in the city.

Education/Outreach

Educational components for this bundle would involve educating businesses and employees about how technological tools can be used to facilitate telecommuting and how businesses can provide incentives for their employees.

Additional Notes

Tracking methods were not explored for strategy 5-2. Consuming local foods has the potential to reduce GHG emissions by reducing the distance that food is transported. This strategy could be implemented in the form of educational and incentive programs.

Strategy 5-3 consists of programs to encourage gasoline lawnmower replacement. Gasoline lawnmowers pollute disproportionately more than other automobiles based on volume of gasoline consumption (CAPPA). However, GHG emissions savings are negligible. At the same time, reducing the number of gasoline lawnmowers can result in significant improvements to local air quality.

6: Transportation Infrastructure

Emissions Source: Transportation (Community)

GHG Reduction Potential: Low (per unit basis) Minimal Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Create transportation infrastructure that minimizes the emissions associated with automobile use for in-town transportation, as well as encourage businesses to minimize the emissions associated with transportation infrastructure projects. This encouragement can be accomplished via educational programs, the creation of new city-run incentive programs, or construction regulations.

Tracking Options

Reduction Strategy	Incentive/Rebate Tracking	City Operations Tracking		Self-Reporting Survey
	Area of Non-Asphalt Pavement Converted (Acres)	Area of Non-Asphalt Pavement Converted (Acres)	Reduction of Ambient Temperature (degrees)	Area of Non-Asphalt Pavement Converted (Acres)
6-1. Use Non-asphalt Pavements	X	X	X	X
6-2. Traffic Light Synchronization	Benefits Unknown			
6-3. Increase Number of Roundabouts	Benefits Unknown			

Recommended Tracking Method

Strategy 6-1 involves the creation of education, incentive, and or/regulatory programs to encourage businesses to use non-asphalt, lower-emission pavements. This strategy does not have any directly attributed GHG emission reductions as quantified by CAPPA. However, using non-asphalt pavements can reduce the urban heat island effect and indirectly reduce GHG emissions by reducing the energy consumption used for cooling buildings. Thus the use of non-asphalt pavement converted can still be useful to track. One tracking metric is the amount of non-asphalt pavement converted by unit area. If using this metric, an emissions factor would need to be developed that accounts for the associated reduction in ambient temperature. Depending on the content of building permit records, the city may be able to use these permits to determine the area of non-asphalt pavement used in the commercial sector. If city-run incentive programs are created, participation records can be used for tracking. Likewise, if new building regulations are created, city permitting or compliance records can be used. These city-based tracking sources would provide the most direct and accurate measure of the area of non-asphalt pavements used if these records are kept by the city. However, if the programs are strictly educational or if incentive records are not accessible to the city, then a self-reporting survey of businesses can be used.

Alternative Tracking Methods

Strategy 6-1 could also be tracked by monitoring the reduction in ambient temperature directly. However, this measure can be unrepresentative since many factors affect ambient temperature besides the use of non-asphalt pavement. Temperature trends in urban and rural areas could be examined using government weather

databases if there is a temperature gauge in the city and in a nearby rural area, or the city could keep records directly.

Effectiveness and Ease of Implementation

Whether strategy 6-1 is implemented as an education program, incentive program, or regulation, continued staff time would be required to develop and maintain the program. An educational program would most likely be the cheapest and most easily expandable because of low incremental costs. To significantly mitigate the urban heat island effect, non asphalt pavements would have to be used on a broad scale. Thus more research would need to be done on the amount of paving that could potentially be converted and what potential benefits would result from this strategy.

Education/Outreach

Educational components for this bundle would involve informing businesses about the affect of paving options on the urban heat island effect and ambient temperature.

Additional Notes

Tracking methods were not explored for strategies 6-2 and 6-3. Both consist of modifying city road infrastructure to minimize stopping and starting of vehicles. These strategies would require initial construction costs, but would require little to no maintenance costs and cold potentially have a small payback period due to decreased fuel consumption.

7: Transportation Fuels

Emissions Source: **Transportation (Community)**

GHG Reduction: Potential **High (per unit basis)**
Substantial Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Municipal Action/Service**

Objective

Promote the use of automobiles that use low-emission fuels by residents and businesses. These goals can be accomplished through educational and incentive programs and the creation of alternative fuel infrastructure.

Tracking Options

Reduction Strategy	City Operations Tracking	Self-Reporting Survey	Applicable Incentives
	Low-Emission Vehicles (#)	Low-Emission Vehicles (#)	
7-1. Develop a Neighborhood Electric Vehicle Program	Benefits Unknown		T1,T2,T5-T8,T10,T11
7-2. Convert to Compressed Natural Gas (CNG)	X	X	T4,T6-T8,T10,T11
7-3. Conversion to Electric Vehicles (EVs)	X	X	T1,T2, T5-T8,T10,T11
7-4. Local Bio-Fuel Production	Benefits Unknown		T7

Recommended Tracking Method

Strategies 7-2 and 7-3 consist of creating programs to encourage the use of low-emission fuel vehicles, compressed natural gas vehicles and electric vehicles respectively. Encouragement could be provided in the form of education and incentive programs. CAPPA has provided a factor (Appendix II) using the number of converted low-emissions vehicles to quantify emissions reductions associated with implementing these strategies. When incentive programs are run by the city, the number of vehicles converted utilizing city-incentives can be tracked directly by the city. However, if incentive tracking records are not accessible to the city or the programs are strictly educational a self-reporting survey of residents and businesses could be used to track the number of converted vehicles.

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

If implemented as incentive programs, strategies 7-2 and 7-3 would require continued program and administrative costs to implement. However, these strategies have a high potential to reduce GHG emissions and are very expandable since there are a large number of personal and commercial vehicles in the city. There is no defined payback period for strategy 7-2 but strategy 7-3 has a defined intermediate length payback period of 6.2 years since electric vehicles have a lower operating cost than gasoline or diesel vehicles (CAPPA Electric Vehicles tab).

Education/Outreach

To make the transition to low-emission fuels feasible, education for these strategies should include information on fueling locations and miles per “fill-up” for each type of vehicle.

Additional Notes

Tracking methods were not explored for strategy 7-1, which involves the creation of a neighborhood electric vehicle program. This strategy includes the creation of electric vehicle infrastructure. Thus, this strategy could be implemented in conjunction with strategy 7-3 to maximize effectiveness. Costs as well as potential GHG reduction potential would be substantial for this strategy. More research should be done to determine the cost effectiveness of this type of program.

Tracking methods were also not explored for strategy 7-4, which involves the production of local bio-fuel. Costs as well as potential GHG reduction potential would be substantial for this strategy. GHG emission reductions would occur due to both the low-emitting nature of bio-fuel and reduction in emissions associated with transporting gasoline for consumption. More research should be done to determine the cost effectiveness of this type of program.

8: Transportation Equipment and Operations

Emissions Source: **Transportation (Community)**

Ease of Implementation: **Education/Outreach**

GHG Reduction: Potential **High (per unit basis)**
Moderate Expandability

Objective

Create programs to limit idling of buses and heavy equipment. Strategies can include education and awareness programs.

Tracking Options

Reduction Strategy	City Operations Tracking		Self-Reporting Survey
	Vehicles Affected (#)	Program Participants (#)	Vehicles Affected (#)
8-1. Limit Idling of Heavy Equipment Vehicles	X	X	X
8-2. Limit Idling of Local Transit Buses and School Buses	X	X	X

Recommended Tracking Method

Strategies 8-1 and 8-2 consist of creating educational programs to encourage reductions in the idling of heavy equipment vehicles and public buses respectively. CAPPA has provided an emissions factor (Appendix II) using the number of vehicles affected by the idling reduction programs. Determining the exact number of vehicles affected may be difficult. However, the number of targeted vehicles can be determined by the city through the examination of business permits, transit records, etc. Thus, at the implementation stage, the city would already have an idea of the composition of potentially affected vehicles. Determining the number of affected vehicles can be further clarified by via a survey of targeted entities (businesses, bus drivers, etc).

Alternative Tracking Methods

If specific vehicle information proves to difficult to obtain, strategies 8-1 and 8-2 could also be tracked using the number of educational program participants and using a general emissions factors for the typical number of affected vehicles per participant. Since the educational program would be city-run, city records could be used to determine the number of participants.

Effectiveness and Ease of Implementation

Strategies 8-1 and 8-2 would require initial research to find potential participants and develop the educational program. However, the program would be relatively inexpensive to administer. The potential GHG emission reductions are significant. Expandability is moderate since there are a limited number of heavy equipment vehicles and buses operating in the city.

Education/Outreach

NA

Additional Notes

NA

9: Transit and Bike/Ped

Emissions Source: **Transportation (Community)**

GHG Reduction: Potential **High (per unit basis)**
Moderate Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Overview

Create programs that encourage and enable the use of alternative lower-emission transportation modes, specifically: public transportation, biking, and walking. These goals can be accomplished via the creation of educational programs, city-run incentive programs, new regulations, and new mass transit infrastructure.

Tracking Options

Reduction Strategy	City Operations Tracking					Other Organization Tracking	Self-Reporting Survey	
	Households Targeted (#)	Transit Passengers (people/time period)	Program Participants (#)	Bike/Pedestrian traffic counts (# trips /week)	Bicycles Available (#)	Transit Passengers (people/time period)	Alternative Transportation Use by mode (people/ time period)	Program Participants (#)
9-1. Provide Low-Carbon Transportation Education	X							
9-2. Increase Mass Transit Ridership		X				X	X	
9-3. Increase Bus Ridership		X				X	X	
9-4. Encourage a Change in Transit Policy Allowing Bicycles on Trains/Buses		X				X	X	
9-5. Transportation Demand Management	Benefits Unknown							
9-6. Provide High School Students with Free Bus Passes			X					X
9-7. Provide Bicycles for Daily Trips					X		X	
9-8. Create a "Safe Routes to School" Program			X	X			X	X
9-9. Expand Bus Service in Range and/or Frequency		X				X	X	
9-10. Improve / Expand Pedestrian Infrastructure				X			X	
9-11. Create Community Programs to Encourage Bicycle Riding and Recycling	Benefits Unknown							
9-12. Implement Bus Rapid Transit (BRT) or Shuttle Programs		X				X	X	
9-13. Create/Expand Bicycling Infrastructure				X			X	

Recommended Tracking Method

Strategy 9-1 consists of a low-emissions transportation educational program targeting residents. Although the effects of educational programs are often difficult to quantify, CAPPA has devised a factor (Appendix II) using the number of households targeted to quantify emissions reductions expected to result from implementing this strategy. Since this educational program is city-run, the city can use program records to keep track of the number of households that have been targeted.

Strategies 9-2 and 9-3 consist of programs to encourage the use of mass/public transit through educational and incentive programs. CAPPA has devised an emissions factor that uses the number of additional daily transit passengers (Appendix II). The increase in the number of passengers is a relatively direct measure of the effectiveness of these programs. For transit systems that are city-run, the number of additional passengers can be tracked directly using city records. For transit systems that are run by a third party (e.g. Yolobus), it is desirable to obtain the number of passengers from the transit agency.

The emissions reductions generated from implementing strategy 9-12 can also be quantified using the CAPPA emission factor for the number of passengers using mass/public transit. This strategy consists of the creation of new public transportation services by the city or regional transit organizations. If the program is city-run, the city could use the total number of passengers as recorded directly by the city service organization. If it is run by a third party, it is desirable to obtain the number of passengers from the transit agency.

Strategy 9-4 consists of creating regulations/policies that encourage bicycles to be allowed on public transportation in order to increase bike use and bus and rail ridership. CAPPA provides emissions factors using the number of additional alternative transportation trips for given time frames. This metric can be estimated from transit records of bike use on transit if the transit organization (city or third party) records bike use on transit.

Strategies 9-8, 9-9, 9-10, and 9-13 also seek to increase the use of alternative transportation by expanding/improving alternate transportation infrastructure. CAPPA factors, which use the number of trips for a given timeframe, can again be used for most of these strategies. Since strategy 9-9 expands bus infrastructure, ridership records (from the city or transit agency) can be used to track the results. Strategies 9-10 and 9-13 expand bike and pedestrian infrastructure. The effects of these strategies can be tracked via bike/pedestrian traffic counts. Depending on the means used to generate counts, the counts might be periodic samples that can be extrapolated to longer time periods. The counts should capture both affected infrastructure and surrounding infrastructure in the area in order to make the distinction between route shifts and mode shifts (new bike/pedestrian travelers). Strategy 9-8 expands pedestrian infrastructure for school children. These infrastructure improvements are also coupled with an aggressive education program. CAPPA provides a factor for emissions reductions using the number of participants in the educational program (Appendix II).

Strategies 9-6 and 9-7 consist of the city providing the public with tools to increase the use of alternative transportation modes. Strategy 9-6 provides students with bus passes. CAPPA provides an emissions factor using the number of students that have been given bus passes. Since the handout program would be city-run, this program could be tracked by city reporting. Strategy 9-7 provides the community with bike lending/rental services. CAPPA provides an emissions factor using the number of bicycles available through the program. Again, this number could be tracked using city reporting since the bike service would be a city-run program.

Alternative Tracking Methods

Strategies 9-2 and 9-3 could also be tracked using a self-reporting survey of residents or the people targeted by the program, although the results are likely less accurate than measuring ridership.

Strategy 9-6 could also be tracked using a self-reporting survey asking high school students if they received a bus pass if the city were not able to track how many bus passes were administered. The survey might also ask about their bus ridership, in which case a trip-based metric (rather than program participation) would be needed to convert their response to emissions savings. Likewise, strategy 9-7 could also be tracked using a self-reporting survey of city residents if direct city tracking was not possible, although a trip-based metric (rather than the number of bikes) would be needed to convert surveyed bike trip information to emissions savings.

Strategy 9-8 could also be tracked using a resident survey asking about program participation, or via tracking of the number of additional pedestrian trips from bike/pedestrian traffic counts or a survey of residents. However, an emissions factor for this value would need to be generated to convert these traffic counts into emissions reductions.

Strategy 9-9 could also be tracked using a resident survey to determine the number of trips shifted to bus due to improved bus service. However, city bus ridership records would be a more direct reliable measure of increased ridership.

Strategies 9-10 and 9-13 could also be tracked using a resident survey to determine the number of trips shifted to bike/pedestrian modes due to infrastructure improvements.

Strategy9-12 could also be tracked using a survey of residents to determine the number of additional passengers generated. However, ridership records would be a more accurate measure.

Effectiveness and Ease of Implementation

Since educational programs are relatively inexpensive, strategy 9-1 would not be very costly to implement, especially if it occurred in conjunction with educational components of other reductions strategies. Potential GHG emissions savings are moderate. There are not many households in the city so the strategy does not have a great potential for expandability. Strategy 9-1 has a minimal payback period (0.1 years) as a result of immediate fuel savings from VMT reduction.

If strategies 9-2 and 9-3 are implemented as incentive programs, ongoing program and administrative costs would be required. Ticket subsidies have the potential to vary greatly in size and type. Thus, a great variability in potential costs exists as well. These strategies have relatively large GHG reduction potential when expandability of the programs is considered since there are many potential public transit riders.

Since strategy 9-4 involves changing a regulation, some ongoing monitoring costs may be required. This strategy contains moderate GHG reduction potential but may not be very expandable if not many people are deterred from using public transportation due to bikes not being allowed. However as other alternative transportation strategies are implemented, the synergistic effects of this strategy may increase.

Since strategies 9-6 and 9-7 involve the creation of new city services, ongoing costs would be incurred to maintain the programs. 9-7 would also require a large initial investment to procure bicycles. However, these strategies also have a relatively large GHG reduction potential when expandability of the programs is considered since there are many potential public transit riders and bicyclists. Strategy 9-7 also has a minimal payback period (0.5 years) as a result of immediate fuel savings from VMT reduction.

Since strategies 9-8, 9-9, 9-10, and 9-13 involve expanding city transportation infrastructure, large initial costs would be required. However, with the exception of strategy 9-8, which requires an ongoing supplementary educational program, operations and maintenance fees would not be exorbitant. These strategies have a moderate GHG reduction potential but are very expandable since there are many potential riders and the total number of alternative transportation trips has potential to increase greatly.

Since strategy 9-12 involves the creation of new public transportation services, large initial and operations and maintenance costs would be required. However, this strategy has the largest potential GHG emissions reduction potential in the bundle and is very expandable since there are a large number of potential passengers.

Education/Outreach

Health benefits associated with biking and walking should be addressed in applicable educational programs. Local air quality benefits of reduced passenger vehicle use can also be highlighted.

Additional Notes

There were no emissions associated with rail travel included in the baseline inventory. The implementation of strategy 9-2 would result in GHG emissions reductions that could not be exclusively attributed as city emission reductions.

Complementary bundles include bundle 10: Parking Policies which also encourages the use of lower-emission means of transportation. When tracking emissions reductions, care should be taken not to double count the emissions reductions associated with increased public transportation ridership or bike/pedestrian travel that comes as a result of one program or the other.

Complementary bundles also include bundle 11: Land Use which includes land use planning strategies that facilitate bicycle and pedestrian travel.

Tracking methods were not explored for strategy 9-5 and 9-11. Strategy 9-5 consists of fees on new developments that are used to fund alternative transportation programs. Potential effects of this strategy should be examined. Strategy 9-11 consists of community programs to encourage biking and provide bicycle care education. Potential costs could vary greatly depending on the types of programs that were offered. This strategy could potentially be implemented in conjunction with strategies 9-4, 9-7, and 9-13 to maximize effectiveness of these strategies.

In addition to the tracking metrics that are specific to each strategy, the City might ask SACOG if they can periodically provide city transit and bike/ped mode shares from the regional travel model. Although this information may be infrequent and it would be an aggregate measure of all strategies, it would still be useful as a means to track the overall mode shares in the city.

10: Parking Policies

Emissions Source: Transportation (Community)

GHG Reduction: Potential: Medium (per unit basis) Low Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Create vehicle parking programs and policies that encourage the use of alternate modes of transportation and ride-sharing by residents and businesses. These goals can be accomplished via the creation of educational programs, city-run incentive programs, new regulations, and preferred parking infrastructure for low-emissions vehicles.

Tracking Options

Reduction Strategy	Incentive/ Rebate Tracking	City Operations Tracking			Self-Reporting Survey	
	Employees Offered Program (#)	Increase in On-Street Parking Prices (%)	Fuel-efficient Vehicle Parking Created (# of spaces)	Electric Vehicle Charging Parking (# of spaces)	Employees Offered Program (#)	Low-Emissions Vehicles Purchased (vehicles)
10-1. Implement Parking Cash-out Program	X				X	
10-2. Create Parking Policies to Encourage Walking, Bicycling, and Using Public Transit		X				
10-3. Create Fuel-Efficient Vehicle Preferred Parking Policies			X			X
10-4. Increase Park-n-Ride Lots	Benefits Unknown					
10-5. Develop Parking Infrastructure to Support Emerging EV Transportation System				X		

Recommended Tracking Method

Strategy 10-1 consists of incentive programs that encourage employees to give up their parking spots. These programs could be city-run, or run by businesses in the commercial sector. The effect of this strategy can be quantified using a CAPPA emissions factor (Appendix II) for the number of employees that the program is offered to. This value can be tracked directly by the city or by the businesses, depending on which entity organizes the program. If the programs are business run, the city would need to obtain tracking information from businesses via a survey or another means.

Strategy 10-2 consists of using parking policies to affect transportation mode choice. There are many policies that could be explored as part of this strategy. One policy suggested by RICAPS that is easily quantifiable is to increase on-street parking prices. RICAPS provides an emissions factor (Appendix II) using the percent change in parking prices. Since this increase would be mandated by the city, this metric can be tracked by the city

directly.

Strategies 10-3 and 10-5 consist of city-implemented parking infrastructure building projects that encourage the use of low emission vehicles by residents and businesses. The effect of strategy 10-3 is quantified using the number of hybrid vehicles purchased, presumably as a result of preferred parking policies. There is no system that directly tracks the number of hybrids purchased in the community. Thus, self-reporting surveys would need to be used – these will be more accurate if they can approximate the number of vehicle purchases for which parking policies were a deciding factor. If other vehicle types are included in strategy 10-3, emissions factors specific to those vehicle types would need to be determined. The effect of strategy 10-5 can be tracked via the number of electric vehicle charging parking spaces created. Since these parking spaces would be created by city programs, the city would be able to track this information directly.

Alternative Tracking Methods

Alternatively, if the number of vehicles procured as a result of strategy 10-3 proves difficult to obtain, the number of fuel-efficient vehicle parking spots that are created by the city could be used as a possible metric. This value could be tracked directly by the city since the parking spots would be created directly by the city. However, an emissions factor per parking spot created would need to be determined.

Effectiveness and Ease of Implementation

If incentive programs that are part of strategy 10-1 were run by third party businesses, costs to the city would be minimal. If the programs were city-run, financial inputs would be more substantial but still relatively small. However, these incentives yield a moderate per unit GHG emissions reduction and are moderately expandable since all employees could potentially be offered these incentives.

Implementing strategy 10-2 results in minimal per unit GHG emission reductions and has minimal expandability. Its' effectiveness in any particular area is likely related to the availability of parking – if parking is plentiful it may have little to no effect. Implementation requires minimal effort and financial input by the city and would most likely result in increased revenues from increased parking fee revenues.

Strategies 10-3 and 10-5 have larger initial costs. Both strategies have substantial per unit GHG emission savings potential with minimal expandability since a limited number of city residents may purchase a hybrid for the parking convenience alone. The cost of maintaining strategy 10-3 would be relatively minimal and there is a relatively short payback period (2.7 years). However, the cost of maintaining strategy 10-5 would be more substantial since energy would continually need to be supplied to the charging stations.

Education/Outreach

Some of these strategies promote the use of alternative means of transportation by making parking more inconvenient. When this is the case, educational programs should also include informing the public about their public transit, walking, and biking options to minimize resident dissatisfaction.

Additional Notes

Implementing parking pricing under strategy 10-2 would also likely complement other strategies within this bundle, particularly 10-1 and 10-4.

Other complementary bundles include 9: Transit and Bike/Ped and 12: Carpool and Carshare. Both of these bundles facilitate the use of alternative transportation modes. Bundle 7: Transportation fuels and 13: Vehicle Efficiency are also complementary. Incentives provided as part of strategies 7-3, and 13-2 may increase the

expandability of strategy 10-3 and 10-5 by increasing the number of city residents that could feasibly purchase a hybrid or electric vehicle.

Tracking methods were not explored for strategy 10-4, which involves the creation of Park-n-Ride lots near public transportation centers.

11: Land Use

Emissions Source: **Transportation (Community)**

GHG Reduction: Potential **Medium (per unit basis)**
High Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Create programs to encourage land use and transportation infrastructure that minimize vehicle miles traveled by residents and businesses. This would require researching and promoting smart growth and transit-oriented development to residential and commercial developers as well as changing city infrastructure directly. Promotion can be accomplished through education and incentive programs and regulations. Changing city infrastructure can be accomplished through city-run construction and development projects.

Tracking Options

Reduction Strategy	Incentive/Rebate Tracking		Self-Reporting Survey		
	Size of Transit Oriented Development (# of residential units)	Change in Housing or Jobs (% change in homes or jobs / acre)	Size of Transit Oriented Development (# of residential units)	Change in Housing or Jobs (% change in homes or jobs / acre)	Change in VMT (% / person in affected developme nt)
11-1. Promote Transit-oriented Development	X		X		X
11-2. Research the use of "Smart Growth" in Future Development		X		X	X
11-3. Participate in Regional Planning	Benefits Unknown				
11-4. Walkable/Bikeable Street Landscape	Benefits Unknown				

Recommended Tracking Method

Strategies 11-1 and 11-2 consist of researching and promoting transit-oriented and “smart growth” development to residential and commercial developers as well as those in charge of developing city-owned infrastructure. CAPPA provides an emissions factor (Appendix II) for strategy 11-1 using the number of residential units included in transit-oriented development. For city-created developments, city records could be used to determine this value. For third-party-created developments, this information could be obtained using building permits, tax records, or other development-related city records. If this information is not easily obtained from city records, a self-reporting survey could be administered to developers. RICAPS provides an emissions factor (Appendix II) for strategy 11-2 using the percent increase in housing or jobs per acre. These values could be obtained using city records as for 11-1. Again, if this information is not given in the permitting process, a self-reporting survey could be administered to the developers or businesses in the affected area.

Alternative Tracking Methods

Strategies 11-1 and 11-2 could also be tracked using the percent reduction in VMT per person with a provided CAPPA emissions factor. However, this information is more difficult to track since obtaining the VMT by privately owned vehicles is challenging and data from multiple years would need to be examined to obtain a percent reduction. Moreover, there are many factors that affect VMT so it would be difficult to attribute reductions on a per strategy basis. This information would need to be collected via self-reporting survey of residents of both TOD or smart growth developments and non-TOD or smart growth developments.

Effectiveness and Ease of Implementation

Strategy 11-1 yields large potential per-unit GHG emissions reductions. The expandability is moderate in the since it is difficult to add a large number of residential units in centrally located areas. Strategy 11-2 yields small potential per-unit GHG emissions reductions. The expandability is moderate since development density in the city has the potential to increase.

Education/Outreach

Educational programs for these strategies would be targeted at developers and homebuyers. Educational materials should illustrate that smart planning also has the potential to increase resident quality of life by increasing convenience and active travel (and the associated health benefits).

Additional Notes

Transportation and Land Use planning guides have already been developed by the Yolo-Solano Air Quality Management District, which may be utilized for all strategies in this bundle (http://www.ysaqmd.org/downloads/toolkit.pdf#view=FitH).

Tracking methods were not explored for strategies 11-3 and 11-4. Strategy 11-3 is similar to strategies 11-1 and 11-2 and consists of participating in SACOGs regional planning process under SB 375. Strategy 11-4 consists of land use planning and streetscaping with walkability and bikability in mind.

12: Carpool and Carshare

Emissions Source: Transportation (Community)

GHG Reduction: Potential: Medium (per unit basis) Moderate Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

Create programs to encourage carpool and carsharing. These goals can be accomplished via the creation of educational programs, city-run incentive programs, regulations, and a new city-run carsharing service.

Tracking Options

Reduction Strategy	Incentive/Rebate Tracking		City Operations Tracking		Self-Reporting Survey			Other Organization Tracking	Applicable Incentives
	Program Participants (#)	Employees Offered Program (#)	Program Participants (#)	Change in VMT (% / person using program)	Program Participants (#)	Employees Offered Program (#)	Change in VMT (% / person using program)	Program Participants (#)	
12-1. Increase Ride-Sharing	X	X			X	X			
12-2. Establish A Car Sharing Program			X		X			X	
12-3. Create High-Occupancy Vehicle (HOV) Lanes							X		T6

Recommended Tracking Method

Strategy 12-1 consists of encouraging ridesharing by employees through the use of policy changes, incentives, and educational programs that target businesses and their employees. CAPPA provides an emissions factor (Appendix II) using the number of employees that have been offered ride-sharing programs. If incentive programs are city-run, the number of employees that the program is offered to could be tracked using business permits or other city records that keep track of the number of employees in the city. If the city does not have access to incentive records or the programs are strictly educational a self-reporting survey can also be administered to businesses.

Strategy 12-2 seeks to encourage carsharing in the commercial and residential sector by creating a carsharing program. CAPPA provides an emissions factor using the number of program participants. Since this program would be city-run, this value can be tracked directly by the city. If a private business implements the car share program (e.g. Zipcar), the city could request participation information from the business organizing the carsharing program.

Strategy 12-3 consists of creating high occupancy vehicle lanes. CAPPA provides an emissions factor using the percent reduction in VMT per person using the lanes. This value could be estimated from a survey of residents

although it will be difficult to separate the effects of this policy from other policies targeting VMT reductions.

Alternative Tracking Methods

Strategy 12-1 could also be tracked using the total number of active participants (vs. the people to which the program was offered) from incentive records (if applicable) or via a survey of residents or participating businesses. However, there is no known emissions factor calculated for this value.

If information about carsharing cannot be obtained from the entity administering the carshare program, Strategy 12-2 could also be tracked with a survey of residents.

Effectiveness and Ease of Implementation

Since strategy 12-1 includes incentive programs, ongoing award and administrative costs would be expended the organization implementing the program, whether it is the city or local businesses. This item has moderate per unit GHG emission reduction potential and is moderately expandable.

Large initial costs would be required to procure the vehicles needed to implement strategy 12-2. Since strategy 12-2 involves the creation of a new service, ongoing costs would also be incurred to maintain and staff the program. However, this item has a relatively large per unit GHG reduction potential and is moderately expandable, and private companies have implemented carsharing programs in several cities in the region.

Strategy 12-3 would require coordination with regional transportation planning efforts. The costs and funding sources for strategy 12-3 depend on the manner in which it is implemented. This item has moderate GHG emission reduction potential and is moderately expandable since carpooling has a moderate potential to reduce percent reduction in VMT.

Education/Outreach

Appropriate signage should be used to inform the public about any new carpool lane regulations and the location of carsharing spots.

Additional Notes

NA

13: Vehicle Efficiency

Emissions Source: Transportation (Community)

Ease of Implementation: **Education/Outreach** **Incentive/Rebate**

GHG Reduction: Potential High (per unit basis) Moderate Expandability

Objective

Encourage the retirement of older high-emissions vehicles and the procurement of new lower emissions vehicles by residents and businesses. These goals can be accomplished through educational and incentive programs.

Tracking Options

Reduction Strategy	City Operations Tracking	Self-Reporting Survey	Applicable Incentives
	Low-Emission Vehicles (#)	Low-Emission Vehicles (#)	
13-1. Encourage Retirement of Old Vehicles	Benefits Unknown		
13-2. Encourage Procurement of Hybrid Vehicles	X	X	T1,T2, T5-T8,T10,T11
13-3. Develop Local "Cash-for-Clunkers" Program	Benefits Unknown		

Recommended Tracking Method

Strategy 13-2 consists of creating programs to encourage the procurement of hybrid vehicles. Encouragement could be provided in the form of education or incentive programs. CAPPA has provided a factor (Appendix II), using the number of purchased vehicles to quantify emissions reductions. If it is implemented as an incentive program, the number of hybrids purchased can be tracked using incentive records. If it is implemented as an educational program (or if incentive records are unavailable), a self-reporting survey of residents can be used.

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

Strategy 13-2 has a high per-unit potential to reduce GHG emissions. The strategy is only moderately expandable despite the fact that there are many privately owned vehicles in the city because there may not be as many private owners that can feasibly purchase a new vehicle. Procuring hybrid vehicles incurs an incremental cost of about $2500 (relative to purchasing another new car). However, there is a relatively short payback period (2.7 years) due to a decrease in operational costs.

Education/Outreach

Educational programs should aim to create awareness that despite the larger initial price of hybrid vehicles versus traditional vehicles, the payback period is short.

Additional Notes

Complementary bundles include bundle 10: Parking Policies which contains strategies that increase the convenience of owning an electric or hybrid vehicle through the creation of car-charging and preferred parking

infrastructure.

Tracking methods were not explored for strategies 13-1 and 13-3. These strategies involve creating programs to encourage the residential and commercial sector to retire old, high-emitting vehicles in favor of lower-emitting vehicles. Incentives may need to be sizable to make purchasing new vehicles feasible for potential participants. More research should be done to determine the cost effectiveness of these types of programs.

14: Municipal Miscellaneous

Emissions Source: **Municipal Operations (Municipal)**

Ease of Implementation: **Regulatory/Policy** **Municipal Action/Service**

GHG Reduction: Potential **Medium (per unit basis)** **Low Expandability**

Objective

Miscellaneous strategies that do not fit in a particular bundle are listed here. The majority of these strategies include changes to the current municipal operations structure which can support/promote other sustainable strategies. The City can make an effort to implement these strategies in order to reduce GHG emissions and promote other bundles.

Tracking Options

Reduction Strategy	City Operations Tracking Number of Trees Planted
14-1. Energy Conservation Education	Benefits Unknown
14-2. Update General Plan	Benefits Unknown
14-3. Favor Contracts with Sustainable Companies	Benefits Unknown
14-4. Plant Trees to Increase Building Shade	X
14-5. Hire Energy/Climate Specialist	Benefits Unknown

Recommended Tracking Method

Strategy 14-4 involves the planting of trees in order to increase shading, carbon storage, and reduce the heat island effect near municipal facilities. Municipal staff can track this strategy using the number of trees planted in conjunction with the associated CAPPA emissions factor (Appendix II).

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

Strategy 14-1 involves educating city employees on energy conservation and can be implemented through educational seminars and events. This strategy would have a low implementation cost and would require minimal changes to current operations. Employee participation and scheduling may be the primary obstacle encountered.

Strategy 14-2 is likely already planned. This strategy consists of updating the general plan with a climate change element such as the Climate Action Plan (CAP). This strategy will have a low implementation cost considering the CAP is already underway.

Strategy 14-3 involves the promotion of sustainable practices in the commercial sector by favoring companies with environmentally friendly operations. For recurring contracts, it may be desirable to develop a sustainability standard, which companies must to meet in order for their bid to be considered or which gives their bid an advantage. This would support local green businesses and help to increase access to sustainable options for private customers in the community as well. The feasibility and benefits of this strategy are unknown and may

be difficult to quantify; more research is required to estimate the necessary implementation efforts and effects.

Strategy 14-4 can have varying costs associated with the number and variety of trees planted. The implementation cost is estimated to be high with an intermediate payback period (11 years). Trees that are native and have low watering and maintenance requirements should be prioritized in order to minimize associated maintenance emissions and long-term costs. In order to maximize the benefit-cost of this strategy, it may be desirable to shade the majority of a facility before moving onto the next, especially in facilities that do not have HVAC zones. This would mitigate the use of air-conditioning more effectively by covering the whole area instead of just a section.

15A: Facilities – Lighting

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **Medium (per unit basis)**
High Expandability

Ease of Implementation:
- **Incentive/Rebate**
- **Regulatory/Policy**
- **Municipal Action/Service**

Objective

The City can install high efficiency lighting and reduce the amount of time that artificial lighting is used. The majority of these strategies will require staff, funding for supplies and installation, and educating city employees on how changes in lighting habits can reduce GHG emissions. Implementing high efficiency lighting in municipal facilities will set an example for the community which may help to increase action on the community level.

Tracking Options

Reduction Strategy	PG&E Data and Reports		City Operations Tracking			Applicable Incentives
	Aggregate Energy Used (kWh)	Energy Savings (kWh)	Units installed or Replaced (#)	Area Upgraded or Affected (Sq. Ft.)	Usage Reduction (hrs/day/ lamp)	
15A-1.Decrease Average Daily Time Street Lights Are On	X				X	
15A-2. Institute a Lights-Out-at-Night Policy	X	X		X	X	L17-L18
15A-3. Install LED Exit Signs	X	X	X			L16
15A-4. Install LED Street Lights	X		X			
15A-5. Install Other Non-LED energy Efficient Street Lights	X		X			
15A-6. Install LED Lighting at Schools and Parks	Benefits Unknown					
15A-7. Installment of Occupancy Sensors		X		X		L17
15A-8. Install Solar Tubes		X		X		
15A-9. LED Holiday Lights			X			
15A-10. Efficient Lighting Retrofits				X		L5-L7, L12

Recommended Tracking Method

Strategy 15A-1 involves the adjustment of street light timers to reduce electricity usage. This strategy would best be tracked by having municipal staff record the number of daily usage hours reduced for each streetlight after the adjustments. Emissions reductions can be estimated from the reduction in hours using the corresponding GHG emissions factor provided by CAPPA (appendix II).

Strategy 15A-2 would require city employees to turn off building lighting at the end of the workday. The best tracking method would be to have municipal staff record the building area that has adopted this policy, which can be used to estimate emissions reductions using the corresponding CAPPA emissions factor.

The most accurate metric for individualized lighting upgrades is the number of units replaced or installed. Using the provided CAPPA emissions factor, tracking can occur by having staff monitor and record which light bulbs are replaced with energy efficient bulbs in all municipal facilities. This metric is preferred for lighting replacement strategies 15A-3 through 15A-5 and 15A-9.

Strategies 15A-7 through 15A-8 involve installations that reduce the need for artificial lighting. This reduction can be tracked by city staff indirectly by recording the area affected by the installation, which can be used to estimate emissions reductions using the CAPPA emissions factor.

Strategy 15A-10 involves retrofitting municipal facilities with energy efficient lighting. The optimal tracking method for this strategy is for municipal or contracted staff to record the area of facilities retrofitted with efficient lighting. Emissions reductions can be estimated using the corresponding CAPPA emissions factor.

Alternative Tracking Methods

Strategies 15A-1through 15A-5 can also be tracked by analyzing the raw aggregated PG&E electricity use data for the city. Streetlights are a category within the PG&E data spreadsheet and therefore measuring the reduced electricity use would be possible for 15-4. Lighting within buildings is only part of the total electricity used for the buildings listed in the spreadsheet so it can only be tracked aggregated with other end-uses with the raw city electricity data, which should therefore not be used as the primary metric for this case.

Strategies 15A-2, 15A-3, 15A-7, and 15A-10 have associated PG&E rebates and therefore the energy saved from participating in these rebates is recorded in the aggregated lighting section of PG&E's Annual Savings Reports. This value is aggregated with other lighting reductions as well as private use of rebates, so this aggregate value should only be used as a secondary tracking method.

Effectiveness and Ease of Implementation

Strategy 15A-1 can be a low cost strategy but may require a moderate amount of staff time to implement. Strategy 15A-2 is also a low cost strategy with a short payback period. The use of timers or motion sensors (15A-7) would likely improve participation rates. The amount of GHG reductions for these strategies can vary depending on how much lighting time is reduced from current lighting hours.

Strategies 15A-3 through 15A-9 have the potential to reduce a large quantity of GHG emissions. The effectiveness and initial cost of these strategies depend on the scale of implementation while the payback periods for switching to LED technology is generally short (0-2 years). Part of this cost to upgrade lighting can be mitigated by using all available rebates.

Strategy 15A-10 may be desirable for municipal facilities that currently use an array of inefficient lighting. The cost can vary depending on the scale of improvements but this strategy is estimated to have a short payback period. PG&E offers customized lighting retrofits that come with incentive options pertaining to these strategies. These programs can help ease the initial implementation costs of lighting retrofits.

15B: Facilities – Appliances

Emissions Source: **Municipal Operations (Municipal)**

Ease of Implementation: **Incentive/Rebate** **Municipal Action/Service**

GHG Reduction: Potential **Medium (per unit basis)** **High Expandability**

Objective

The City can install energy efficient appliances in city facilities. These strategies can occur through internal incentive programs or by direct action.

Tracking Options

Reduction Strategy	PG&E Data and Reports		City Operations Tracking		Applicable Incentives
	Aggregate Energy Used (kWh or therms)	Energy Savings (kWh or therms)	Units installed or Replaced (#)	Area Upgraded (Sq. Ft.)	
15B-1. Use ENERGY STAR Water Coolers	X		X		
15B-2. Use ENERGY STAR Copiers	X		X		
15B-3. Use of ENERGY STAR Refrigerators	X	X	X		A1
15B-4. Use ENERGY STAR Vending Machines	X	X	X		A28
15B-5. Use ENERGY STAR Printers	X		X		
15B-6. Use ENERGY STAR monitors	X		X		
15B-7. Use ENERGY STAR Computers	X	X	X		A9
15B-8. Use High Efficiency Water Heaters	X	X	X		A29-A31
15B-9. Use Energy Efficient Boilers	X	X	X	X	TC13

Recommended Tracking Method

Strategies 15B-1 through 15B-8 involve the replacement of appliances in municipal facilities. This could be quantified by having staff monitor and record which appliances are replaced with energy efficient models in all municipal facilities and using the corresponding CAPPA emissions factor (Appendix II).

Strategy 15B-9 involves the replacement of current boilers with energy efficient units. Boilers vary greatly in size and therefore should be tracked using the square feet of space that is served by efficient boilers. Municipal staff could record this value via correspondence with the staff or contractors who do the installations and use the corresponding CAPPA emissions factor to quantify the reduction.

Alternative Tracking Methods

In conjunction with using the number of appliances replaced/installed for strategies 15B-1 through 15B-8 and the area served by new boilers (15B-9), it may be desirable to analyze the total annual residential and commercial energy usage. This can be used to crosscheck the total estimated energy reduced from switching appliances.

Strategies 15B-3, 15B-4, and 15B-7 through 15B-9 all have corresponding PG&E rebates, which enables tracking via the PG&E savings reports. These savings will be part of the total electricity savings under the appliances section for the non-residential categories, so will be aggregated by end use as well as by city and community

users, so this should not be the primary tracking method.

Effectiveness and Ease of Implementation

The effectiveness of reducing GHG emissions from strategies 15B-1 through 15B-9 depends on the scale replacements in municipal facilities but overall this bundle has a high potential for GHG reductions in the municipal inventory. The implementation cost of these strategies is estimated to be low per unit with short payback periods. If these appliances are purchased locally, these replacements also have potential to increase demand for efficient appliances locally, which may increase the likelihood that local businesses will provide more energy efficient appliance options for all local consumers.

15C: Facilities – Comprehensive Improvements

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **Low (per unit basis)**
Moderate Expandability

Ease of Implementation:
- **Regulatory/Policy**
- **Incentive/Rebate**
- **Municipal Action/Service**

Overview

The City can increase energy efficiency in municipal facilities as well as offset their current emissions through the strategies in this bundle. Higher municipal facility energy performance can be obtained by retro-commissioning to understand current performance, performing retrofits to reach an efficiency goal, adopting an energy performance code to sustain this energy efficiency in future facilities, and purchasing carbon credits.

Tracking Options

Reduction Strategy	PG&E Data and Reports	City Operations Tracking			Applicable Incentives
	Energy Savings (kWh)	Area of New Construction Meeting Energy Code (Sq. Ft.)	Area Retrocomissioned /Retrofitted (Sq. Ft.)	Offsets Purchased (Tons CO_2)	
15C-1. Adopt a High Performance Local Energy Code (including a Green Building Ordinance) for New Construction and Renovation of Municipal Facilities		X			
15C-2. Purchase Carbon Credits				X	
15C-3. Perform Energy Efficiency Retrofits of Existing Facilities	X		X		All Municipal Facility Rebates
15C-4. Retro Commission for Energy Efficiency			X		

Recommended Tracking Method

Strategy 15C-1 involves the adoption of high performance energy codes for all municipal facility construction. This strategy would best be tracked using the area of facilities constructed that meet the energy code in conjunction with the provided CAPPA emissions factor (Appendix II). These values could be obtained by working with the staff involved in planning or contracted construction companies to obtain records.

Strategy 15C-2 involves offsetting GHG emissions by purchasing carbon credits. Municipal staff can easily track this strategy directly by recording the quantity of GHG emissions that are offset when the credits are purchased.

Strategy 15C-3 and 15C-4 involves the retrocommissioning or retrofitting of municipal facilities for higher energy efficiency. These strategies are best tracked using the square feet of buildings retrocomissioned or retrofitted and the corresponding CAPPA emissions factor. Municipal staff should work with the staff or contracted companies doing the retrofits to obtain records.

Alternative Tracking Methods

Strategy 15C-3 involves the improvement of buildings via appliance replacements and HVAC system upgrades. Many of these facility improvements have corresponding PG&E rebates. If these rebates are used, the estimated amount of electricity saved could be tracked using PG&E's electricity savings reports. However the savings reports only track the aggregate amount of electricity per rebate program (covering multiple rebate programs and both public and private customers) so this method should only be used in conjunction with the preferred tracking method.

Effectiveness and Ease of Implementation

Strategy 15C-1 has a high implementation cost strategy and may require strategies 15C-3 and 15C-4 to be performed beforehand. This strategy can be effective in regulating future facility energy performance, which has a high potential for reducing GHG reductions.

Strategy 15C-2 is relatively simple to implement, although implementation depends directly on the amount of funding available for carbon credit purchases. This strategy may help achieve targets when other feasible strategies have been exhausted.

Strategy 15C-3 can have varying costs depending on the extent of the retrofit projects. The costs of retrofitting can be reduced by taking advantage of rebates. These retrofits have a high potential for reducing GHG emissions and generally have intermediate payback periods.

Strategy 15C-4 is estimated to have a moderate implementation cost (primarily comprised of staff or contractor time) with an intermediate payback period and has potential to also benefit municipal retrofit strategies. This strategy would ease the implementation and effectiveness of other municipal strategies by analyzing which buildings are in need of retrofits.

15D: Facilities – Temperature Control

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **Medium (per unit basis)**
High Expandability

Ease of Implementation: **Incentive/Rebate**
Municipal Action/Service

Objective

The City can install high efficiency HVAC components or related infrastructure to reduce the energy used to regulate indoor temperatures in municipal facilities. The majority of these actions will require staff time, funding for installation, and educating city employees on energy efficient practices. Implementing efficient temperature control practices and installing efficient HVAC related components and infrastructure in municipal facilities will set an example for the community and may create incentives for local suppliers and contractors to supply efficient products and services, which may help to increase efficient options in the community.

Tracking Options

Reduction Strategy	City Operations Tracking Area of Installation or of Facilities Upgraded (Sq. Ft.)	Applicable Incentives
15D-1. HVAC Energy Conservation	Benefits Unknown	
15D-2. HVAC Fan Upgrade	X	TC6,TC8
15D-3. Use Energy Efficient Chillers	X	
15D-4. Switch Electric Heat to Natural Gas	X	TC11,TC12
15D-5. Install Reflective Roofing	X	TC4
15D-6. Install Green Roofing	X	

Recommended Tracking Method

Actions 15D-2 through 15D-6 consist of replacing HVAC system components and related infrastructure with energy efficient options. The results of these actions depend on the area affected by the installations. The area can be tracked by municipal staff managing the upgrade and/or through correspondence with the contractors making the upgrades. The provided CAPPA emissions factor (Appendix II) can then be used to quantify the reductions.

Effectiveness and Ease of Implementation

Action 15D-1 consists of setting thermostats to use less energy. This action would have minimal costs and would rely mostly on promotion of action by city employees through educational programs. The GHG reductions from this strategy will rely on the degree of adjustment and the area of facilities that are affected. This action is highly expandable and has potential to reduce a significant amount of GHG emissions if implemented on a large enough scale.

Action 15D-2 consists of upgrading the fan on HVAC systems with high efficiency models. Fans are responsible for the majority of electricity drawn from HVAC systems and energy efficient models have low replacement costs and short payback periods. The potential GHG reduction per unit has been classified as low, however this action is highly expandable because it can be applied to almost all facilities and there is a

related rebate offered by PG&E.

Action 15D-3 consists of replacing over-sized chillers with appropriately sized units. Depending on how inefficient the system being replaced is, the GHG reduction potential can vary from low to moderate per unit replaced. These actions can have high initial costs but can have short payback periods and can moderately reduce facility operation costs.

Action 15D-4 involves the replacement of electrical heating systems with natural gas systems. This switch can have a substantial implementation cost with an estimated payback period of 3 years and potential for a large amount of savings. This strategy offers the highest amount of GHG reduction per unit for this bundle. This action is also fairly expandable because it can be applied to all facilities that currently have electrical heating systems.

Actions 15D-5 and 15D-6 both involve the replacement of current roofing with green or reflective roofing. Although the GHG reductions from these actions are classified as low, large-scale projects can help to reduce GHG emissions through other means. Reflective roof can potentially reduce the urban heat island effect and green roofing can be used to sequester GHG emissions through plants. These actions have moderate implementation costs and reflective roofing can have a short payback period and the costs may be reduced if it is possible to take advantage of a PG&E rebate.

Additional Notes

Additional PG&E rebates not included by the actions exist for both residential and commercial buildings. These rebates include whole house fans and insulation.

16: Renewable Energy Generation and Procurement

Emissions Source: **Municipal Operations (Municipal)**

Ease of Implementation: **Municipal Action/Service**

GHG Reduction: Potential **Medium (per unit basis)**
High Expandability

Objective

This bundle involves installing renewable energy generation infrastructure and/or procuring renewable energy. This can be accomplished by installing renewable energy harnessing improvements at existing municipal facilities, creating new city-run renewable energy generation projects, or by purchasing rights to renewable energy that has been generated by a third-party.

Tracking Options

Reduction Strategy	PG&E Data and Reports		City Operations Tracking					Applicable Incentives
	Aggregate Energy Used (kWh or therm)	Energy Generated (kWh)	Total Electricity Purchased (kWh)	People served by the Wastewater Treatment Plant (#)	Facilities Using Renewable Technology (Sq. feet)	Capacity Installed (kWh)	Hot Water Heated with Solar Water Heater (Gallons/Day)	
16-1. Funding for Energy Efficiency and Renewable Energy	Benefits Unknown							
16-2. Purchase Electricity from Renewable Energy Sources from the Grid			X					
16-3. Purchase Green Tags / Renewable Energy Certificates			X					
16-4. Install Solar Water Heaters	X						X	R2,R6
16-5. Install Solar Water Heaters at Swimming Pools	X				X			R2,R6
16-6. Install Solar (PV) Panels on Municipal Facilities	Benefits Unknown							R1
16-7. Install Wind Turbines		X				X		R1
16-8. Use Geothermal Heat Pumps at Government Facilities	X				X			R1
16-9. Implement Methane Flaring at WWTP				X				R1

Recommended Tracking Method

Strategies 16-2 and 16-3 involve purchasing the renewable energy that has been third-party generated. CAPPA provides GHG emissions reduction factors (Appendix II) using the amount of renewable energy purchased. This information can be tracked directly using city renewable energy purchasing records.

Strategies 16-4, 16-5, and 16-8 consist of installing devices that harness renewable energy at existing municipal facilities to reduce the energy consumed from the grid. CAPPA provides GHG emission factors that can be applied to each type of devices based on the area or volume of water served. City operational data can be used to obtain this information.

Strategies 16-7 and 16-9 consist of creating new city-run renewable energy generation projects. CAPPA provides GHG emission factors that could be applied to the specifications of these facilties. City operational data can be used to obtain this information.

Alternative Tracking Methods

For strategies 16-2 and 16-3, the quantity of energy purchased can be combined with city emissions factors (as determined by PG&E) less the emissions factors of purchased emissions (if they are nonzero) to determine emissions savings.

Since strategies 16-4, 16-5, and 16-8 result in reduced energy consumption at municipal facilities. The impact of these strategies could also be measured using the annual reduction in energy consumption specifically at the upgraded facility together with the city PG&E energy use records and emissions factors. This information could be determined using applicable line items of the aggregated municipal PG&E consumption report or using an estimated fraction of the total PG&E renewable energy savings report data. However, several factors can affect a change in energy consumption so this reduction tracking method may only approximate consumption changes that have resulted from individual strategies.

Since wind turbines generate electricity which is first fed into the grid, the amount of energy that is supplied to the grid may be determined from PG&E data and can also be used to quantify the impacts of strategy 16-7 by using the city PG&E emissions factor. If there are any emissions associated with wind turbine operations they should be identified and added back to the net emissions total.

Effectiveness and Ease of Implementation

Strategies 16-2 and 16-3 have a high implementation cost in general. However, these purchasing systems allow the city to purchase renewable energy in any increment depending on available financial resources. Administrative efforts needed for implementation would be fairly minimal since no maintenance would be required. The per unit GHG emissions reduction potential is relatively low. However, this strategy is highly expandable since all electricity consumed by the city that could conceivably be purchased from renewable sources.

Strategies 16-4, 16-5, and 16-8 all require some financial investment since the strategies involve facility retrofits. Implementing strategy 16-4 has a low implementation cost, 16-5 a medium implementation cost, and 16-8 a large implementation cost. Minimal maintenance efforts would be required for the solar water heater strategies (16-4 and 16-5). However moderate maintenance efforts would be required for geothermal heat pump operations and maintenance (strategy 16-8). Moderate to large GHG emissions saving are possible per unit. Per unit expandability is moderate since the defined units for these strategies are small increments of consumption of a facility (e.g. gallons of water heated). Benefits of implementing these strategies are scaled by

the magnitude of consumption of the facilities. Strategies 16-4 and 16-8 have a relatively long payback period (20-21 years) and strategy 16-5 has a medium payback period (5 years), with benefits derived from electricity and gas purchase savings.

Strategies 16-7 has a medium implementation cost and 16-9 has a low implementation cost. Operating costs for these strategies are low but both require substantial staff-time investment since the strategies involve operating new energy generation projects. However, substantial GHG emissions saving could be possible. Strategies 16-7 and 16-9 both yield large per unit GHG reductios. Both strategies are substantially expandable since benefits are quantified using small increments of energy producing potential of the new facilities (e.g. kWh of wind turbine capacity). Strategy 16-7 has an intermediate length payback period (10 years) and the payback period for strategy 16-9 is undefined.

Additional Notes

Tracking methods were not explored for strategies 16-1 and 16-6. Strategy 16-1 consists of establishing a financing district for renewable projects. These financing options would allow for renewable energy projects to be implemented. However, the direct impact of this strategy would be difficult to quantify. Strategy 16-6 involves the installation of new solar panels which require substantial startup costs but can potentially result in large GHG emissions reductions. More research would need to be conducted to determine the costs and benefits of these projects.

17: Waste Diversion & Reduction

Emissions Source: **Municipal Solid Waste (not in inventory)**

Ease of Implementation: **Education/Outreach**, **Incentive/Rebate**

GHG Reduction: Potential **Low (per unit basis)** **Low Expandability**

Overview

Create programs to reduce waste-creation and divert waste from municipal operations that would otherwise end up in landfill for reuse. This can occur via the creation of educational and incentive programs aimed at City employees.

Tracking Options

Reduction Strategy	City Operations Tracking		
	Waste Diverted (Weight/ capita/ year)	Waste Diverted (Weight / Area of Construction)	Program Participants (#)
17-1. Encourage City Employees to Recycle	X		X
17-2. Encourage Organics Composting by City Employees	X		X
17-3. Encourage Reuse or Recycling of Construction and Demolition Materials		X	

Recommended Tracking Method

Strategies 17-1 and 17-2 involve encouraging city employees to recycle and compost respectively through education and incentive programs. CAPPA provides emissions factors (Appendix II) using the per capita amount of waste diverted. Since this diverted trash will be collected at municipal facilities, this value can be tracked by municipal staff directly.

Strategy 17-3 involves encouraging city employees and contractors to reuse and recycle construction and demolition materials generated from municipal projects. This strategy could be implemented through education programs for applicable city employees and contractors. CAPPA provides emissions factors using the weight diverted per area of construction. For construction projects carried out by permanent city employees direct city record keeping may be the best way to track this value. For third-party contractors employed by the city a correspondence with the contractor may be more feasible to track this strategy.

Alternative Tracking Methods

Strategies 17-1 and 17-2 could also be tracked using the number of employees that participate in the programs. However, an emissions factor per participant would need to be developed.

Effectiveness and Ease of Implementation

Strategies 17-1 and 17-3 could be implemented at relatively little cost but include some staff time to conduct educational and incentive (if applicable) programs. Strategy 17-2 could be implemented at a slightly higher cost due to the challenges associated with storing and disposing of organic material. This strategy would require slightly more staff time as well.

Additional Notes

Complementary bundles include community bundle 3: Waste Diversion and Reduction, which includes items that create and expand recycling and composting collection/processing infrastructure.

The bundle 17 Waste Diversion & Reduction strategies aim to prevent GHG emissions that are generated when trash is disposed of at a landfill. These emissions were not included in the baseline inventory, but are a potential source of emissions reductions.

18: Transportation Fuels

Emissions Source: **Municipal Operations (Municipal)**

Ease of Implementation: **Municipal Action/Service**

GHG Reduction: Potential **High (per unit basis)**
Low Expandability

Objective

Reduce GHG emissions by procuring fleet vehicles that use low-emission fuels and by using low-emissions fuels in lieu of traditional fuels when feasible.

Tracking Options

Reduction Strategy	City Operations Tracking		Applicable Incentives
	Low-Emission Vehicles (#)	Vehicles Switching From Diesel to Biodiesel (#)	
18-1. Fleet Conversion to Electric Vehicles (EVs)	X		T1,T2, T6-T8,T10,T11
18-2. Fleet Conversion to Ethanol (E85)	X		T7,T8,T10,T11
18-3. Convert to Compressed Natural Gas (CNG)	X		T4,T6-T8,T10,T11
18-4. Fleet Conversion to Bio-Diesel (B20)		X	T3,T7,T8,T10,T11
18-5. Fleet Conversion to Bio-Diesel (B100)		X	T3,T7,T8,T10,T11

Recommended Tracking Method

Strategies 18-1 through 18-3 consist of purchasing and using low-emission fuel fleet vehicles and using the appropriate low-emissions fuel for those vehicles. CAPPA has provided a factor (Appendix II) which uses the number of converted low-emissions vehicles to quantify emissions reductions associated with implementing these Strategies. These vehicle quantities can be tracked directly using city records.

Strategies 18-4 and 18-5 consist of using bio-diesel in lieu of traditional diesels for existing diesel fleet vehicles. CAPPA has devised an emissions factor using the number of vehicles that have been switched from diesel to bio-diesel. These vehicle quantities can again be tracked using city records.

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

Strategies 18-1 through 18-3 would require moderate initial investments to procure new fleet vehicles. Vehicle operational costs are also moderate since the alternative fuels will need to be purchased on a continuing basis. However, strategy 18-1 has an intermediate payback period (6.2 years) due to reduced fuel costs. Strategy 18-3 requires a high level of staff effort since CNG is more difficult to obtain. These strategies have a high potential

to reduce GHG emissions but have minimal expandability since the number of municipal fleet vehicles is limited; however they may influence the local supply of alternative fuel vehicles and fuels, which may facilitate adoption of similar policies by the community.

Strategies 18-4 and 18-5 would have low implementation costs since new vehicles would not need to be purchased. However, moderate increased operational costs may be required depending on the source of the biodiesel. These strategies have a high potential to reduce GHG emissions but have minimal expandability since the existing municipal diesel vehicle fleet is not very large.

Additional Notes

Complementary bundles include bundle 7: Transportation Fuels, which includes a strategy for local bio-fuel production. Local bio-fuel production could decrease the costs of procuring bio-diesel and facilitation the implementation of strategies 18-4 and 18-5.

19: Transportation Equipment and Operations

Emissions Source: **Municipal Operations (Municipal)**

Ease of Implementation: **Education/Outreach**

GHG Reduction: Potential **High (per unit basis)**
Low Expandability

Objective

Educate municipal employees about the benefits of limiting idling of fleet and heavy equipment vehicles.

Tracking Options

Reduction Strategy	City Operations Tracking Vehicles Affected (#)
19-1. Limit Idling of Government Operations Vehicles	X
19-2. Limit Idling of Heavy Equipment Vehicles	X

Recommended Tracking Method

Strategies 19-1 and 19-2 consist of programs to educate city employees about GHG emissions associated with idling. CAPPA has provided an emissions factor (Appendix II) using the number of vehicles affected by the idling reduction programs. The city can use fleet and equipment records to determine these values directly.

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

Strategies 19-1 and 19-2 would be relatively easy to implement because the educational programs are inexpensive to implement and operate and because program participants (city employees) are easily targeted. The potential GHG emission reductions are large. However, expandability is low since there are a limited number of government owned fleet and heavy equipment vehicles.

Additional Notes

Educational programs can also emphasize the air quality benefits (and corresponding health benefits) of reduced idling.

20: Transit and Bike/Ped

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **High (per unit basis)**
Minimal Expandability

Ease of Implementation: **Education/Outreach**
Municipal Action/Service

Objective

Reduce GHG emissions associated with municipal travel by creating programs that enable the use of alternate, lower-emission, transportation, specifically: mass transit, biking, and walking. These goals can be accomplished via the creation of city-run programs to replace automobile fleet usage with bicycle use.

Tracking Options

Reduction Strategy	City Operations Reporting		
	Program Participants (#)	Police Officers Patrolling on Bicycles Instead of Cars (#)	Alternative Transportation Use (Trips or distance /time period)
20-1. Implement a Police on Bicycle Program		X	X
20-2. Bicycle Lending Program	X		X

Recommended Tracking Method

Strategy 20-1 consists of creating a program to reduce municipal automobile vehicle fleet use by creating a bicycle fleet to be used by police officers. CAPPA has devised a factor (Appendix II), using the number of police officers patrolling on bicycles in lieu of cars, to quantify emissions reductions associated with implementing this strategy. Since municipal law enforcement is a city-run program, these values can be tracked directly by the city.

Strategy 20-2 consists of a similar program to reduce municipal automobile fleet usage by creating a bicycle fleet to be used by municipal employees when traveling locally on city business. CAPPA has devised a factor, using the number employees enrolled in the program, to quantify emissions reductions associated with implementing this strategy. Since vehicle fleet use is a city operated program, the number of participants can be tracked directly by the city.

Alternative Tracking Methods

Strategies 20-1 and 20-2 could also be tracked using the number of bicycle trips or distances traveled for a given time frame. These trips would again be tracked directly by the city. However, this metric would require obtaining an emissions factor and more extensive record keeping, and thus staff time.

Effectiveness and Ease of Implementation

Strategies 20-1 and 20-2 would require some initial investment to procure a bicycle fleet and train employees in use and maintenance of the bikes. Strategy 20-1 has a low implementation cost. Strategy 20-2 has a moderate implementation cost because there are more total city employees for whom bikes could be purchased. Strategy 20-2 has a short payback period (1.9 years). Implementing these strategies can yield large

potential cost saving from reduced fuel use and vehicle maintenance costs.

Implementing strategy 20-1 yields large per unit GHG emissions reductions, since constant vehicle use is required during police patrol. However, since the municipal police fleet is not very large, this program would be minimally expandable.

Implementing strategy 20-2 yields moderately substantial per unit GHG emissions reductions. Potential reductions are smaller since non-patrolling municipal employees use vehicles less extensively. However, this strategy is somewhat more expandable since there are more municipal employees then there are police officers.

Additional Notes

Complementary bundles include bundle 9: Community Transit Bike/Ped, which creates and improves city bike riding infrastructure that could be utilized by municipal employees using a bicycle fleet.

Benefits of bicycle use by police include improved access to pedestrian areas and alleys, although travel over long distances is slower than in a vehicle. Benefits of bicycle use by city staff include avoiding costs and hassle required to find parking. General benefits of bicycle use include improved health and wellness of riders.

21: Vehicle Efficiency

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **High (per unit basis)**
Minimal Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Municipal Action/Service**

Objective

This bundle involves procuring more fuel-efficient fleet vehicles and reducing fleet mileage.

Tracking Options

Reduction Strategy	City Operations Tracking		Applicable Incentives
	Low-Emission Vehicles (#)	Reduced Vehicle Miles Traveled (#/year)	
21-1. Reduce Municipal Fleet Mileage		X	
21-2. Utilize Fuel-Efficient Vehicles For Parking Enforcement	X		
21-3. Procurement of Smaller Fleet Vehicles	X		
21-4. Procurement of Hybrid Vehicles	X		T1,T2,T5-T8,T10,T11

Recommended Tracking Method

Strategy 21-1 consists of creating educational and incentive programs to encourage municipal employees to reduce fleet mileage. CAPPA has provided an emissions factor (Appendix II) that uses the annual number of vehicle miles reduced. This mileage value can be obtained directly by the city using fleet odometer readings.

Strategies 21-2 through 21-4 consist of procuring efficient low-emission fleet vehicles. CAPPA has provided a factor, using the number of low-emission vehicles used, to quantify emissions reductions associated with implementing these strategies. These vehicle fleet quantities can be tracked using city records.

Alternative Tracking Methods

NA

Effectiveness and Ease of Implementation

Strategy 21-1 would be relatively easy to implement since the target audience (city employees) is easily accessible and the education/incentive programs have a low implementation cost. This strategy has a low potential to reduce GHG emissions and has moderate expandability since the annual fleet mileage has moderate potential to be reduced.

Strategies 21-2 through 21-4 would require some initial investments to procure new fleet vehicles. Strategies 21-2 and 21-3 have a low implementation cost since these vehicles are cheaper than their alternatives. Strategy 21-4 has a moderate implementation cost since hybrids tend to cost more than their alternatives. However, strategy 21-4 has a short payback period (2.7 years). These three strategies have high per unit potential to reduce GHG emissions but have minimal expandability since the municipal vehicle fleet is not very

large.

Additional Notes

Complementary bundles include bundle 20: Transit and Bike/Ped. This bundle includes programs to provide bicycles to municipal employees. This bundle could be implemented in conjunction with strategy 21-1 to further reduce fleet mileage.

22: Transportation Miscellaneous

Emissions Source: **Municipal Operations (Municipal)**

GHG Reduction: Potential **High (per unit basis)**
Minimal Expandability

Ease of Implementation:
- **Education/Outreach**
- **Incentive/Rebate**
- **Municipal Action/Service**

Objective

This bundle includes encouraging telecommuting for city employees and using non-asphalt pavements in construction.

Tracking Options

Reduction Strategy	City Operations Reporting		
	Area of Non-Asphalt Pavement Converted (Acres)	Reduction of Ambient Temperature (degrees)	Employees Offered Telecommuting Incentives (#)
22-1. Encourage Telecommunicating			X
22-2. Use Non-asphalt Pavements	X	X	

Recommended Tracking Method

Strategy 22-1 consists of encouraging city employees to telecommute by creating telecommuting infrastructure in the workplace and offering telecommuting education and incentives for employees. CAPPA had devised an emissions factor (Appendix II) using the number of employees offered telecommuting incentives. This value can be tracked by the city itself.

Strategy 22-2 consists of converting pavement on municipal property to non-asphalt pavement. This retrofit does not have any directly attributed GHG emission reductions. However, using non-asphalt pavement can reduce the urban heat island effect. This strategy can indirectly reduce GHG emissions by reducing the energy consumption used to cool buildings. Thus the amount of non-asphalt pavement converted could be useful to track by unit area. These construction projects could be tracked by the city directly or via correspondence with contractors performing the work.

Alternative Tracking Methods

Strategy 22-2 could also be tracked by monitoring the reduction in ambient temperature where changes have occurred and comparing them to temperature changes outside of the city. However, this measure can be unrepresentative since many factors affect ambient temperature besides the use of non-asphalt pavement. Temperature trends in urban and rural areas could be examined using government weather databases if there is a temperature gauge in the city and in a nearby rural area, or the city could keep records directly.

Effectiveness and Ease of Implementation

Strategy 22-1 would require the creation of telecommuting infrastructure in addition to telecommuting incentives for city employees. To implement this strategy, the city would need to purchase conferencing equipment, establish accountability systems and educate and encourage employees to participate. However, the implementation cost is still relatively small. The potential GHG emissions reductions for this strategy are substantial since commuting generates large amounts of emissions. However expandability of this strategy may

be low since there may not be many city employees that can feasibly telecommute.

Strategy 22-2 would require large initial financial inputs for construction of non-asphalt pavement projects. To significantly mitigate the urban heat island effect, non-asphalt pavements would have to be used on a broad scale. The city is relatively small. Thus more research would need to be done on the amount of paving that could potentially be converted and what potential benefits would be yielded.

Additional Notes

In some cases, an increase in employee efficiency can be a side benefit of providing telecommuting options. However reductions in employee telecommuting will affect emissions counted in the community (not municipal) inventory.

23: Water Conservation

Emissions Source: **Water Conservation (Municipal)**

GHG Reduction: Potential **Medium (per unit basis)**
Moderate Expandability

Ease of City's Implementation:
- **Education**
- **Incentives**
- **Regulations**
- **Municipal Action/Service**

Overview

The City can promote water conservation in residential and commercial buildings through regulations, economic incentives, and education. Water conservation can also be improved in municipal facilities by replacing current equipment and appliances with more efficient models and by requiring new developments to minimize water supply needs. Reductions in water use reduce energy use at municipal facilities.

Tracking Options

Reduction Strategy	PG&E Data and Reports	Incentive/ Rebate Tracking		Self-Reporting Survey		City Operations Tracking					Applicable Incentives
	Aggregate Energy Used (kWh)	Units Replaced (#)	Area of Land (Acres)	Units Replaced (#)	Area of Land (Acres)	Units Replaced (#)	Area of Land (Acres)	Water Use (gallons)	Household Savings Under Ordinance (%)	Increase in Pump Efficiency (kWh/Gal)	
23-1. Adopt Water Conservation Ordinance	X								X		WC1-WC3
23-2. Install Low Flow Faucets	X	X		X		X					
23-3. Install Low Flow Shower Heads	X	X		X		X					
23-4. Install High Efficiency Toilets	X	X		X		X					
23-5. Install Central Lawn Irrigation			X		X		X	X			WC1-WC3
23-6. Use Low-Maintenance Landscaping			X		X		X	X			WC1-WC3
23-7. Funding for Municipal Water Conservation Projects	Benefits Unknown										
23-8. Low Impact Development	Benefits Unknown										WC1-WC3
23-9. Water Efficient Model Homes	Benefits Unknown										WC1, WC2
23-10. Improve Water Pumping Energy Efficiency	X									X	
23.11 Water Leak Detection and Repair	Benefits Unknown										WC3

Recommended Tracking Method

Strategy 23-1 involves the establishment of a baseline energy use for water production, processing, and use and

then developing strategies to move towards a zero energy use system. This strategy can best be tracked by the percent change in energy used. This percentage can be acquired by analyzing the difference in electricity used for water and wastewater items in the PG&E raw data. A PG&E specific emissions factor could be used instead of the factor provided by CAPPA.

Strategies 23-2 through 23-4 would replace inefficient appliances with more water-efficient models. These strategies should be tracked using the total number of inefficient appliances replaced with water-efficient models in conjunction with the CAPPA emission factor (Appendix II) listed for this replacement. These numbers can be tracked on the community scale through programs that incentivize the replacements or via surveys sent to owners or managers of residential and commercial buildings. This strategy is also suggested for municipal facilities in which municipal staff would be in charge of tracking the replacements.

Strategies 23-5 and 23-6 would improve water conservation for lawns and other landscaping. The amount of water conserved over an area of land would be difficult to measure and track; therefore, the recommended tracking metric is the area of land that is subject to a decrease in water usage. This amount of decreased water usage can be used in conjunction with the provided CAPPA emissions factor to find the net GHG reduction. At the community scale, this tracking can take place via records from an incentive or rebate based program implemented by the City. If the City is unable to create such programs, tracking can occur via residential and business surveys and through correspondence with local landscaping contractors. At a Municipal scale, strategies can similarly be tracked via correspondence with the municipal staff in charge of landscaping. The area of land being irrigated may often be unknown for both municipal and community properties; therefore, it may be necessary to look at building/land records to avoid taking physical measurements. If water meter records for those areas are available (and they do not overlap with other water uses) it may be of interest to track water use directly. If this method is used emissions for water savings can be estimated using a city-specific emissions factor from the inventory documents in this report.

Strategy 23-10 involves improving the water pumping efficiency. This strategy should be tracked by the total improvement in pumping efficiency. The change in pumping efficiency can be tracked by analyzing the change in electricity used for pumping from PG&E data and also the change in flow rate if any occurs.

Effectiveness and Ease of Implementation

Strategy 23-1 has already been begun; a baseline for the year 2005 has been prepared in this report, which includes the emissions from water production, processing, and usage. This report can also aid in the selection of specific strategies required to move to zero energy use.

Strategies 23-2 through 23-4 have a high potential for reducing GHG emissions at the community scale but effectiveness will depend on the level of effort invested in encouraging the community. The implementation cost of these strategies is low with short payback periods; however, these strategies currently do not have any associated incentives. To increase the replacement rates of these appliances in the community, the City could create incentive programs that subsidize costs or reward large-scale upgrades. These replacements can also be made in municipal facilities for a relatively low cost.

Strategy 23-5 has the greatest potential to reduce energy usage for municipal and community water supplies. The implementation cost of this strategy for the City, residents, and businesses depends on the total area irrigated but is estimated to be low with a short payback period. Promotion of this strategy should focus on densely irrigated areas of land such as commercial agriculture in order to maximize effectiveness. Community promotion should also rely on educating residents and businesses on the potential savings they can incur by switching irrigation systems. Switching irrigation systems for gardens and lawns surrounding municipal facilities can also effectively conserve water.

Strategy 23-6 has a minimal implementation cost. Community promotion of this strategy should focus on areas of irrigated vegetation such as community gardens, landscaped areas, or large green spaces. This strategy can be promoted through education and incentive-based programs. The City should make a publicly accessible list of all native and low water/maintenance plants along with the expected maintenance requirements for each. The City should also evaluate the benefits of replacing current plants with low-maintenance plants as well as planning future sites of vegetation. This strategy has a high potential to reduce GHG emissions from the high potential water savings and from reducing the use of gasoline-powered maintenance vehicles.

Strategy 23-7 would require a large monetary investment; however; funding may be available from conservation block grants, the State Energy Program, and the CaliforniaFIRST program. The City can also take advantage of AB811 to create a financing program for this strategy (as other California cities have done). More research on this strategy is required in order to estimate its feasibility.

Strategy 23-8 can be implemented in future infrastructure by adjusting development plans to minimize the amount of pumping required for potable water, storm water, and wastewater. More research on this strategy is required in order to estimate its feasibility.

Strategy 23-9 would require the city to promote the use of water-efficient appliances through purchasing or incentivizing the purchase of water-efficient appliances to be used in model homes. This strategy would promote the use of water-saving appliances in current and future housing developments.

Strategy 23-10 would require the City to assess its current water pumping system and then decide pumping efficiency can be improved. Depending on which improvements to the water pumping system can be made, costs would vary. One such improvement may be to upgrade older, inefficient pumps with newer, high-efficiency models. This upgrade can have a high implementation cost but can also have short payback period, estimated at 1.5 years.

Strategy 23-11 will require the City to examine all water pipes for leaks. It may be desirable to develop a regular procedure for water leak detection once a system for implementing this strategy is created. Feasibility data for this strategy is unavailable; more research on this strategy is required.

Education/Outreach

Education should consist of informing residents about recommended water-saving habits and devices and informing businesses about how they can change operations to decrease water usage. Options for updating water-using technologies should be made accessible to the public.

24: Wastewater Management

Emissions Source: **Municipal Wastewater (Municipal)**

Ease of City's Implementation: **Regulations** **Municipal Action/Service**

GHG Reduction: Potential **High (per unit basis)** **Low Expandability**

Objective

The City can upgrade its wastewater treatment plant in order to decrease GHG emissions associated with processing waste and install digesters to produce energy. These actions would require large capital investments but funds may be available from federal and state grants.

Tracking Options

Action	City Operations Tracking Population Served by Wastewater Treatment Plant (people)
24-1. Install Sludge Incinerators at WWTP	Benefits Unknown
24-2. Install Anaerobic Digester at WWTP	X
24-3. Install Anaerobic Co-digester at WWTP to Process High-Strength Organic Waste	Benefits Unknown
24-4. Reuse Wastewater	Benefits Unknown
24-5. Secondary Aeration System Retrofit	Benefits Unknown
24-6. Install Hydroelectric Turbine in Wastewater Pipeline	Benefits Unknown

Recommended Tracking Method

Action 24-2 was the only suggested wastewater action from CAPPA and therefore the only action with a preferred metric and associated GHG emissions factor (Appendix II). This action involves the installation of an anaerobic digester to produce methane for energy production. The population served by the wastewater treatment plant upgrade is the best metric for tracking.

Effectiveness and Ease of Implementation

Action 24-1 involves the installation of a sludge incinerator, which would eliminate the need for transporting sludge products and provide an energy source. Three types of incinerators commonly used include multiple hearth, fluidized bed, and electric infrared[1]. All have varying costs and emissions. More research is needed to estimate the feasibility and benefits of this action.

Action 24-2 involves the installation of an anaerobic digester at the WWTP. Anaerobic digesters reduce GHG emissions by reducing the mass of organic matter sent to landfills. These emissions would mostly affect landfill emissions which are not part of the city inventory, although City-specific GHG emissions may also be reduced by a decreased need for electricity and sludge transport to the Yolo County landfill. This action has a high implementation cost and an estimated payback period of 43 years.

Action 24-3 is an enhanced version of action 24-2 for processing high-strength organic waste from other sources

[1] "AP 42 Section 2.2 Sewage Sludge Incineration - Related Information." *US* Environmental Protection Agency. Accessed on 03 Aug. 2012 at http://www.epa.gov/ttnchie1/ap42/ch02/related/c02s02.html.

in the community. This action would require coordination with local food providers and processing facilities to acquire organic waste for the digester. This action can greatly reduce food waste sent to landfills, which in turn would reduce the amount of methane produced. Further research is needed to estimate the feasibility and net GHG emissions reduction of this strategy.

Action 24-4 would reuse wastewater locally, which may require a large capital investment depending on where and how the treated wastewater is used. Large costs may be incurred if the redirection of effluent pumping is necessary or if increased treatment is required to enable reuse. The amount of GHG emissions reduced is estimated to be high however more research is required to determine feasibility.

Actions 24-5 and 24-6 involve upgrading the WWTP's secondary treatment process to reduce energy requirements and to reduce current effluent nitrogen concentrations. Although data is unavailable for these actions, they appear to be more feasible because they make use of current technology. These retrofits would require a large capital investment but have a high potential for GHG reduction.

Technical Appendix IIIB: Short and Long-term Strategies

Implementation Timeline of Community Reduction Strategies				
Reduction Strategy		Implementation Timeframe[1]		
ID #	Title	Implement short-term for short-term reductions	Implement short-term for long-term reductions	Implement long-term for long-term reductions
Bundle 1A: Buildings - Lighting (Residential and Commercial Energy)				
1A-1	Encourage Community Members to Use CFL Bulbs and/or Fixtures	X		
1A-2	Encourage Installment of LED Exit Signs	X		
1A-3	Encourage Installment of Occupancy Sensors	X		
1A-4	Encourage the Installment of Solar Tubes	X		
1A-5	Encourage Commercial Lighting Fixture Upgrades	X		
1A-6	LED Holiday Light Exchange	X		
1A-7	Halogen Torchiere Lamp Exchange	X		
1A-8	Institute a Lights-out-at-night Policy	X		
Bundle 1B: Buildings - Appliances (Residential and Commercial Energy)				
1B-1	ENERGY STAR Computer Replacements	X		
1B-2	ENERGY STAR Monitor Replacements	X		
1B-3	ENERGY STAR Printer Replacements	X		
1B-4	ENERGY STAR Copier Replacements	X		
1B-5	ENERGY STAR Refrigerator Replacements	X		
1B-6	ENERGY STAR Dishwasher Replacements	X		
1B-7	ENERGY STAR Clothes Washer Replacements	X		
1B-8	ENERGY STAR Water Cooler Replacements	X		
1B-9	High Efficiency Water Heater Replacements	X		
1B-10	ENERGY STAR Vending Machine Replacements	X		
1B-11	Water and Energy Efficient Model Homes		X	
Bundle 1C: Buildings - Comprehensive Improvements (Residential and Commercial Energy)				
1C-1	Retro Commissioning for Energy Efficiency Performance	X		
1C-2	Enable Smart meter Data Availability	X		
1C-3	Promote Energy Conservation Through Campaigns Targeted at Residents	X		
1C-4	Promote Energy Conservation Through Campaigns Targeted at Businesses	X		
1C-5	Promote Green Building Practices Through a Local Green Building Assistance Program or Creating Incentives		X	
1C-6	Perform Energy Efficiency Retrofits of Existing Facilities	X		
1C-7	Require Energy Upgrades of Facilities at Time Of Sale		X	
1C-8	Require New Homes to be Solar Ready		X	
1C-9	Adopt a High Performance Local Energy Code (Including a Green Building Ordinance) for New Construction and Renovation of Community Facilities		X	
1C-10	Adopt a Strict Commercial Energy Code		X	
1C-11	Adopt Strict Residential Energy Code Requirements		X	
1C-12	Create Carbon Tax		X	
1C-13	Implement New Energy-efficient Public/Affordable Housing Projects			X
1C-14	Funding for Energy Efficiency and Renewable Energy Projects			X
1C-15	Energy Efficient Weatherization of Low-Income Housing Program	X		
1C-16	Green Lease Program	X		
1C-17	"Green Business/Developer" Recognition Program	X		
1C-18	Create Volunteer-based Energy Auditing/Maintenance Program	X		
Bundle 1D: Buildings - Temperature Control (Residential and Commercial Energy)				
1D-1	HVAC Temperature Control	X		
1D-2	ENERGY STAR Window Air Conditioner Replacements	X		
1D-3	EPA Certified Wood Stoves Replacements	X		
1D-4	Energy Efficient Boiler Replacements	X		
1D-5	Energy Efficient Chiller Replacements	X		
1D-6	HVAC Fan Upgrades	X		
1D-7	Electric to Natural Gas Heating Conversion	X		
1D-8	Install Reflective Roofing	X		
1D-9	Install Green Roofing	X		
Bundle 2: Renewable Energy Generation and Procurement (Residential and Commercial Energy)				
2-1	Encourage Installment of Geothermal Heat Pumps	X		
2-2	Encourage R&C Solar Photovoltaic (PV) Panels	X		
2-3	Encourage R&C Solar Water Heaters	X		
2-4	Encourage Commercial Wind Turbines Installation	X		
2-5	Purchase Green Electricity Via the Grid from Solar, Geothermal, Wind or Hydroelectric Sources	X		
2-6	Purchase Green tags / Renewable Energy Certificates	X		
2-7	Create Community Solar Facilities			X
Bundle 3: Waste Diversion and Reduction (Solid Waste Disposal - Residential and Commercial)				
3-1	Encourage Sustainable Actions in Schools	X		
3-2	Encourage Reuse or Recycling of Construction and Demolition Materials	X		
3-3	Implement "Pay-As-You-Throw" Program	X		
3-4	Create Sustainable Vendor Ordinance for Public Events	X		
3-5	Cooperative Purchasing program	X		
3-6	Establish/Expand Curbside Organics Composting Program	X		
3-7	Establish/Expand Curbside Recycling Programs	X		
3-8	Establish/Expand Business Recycling Programs	X		
3-9	Create Yard Waste Collection and Composting Program	X		
3-10	Reuse Facilities/ Programs to Foster Solid Waste Reduction	X		

Implementation Timeline of Community Reduction Strategies				
Reduction Strategy		Implementation Timeframe[1]		
ID #	Title	Implement short-term for short-term reductions	Implement short-term for long-term reductions	Implement long-term for long-term reductions
Bundle 4: Urban Forestry (Residential and Commercial energy) (Carbon Sequestration - not in inventory)				
4-1	Low Maintenance Gardens in New Development Model Homes		X	
4-2	Tree Planting to Shade Buildings		X	
4-3	Develop Policies to Encourage Community-Based Farms		X	
4-4	Tree Planting for Carbon Storage & Heat Island		X	
Bundle 5: Transportation Miscellaneous (Transportation)				
5-1	Encourage Telecommunicating	X		
5-2	Encourage Consumption of Local Food, Produce, and Goods	X		
5-3	Gasoline Lawnmower Replacement	X		
Bundle 6: Transportation Infrastructure (Transportation)				
6-1	Use Non-asphalt Pavements			X
6-2	Traffic Light Synchronization	X		
6-3	Increase Number of Roundabouts			X
Bundle 7: Transportation Fuels (Transportation)				
7-1	Develop a Neighborhood Electric Vehicle Program		X	
7-2	Convert to Compressed Natural Gas (CNG)	X		
7-3	Conversion to Electric Vehicles (EVs)	X		
7-4	Local Bio-Fuel Production			X
Bundle 8: Transportation Equipment and Operations (Transportation)				
8-1	Limit Idling of Heavy Equipment Vehicles	X		
8-2	Limit Idling of Local Transit Buses and School Buses	X		
Bundle 9: Transit and Bike/Ped (Transportation)				
9-1	Provide Low-Carbon Transportation Education		X	
9-2	Increase Mass Transit Ridership		X	
9-3	Increase Bus Ridership		X	
9-4	Encourage a Change in Transit Policy Allowing Bicycles on Trains/Buses		X	
9-5	Transportation Demand management	X		
9-6	Provide High School Students with Free Bus Passes	X		
9-7	Provide Bicycles for Daily Trips		X	
9-8	Create a "Safe Routes to School" Program		X	
9-9	Expand Bus Service in Range and/or Frequency			X
9-10	Improve / Expand Pedestrian Infrastructure		X	
9-11	Create Community Programs to Encourage Bicycle Riding and Recycling		X	
9-12	Implement Bus Rapid Transit (BRT) or Shuttle Programs			X
9-13	Create/Expand Bicycling Infrastructure			X
Bundle 10: Parking Policies (Transportation)				
10-1	Implement Parking Cash-out Program		X	
10-2	Create Parking Policies to Encourage Walking, Bicycling, and Using Public Transit		X	
10-3	Create Fuel-Efficient Vehicle Preferred Parking policies	X		
10-4	Increase Park-n-Ride Lots			X
10-5	Develop Parking Infrastructure to Support Emerging EV Transportation System	X		
Bundle 11: Land Use (Transportation)				
11-1	Promote Transit-oriented Development		X	
11-2	Research the use of "Smart Growth" in Future Development		X	
11-3	Participate in Regional Planning		X	
11-4	Walkable/Bikeable Street Landscape		X	
Bundle 12: Carpool and Carshare (Transportation)				
12-1	Increase Ride-Sharing		X	
12-2	Establish A Car Sharing Program		X	
12-3	Create High-Occupancy Vehicle (HOV) Lanes			X
Bundle 13: Vehicle Efficiency (Transportation)				
13-1	Encourage Retirement of Old Vehicles	X		
13-2	Encourage Procurement of Hybrid Vehicles	X		
13-3	Develop Local "Cash-for-Clunkers" Program	X		

[1] We divide the individual reduction strategies into categories that correspond to: 1) strategies that should be implemented quickly in order to achieve reductions for the 2020 target; 2) strategies that should be implemented now, but will likely contribute to GHG reductions after 2020, and 3) strategies that are larger infrastructure improvements and will take longer term planning and capital.

Implementation Timeline of Municipal Reduction Strategies				
Reduction Strategy		Implementation Timeframe[1]		
ID #	Title	Implement short-term for short-term reductions	Implement short-term for long-term reductions	Implement long-term for long-term reductions
Bundle 14: Municipal Miscellaneous				
14-1	Energy Conservation Education	X		
14-2	Update General Plan		X	
14-3	Favor Contracts with Sustainable Companies	X		
14-4	Plant Trees to Increase Building Shade		X	
14-5	Hire Energy/Climate Specialist	X		
Bundle 15A: Facilities - Lighting (Municipal Energy)				
15A-1	Decrease Average Daily Time Street Lights Are On	X		
15A-2	Institute a Lights-Out-at-Night Policy	X		
15A-3	Install LED Exit Signs	X		
15A-4	Install LED Street Lights	X		
15A-5	Install Other Non-LED energy Efficient Street Lights	X		
15A-6	Install LED Lighting at Schools and Parks	X		
15A-7	Installment of Occupancy Sensors	X		
15A-8	Install Solar Tubes	X		
15A-9	LED Holiday Lights	X		
15A-10	Efficient Lighting Retrofits	X		
Bundle 15B: Facilities - Appliances (Municipal Energy)				
15B-1	Use ENERGY STAR Water Coolers	X		
15B-2	Use ENERGY STAR Copiers	X		
15B-3	Use of ENERGY STAR Refrigerators	X		
15B-4	Use ENERGY STAR Vending Machines	X		
15B-5	Use ENERGY STAR Printers	X		
15B-6	Use ENERGY STAR monitors	X		
15B-7	Use ENERGY STAR Computers	X		
15B-8	Use High Efficiency Water Heaters	X		
15B-9	Use Energy Efficient Boilers	X		
Bundle 15C: Facilities - Comprehensive Improvements (Municipal Energy)				
15C-1	Adopt a High Performance Local Energy Code (including a Green Building Ordinance) for New Construction and Renovation of Municipal Facilities		X	
15C-2	Purchase Carbon Credits	X		
15C-3	Perform Energy Efficiency Retrofits of Existing Facilities	X		
15C-4	Retro Commission for Energy Efficiency	X		
Bundle 15D: Buildings - Temperature Control (Municipal Energy)				
15D-1	HVAC Energy Conservation	X		
15D-2	HVAC Fan Upgrade	X		
15D-3	Use Energy Efficient Chillers	X		
15D-4	Switch Electric Heat to Natural Gas	X		
15D-5	Install Reflective Roofing	X		
15D-6	Install Green Roofing	X		
Bundle 16: Renewable Energy Generation and Procurement (Municipal Energy)				
16-1	Funding for Energy Efficiency and Renewable Energy			X
16-2	Purchase Electricity from Renewable Energy Sources from the Grid	X		
16-3	Purchase Green Tags / Renewable Energy Certificates	X		
16-4	Install Solar Water Heaters	X		
16-5	Install Solar Water Heaters at Swimming Pools	X		
16-6	Install Solar (PV) Panels on Municipal Facilities	X		
16-7	Install Wind Turbines	X		
16-8	Use Geothermal Heat Pumps at Government Facilities	X		
16-9	Implement Methane Flaring at WWTP	X		
Bundle 17: Waste Diversion and Reduction (Solid waste disposal from municipal operations - not in inventory)				
17-1	Encourage City Employees to Recycle		X	
17-2	Encourage Organics Composting by City Employees		X	
17-3	Encourage Reuse or Recycling of Construction and Demolition Materials		X	
Bundle 18: Transportation Fuels (Transportation)				
18-1	Fleet Conversion to Electric Vehicles (EVs)	X		
18-2	Fleet Conversion to Ethanol (E85)	X		
18-3	Convert to Compressed Natural Gas (CNG)	X		
18-4	Fleet Conversion to Bio-Diesel (B20)	X		
18-5	Fleet Conversion to Bio-Diesel (B100)	X		
Bundle 19: Transportation Equipment and Operations (Transportation)				
19-1	Limit Idling of Government Operations Vehicles	X		
19-2	Limit Idling of Heavy Equipment Vehicles	X		

Implementation Timeline of Municipal Reduction Strategies				
Reduction Strategy		Implementation Timeframe[1]		
ID #	Title	Implement short-term for short-term reductions	Implement short-term for long-term reductions	Implement long-term for long-term reductions
Bundle 20: Transit and Bike/Ped (Transportation)				
20-1	Implement a Police on Bicycle Program	X		
20-2	Bicycle Lending Program	X		
Bundle 21: Vehicle Efficiency (Transportation)				
21-1	Reduce Municipal Fleet Mileage	X		
21-2	Utilize Fuel-Efficient Vehicles For Parking Enforcement	X		
21-3	Procurement of Smaller Fleet Vehicles	X		
21-4	Procurement of Hybrid Vehicles	X		
Bundle 22: Transportation Miscellaneous (Transportation)				
22-1	Encourage Telecommunicating	X		
22-2	Use Non-Asphalt Pavements			X
Bundle 23: Water Conservation (Water and Wastewater)				
23-1	Adopt Water Conservation Ordinance			X
23-2	Install Low Flow Faucets	X		
23-3	Install Low Flow Shower Heads	X		
23-4	Install High Efficiency Toilets	X		
23-5	Install Central Lawn Irrigation	X		
23-6	Use Low-Maintenance Landscaping	X		
23-7	Funding for Municipal Water Conservation Projects			X
23-8	Low Impact Development		X	
23-9	Water Efficient Model Homes		X	
23-10	Improve Water Pumping Energy Efficiency	X		
23-11	Water Leak Detection and Repair	X		
Bundle 24: Wastewater Management (Water and Wastewater				
24-1	Install Sludge Incinerators at WWTP			X
24-2	Install Anaerobic Digester at WWTP	X		
24-3	Upgrade Anaerobic Digester to Allow Co-Digestion of High-Strength Organic Waste at WWTP	X		
24-4	Reuse Wastewater	X		
24-5	Secondary Aeration System Retrofit	X		
24-6	Install Hydroelectric Turbine in Wastewater Pipeline	X		

[1] We divide the individual reduction strategies into categories that correspond to: 1) strategies that should be implemented quickly in order to achieve reductions for the 2020 target; 2) strategies that should be implemented now, but will likely contribute to GHG reductions after 2020, and 3) strategies that are larger infrastructure improvements and will take longer term planning and capital.

Technical Appendix IIIC: Rebates and Incentives

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
A1	High-Efficiency Refrigerator Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $75 per unit replaced with a Refrigerator that is a CEE Tier 3 model and has a volume of 7.75 cubic feet or larger.	12/31/2012	Business: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List2010.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
A2	Commercial Glass Door Refrigerator Rebate	Utility (PG&E)	Commercial PG&E Consumers	Depending on the size of the refrigerator, this rebate offers $75-$150 per qualifying unit installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A3	Commercial Solid Door Refrigerator Rebate	Utility (PG&E)	Commercial PG&E Consumers	Depending on the size of the refrigerator, this rebate offers $50-$200 per qualifying unit installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A4	Commercial Glass Door Freezer Rebate	Utility (PG&E)	Commercial PG&E Consumers	Depending on the size of the freezer, this rebate offers $200-$1,000 per qualifying unit installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A5	Commercial Solid Door Freezer Rebate	Utility (PG&E)	Commercial PG&E Consumers	Depending on the size of the freezer, this rebate offers $100-$600 per qualifying unit installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A6	New Refrigeration Display Cases with Doors Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $75 per linear foot of qualifying new medium temperature refrigeration display cases installed and $175 per linear foot of low temperature models installed. Newly installed display cases must replace an existing open, multi-deck display case. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A7	New High-Efficiency Refrigeration Display Cases with Special Doors Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $75 per linear foot of new high-efficiency remote reach-in cases installed. New display cases must replace an existing low temperature self-contained or remote reach-in case. Additional requirements and exclusions exist for the new installed case as well as the existing case; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A8	Special Doors with Low/No Anti-Sweat Heat on Low Temperature Display Cases Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $100 per door installed on low temperature display cases. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A9	Night Covers for Open Vertical and Horizontal Display Cases Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $3.50 per linear foot of low temperature or medium temperature night covers installed. Cover must be installed on an existing display case to decrease the cooling load for the case during off hours.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A10	Evaporative Fan Controller for Walk-In Cooler Coolers and Freezers Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $75 per controller installed in walk-in coolers or freezers. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
A11	Auto-Closer for Walk-In Coolers or Freezer Doors Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $75 per auto-closer installed for cooler or freezer doors. Auto closers must be installed to the main insulated door of a walk-in cooler or freezer and must be able to firmly shut when within one-inch of full closure.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A12	Anti-Sweat Heater Controls Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $25 per linear foot of display cases installed with ant-sweat heater controls. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	This rebate cannot be used in conjunction with the 'New Refrigeration Display Case with Doors Rebate' (A6).
A13	Strip Curtain Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $3.00 per sq. ft. of doorways covered with strip curtains. Rebate applies when doorways are fully covered by strip curtains; Partial doorway coverage does not apply. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A14	Efficient Evaporative Fan Motor Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $35 for the replacement of display case motors and $50 for walk-in coolers. New motors must be electronically commutated motors (ECM) and replace standard efficiency shaded-pole evaporator fan motors	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A15	Insulation for Bare Suction Lines Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $2.00 per linear foot of suction line insulation installed. New insulation must cover bare refrigeration suction lines of 1-5/8 inches in diameter or less on existing equipment. Additional requirements; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	
A16	Commercial Ice Machine Rebate	Utility (PG&E)	Commercial PG&E Consumers	Depending on the ice machine's daily load (lbs of ice made per day), this rebate offers $50-$250 per ENERGY STAR unit installed and $100-$500 per Super-Efficient unit installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A17	Insulated Holding Cabinets Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $200 per 1/2 sized, $250 per 3/4 sized, and $300 per full sized holding cabinet installed. Cabinets must meet CEE Tier II specifications and must be insulated, electric, hot food holding cabinets with solid doors.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A18	Commercial Combination Oven/Steamer Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $1,000 per electric combination oven/steamer installed and $750 for natural gas models. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A19	Commercial Convection Oven Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $350 per electric convection oven installed and $500 for natural gas models. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A20	Commercial Rack Oven Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $1000 per single rack oven and $2000 per double rack oven installed. Ovens must run on natural gas and have a tested baking energy efficiency of 50% or more utilizing ASTM F2093.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A21	Commercial Conveyor Oven Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $500 per small natural gas conveyor oven installed and $750 per large model installed. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A22	Commercial Fryer Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $200 per qualifying electric vat installed and $749 per qualifying natural gas model installed. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A23	Commercial Large Vat Fryer Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $200 per qualifying large electric vat installed and $500 per qualifying large natural gas model installed. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A24	Commercial Griddle Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $300 per qualifying natural gas griddle installed and $125 per qualfying natural gas model installed. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
A25	Commercial Steam Cooker Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $1,250 per qualifying electric steam cooker installed and $2,000 per qualifying natural gas model installed.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A26	Commercial Kitchen Ventilation Controls Retrofit Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $350 per new exhaust hood control system installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A27	Commercial Kitchen Ventilation Hood Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $300 per new exhaust hood installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/foodservice_catalog_final.pdf	
A28	Vending Machine Controller Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $100 per controller installed in refrigerated vending machines. Installed controller must include a passive infrared occupancy sensor that turns off the compressor and fluorescent lights when the surrounding area is unoccupied for at least 15 minutes.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf	Refurbished vending machines in which the controller can be installed are eligible.
A29	Direct Water Heater Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $2.00 per MBtuh of qualified water heaters installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
A30	Electric Storage Water Heater Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $30 per unit replaced with an electric storage water heater that has an EF rating of 0.93 or greater and has at least a 40 gallon capacity.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List2010.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
A31	Natural Gas Tank Water Heater Rebate	Utility (PG&E)	Residential PG&E Consumers	Rebate offers $30 per level 1 Natural Gas Tank Water Heater installed and $50 per each level 2 model installed. Water Heater capacity must be at least 40 gallons. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
A32	Tank Insulation Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $2.00-$4.00 per sq. ft. of qualifying tank insulation installed. Tanks with pre-existing insulation or tanks with old or damage insulation do not qualify for the rebate.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
A33	Pipe Insulation Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $2.00-$3.00 per linear ft. of qualifying pipe insulation installed. This rebate can only be used for pipes have old or damaged insulation. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
A34	High-Efficiency Clothes Washer Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $50 per unit replaced with a qualifying clothes washer. See source for list of qualifying clothes washers.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/appliances_generalimprovements_catalog_final.pdf Residential: http://www.pge.com/myhome/saveenergymoney/rebates/appliance/clothes/	
A35	Ozone Laundry System Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $39/lb of ozone capacity the newly installed washing machines support. Rebate can only be applied to facilities with on-premise laundry equipment (i.e. Hotels and Fitness Centers). Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
A36	Network Computer Power Management Software Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $15 per desktop computer installed with qualifying software. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
C1	Energy Savings Assistance Program	Utility (PG&E)	Low income-Qualifying PG&E Consumers	Free housing upgrades are offered to low income customers for items including: compact fluorescent lights, caulking, showerheads, minor home repair, old refrigerator, furnace and/or water heater replacement, etcetera.	5/31/2013	http://www.pge.com/myhome/customerservice/financialassistance/energysavingsassistanceprogram/	
C2	Residential Energy Conservation Subsidy Exclusion	Federal Govt (Tax Break)	Residential	A tax exclusion is available for energy conservation subsidies provided, either directly or indirectly, to customers by public utilities. This exclusion does not apply to electricity-generating systems registered as "qualifying facilities" under the Public Utility Regulatory Policies Act of 1978.	12/31/2016	Exemption Description: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US03F&re=1&ee=1 IRS Exemption Publication: http://www.irs.gov/publications/p525/index.html	
C3	Multi-Family Residential Energy Efficiency Rebates	Utility (PG&E)	Owners and Managers of Multifamily Properties	PG&E offers rebates for comprehensive improvements made to multifamily properties. Rebates are offered for appliances, HVAC systems, water heaters, pool systems and others. See source for a complete list of the multifamily rebates offered.	12/31/2012	http://www.pge.com/includes/docs/pdfs/myhome/saveenergymoney/rebates/property/multifamily_catalog.pdf	
C4	California Advanced Homes Incentives	Utility (PG&E)	Residential and Construction Management	PG&E provides incentives for those who build homes which exceed Title 24 standards by at least 15%. Incentives are available for all single and multi-family new construction projects. The incentives are offered in two different forms: a performance based approach and a measure based approach. Amount of incentives based on type: Baseline Advanced Home Incentives: $75-$225/kW, $0.43-$1.29/kWh, $1.72-$5.14/Therm (15%-45% above code) California ENERGY STAR, Green Builder, Green Point Rated and LEED-H Certification Bonus Incentive: 10% Compact Home Bonus: 15% Design Team Incentive Charrette: 50% of cost for projects that have at least ten units Photovoltaics: $75-$225/peak kW reduced	12/31/2012	http://www.californiaadvancedhomes.com/	
C5	Energy Upgrade California	State Govt (California Energy Commission, funding from the American Reinvestment and Recovery Act of 2009)	Residential	If a homeowner uses a participating contractor to make upgrades in the following areas: Equipment Insulation, Furnaces , Central Air conditioners, Duct/Air sealing, Building Insulation, Windows, Custom/Others pending approval, they are eligable for up to $1000 for the basic upgrade package and up to $1500-$4000 for the advanced upgrade package. Additional requirements and exclusions exist; see source for details. See source for details about available packages.	Unknown	https://energyupgradeca.org/overview	
C6	Refrigerator, Freezer & Room AC Recycling Rebate	Utility (PG&E)	PG&E Consumers	PG&E offers to pick up used refrigerators and freezers that are 10 years or older and pay customers up to $35 as a rebate for recycling the units. Old working room air conditioners that blow tepid air can also be picked up with a recycling rebate value of $25. See source for additional details.	12/31/2012	http://www.pge.com/myhome/saveenergymoney/rebates/recycling/	
C7	Swimming Pool Filtration Pump Rebate	Utility (PG&E)	Residential PG&E Consumers	Rebate offers $100 per qualifying pump installed on residential in-ground swimming pools. Qualifying pumps must be three horsepower or less and must only be for filtration. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/myhome/saveenergymoney/rebates/seasonal/poolpumps/	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
C8	Plug Load Occupancy Sensor Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $15 per passive infrared or ultrasonic detector installed. Sensors must control electricity using equipment such as copiers and printers.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/businesscomputing_final.pdf	
C9	School Facility Program - Modernization Grants	State Govt (Department of General Services)	Schools 25 years older or more	Program works to modernize schools 25 years and older through comprehensive improvements including lighting, air conditioning, plumbing, and other electrical systems. The amount of modernization funding available per eligible school is determined on a case-by-case basis.	Unknown	http://www.dgs.ca.gov/opsc/Programs/modernizationprogram.aspx	
L1	CFL & LED Lighting Rebate	Utility (PG&E)	PG&E Consumers	Rebates listed on the back of CFL Lightbulbs from participating retailers; see source for list of retailers.	Unknown	http://www.pge.com/myhome/saveenergymoney/rebates/light/products/retailers/	
L2	Compact Fluorescent Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers between $17-$75 per incandescent or HID fixture replaced with a qualifying compact fluorescent fixture. Rebate amount offered depends on the existing fixture type as well as the wattage. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L3	Interior Linear Fluorescent Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers between $25-$200 per incandescent or HID fixture replaced with a qualifying compact fluorescent fixture. Rebate amount offered depends on the existing fixture type as well as the wattage. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L4	Interior and Exterior Induction Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers between $25-$125 per incandescent or HID fixture replaced with a qualifying compact fluorescent fixture. Rebate amount offered depends on the existing fixture type as well as the wattage. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L5	Interior and Exterior HID Fixture w/ Electronic Ballast Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers between $20-$150 per incandescent or HID fixture replaced with a qualifying compact fluorescent fixture. Rebate amount offered depends on the existing fixture type as well as the wattage. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L6	High Performance T8 or T5 Linear Fluorescent Lamp with Electronic Ballast Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $4.50-$9.00 per T12 lamp or ballast replaced with qualifying High Performance T8 or T5 systems. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L7	Integrated Ballast Ceramic Metal Halide (CMH) Par Lamp Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $17.50 per lamp replaced must be 25 Watts or less integrated ballast or a ceramic metal halide PAR lamp with a rated life of 12,000 or greater.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L8	Screw-In Compact Fluorescent 14-28 Watt Reflector Lamp Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $7.00 per ENERGY STAR rated induction or electrodeless reflector lamp installed.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L9	Ceramic Metal Halide Directional Lighting Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $45 per fixture installed. Fixtures must be 39 Watts or less.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
L10	Low or Reduced-Wattage T8 System (28 and 25 Watt) Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $1.00-$1.50 per 32 Watt T8 lamp replaced with qualifying low wattage T8 lamps. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L11	Cold Cathode Lamps Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $4.00 per incandescent lamp (≥10W) replaced with a screw-in-lamp having a wattage level between 2 and 8. The screw-in-lamps must have either a medium Edison or candelabra base and be rated for at least 18,000 average life hours.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L12	De-Lamping Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $6.00-$20.00 per T-12 lamp removed. De-lamping must be used in conjunction with the lamp and ballast replacement/retrofit.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L13	Bi-Level Stairwell/Hall/Garage Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $25 per qualifying fluorescent fixture with Program Rapid-Start electronic ballasts installed. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L14	ENERGY STAR LED Surface, Pendant, and Recessed Downlight Fixture Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $30 per each halogen or incandescent or halogen fixture replaced with a qualifying ENERGY STAR LED fixture. Existing fixture must be 40 Watts or greater and the newly installed fixture must be 15 Watts or less. LED replacement lamps are not eligible for this rebate.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L15	Exterior Photocell Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $11 per photocell installed or fixture controlled. Rebate applies to built-in or stand-alone photocells that control exterior lighting fixtures.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
L16	High Efficiency Exit Sign Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $27 per incandescent exit sign and $15 per CFL exit sign replaced with a qualifying LED, electroluminescent, or photoluminiscent exit sign. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List2010.pdf	
L17	Occupancy Sensor Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $15-$55 per occupancy sensor installed. Occupancy sensors must be hardwired passive infrared and/or ultrasonic detectors that control interior lighting and follow specified wattage requirements found on the source webpage. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List2010.pdf	
L18	Time Clock Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $36 per timeclock installed. Timeclocks must control on/off schedule for interior and/or exterior lighting.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/lighting_catalog_final.pdf	
R1	Self-Generation Incentive Program (SGIP)	State Govt (California Public Utilities Commission)	PG&E Consumers	The California Public Utilities Commision offers incentives for renewable energy self generation projects. To be eligible the project must offset 379 kg CO2/MWh.The maximum incentive amount is 5M dollars or 30% of the project cost. Additional requirements and exclusions exist; see source for more information.	Until funds are depleted or year 2014	http://energycenter.org/index.php/incentive-programs/self-generation-incentive-program/program-overview	Incentive is reduced annually by 5%
R2	CSI Thermal (Solar Water Heating) Rebate	State Govt (California Public Utilities Commission)	Residential & Commercial	The CSI-Thermal Program offers rebates for installing solar water heating systems in single family homes as well as multi-family and commercial properties. Up to $1875 is offered for single-family homes and up to $500000 is offered for multi-family and commercial properties. Currently, homeowners can get $12.82/thm of natural gas displacing solar water heating systems or 37c/kWh for systems that displace electricity.	12/31/2017	Initiative Home-Page: http://www.gosolarcalifornia.org/solarwater/ Initiative Handbook: http://www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
R3	MASH Multifamily Affordable Solar Housing	State Govt (California Public Utilities Commission)	Multifamily Housing or Individual Residence with Low-Income Housing	Rebate offers $1.90 - $2.80 per watt of solar panels installed. Actual rebate value depends on the size of the system and the expected performance. Additional requirements and exclusions exist; see source for more information.	Unknown	http://www.pge.com/mybusiness/energysavingsrebates/solar/csi/csihandbookforms/	
R4	Single-Family Affordable Solar Housing (SASH) Program	State Govt (California Public Utilities Commission)	Low-Income Residential	Rebates apply to photovoltaics only. The amount of each rebate depends on the household's annual income and the California Alternate Rates for Energy (CARE) program eligibility. There is a maximum incentive amount for fully subsidized systems is 10,000 and the minimum size of the system is 1kW CEC-AC. Additional requirements and exclusions exist; see source for details.	12/31/2015	http://www.gridalternatives.org/sash	
R5	New Solar Homes Partnership	State Govt (California Public Utilities Commission)	Commercial	Rebates are offered for solar panels for home builders and developers from $2.50/watt to $3.50/watt depending on income and the system installed. The home(s) must be 15% higher energy efficiency than Title 24.	Unknown	http://www.gosolarcalifornia.ca.gov/about/nshp.php	
R6	Property Tax Exclusion for Solar Energy Systems	State Govt (Tax Break)	Residential & Commercial	In California property tax exclusions are available for Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, and Solar Mechanical Energy. The Property tax incentive amount is typically 100% of the system value and in the case of dual-use equipment there is a 75% of system value incentive.	12/31/2016	Exclusion Description: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25F&re=0&ee=0 Contact Information: http://www.boe.ca.gov	
R7	Residential Renewable Energy Tax Credit	Federal Govt (Tax Break)	Residential	A tax credit of 30% of qualified expenditures is available for resident-owned renewable energy systems. Systems must be located in the United States and on the tax-payers property. Additional requirements and exclusions exist; see source for more information.	Unknown	http://www.energystar.gov/taxcredits	
T1	Clean Vehicle Rebate Project (CVRP)	State Govt (California Air Resource Board)	Residents, Business Owners, Non-Profits, Local and State Governments	Rebates for the purchase or lease of fuel cell, plug-in hybrid, and battery electric vehicles (up to $2,500).	Until funds are depleted (Estimated through 2015)	http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project	
T2	Hybrid Vehicle Incentive Program (HVIP)	State Govt (California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project and California Air Resource Board)	Fleet owners that operate in California	Vouchers are offered for purchasing hybrid electric vehicles to reduce the incremental cost of qualified medium- and heavy-duty hybrid electric vehicles at the time of purchase. Vouchers range from $10,000 to $40,000 with additional vouchers from $2,000 to $10,000 for the first three vehicles. A list of qualified vehicles and other requirements is available on the HVIP website.	Until funds are depleted	http://www.californiahvip.org/	
T3	Biofuel Volume Rebate Program	Private (Propel Fuels)	Fleet owners that consume more than 500 gallons of biodiesel blends and E85 per month	Rebate offers $0.03 per gallon for purchases of less than 1,000 gallons of biofuel per month, and $.05 per gallon for purchases of 1,000 gallons or more per month. Rebates are applied at the end of each monthly billing cycle with the procurement of a Propel CleanDrive Wright Express fleet card.	Unknown	http://propelfuels.com/fleet_and_commercial/clean_fleet_solution/	
T4	Compressed Natural Gas (CNG) Tax Exemption for Transit Use	State Govt (California Revenue and Taxation Code)	Local transit agencies or public transit operators	Tax code offers county user tax exemption when CNG is used as a motor vehicle fuel by local agencies or public transit operators to operate public transit services (as mandated by California Revenue and Taxation Code 7284.2)	Unknown	http://www.oal.ca.gov/	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
T5	Clean Vehicle Electricity and Natural Gas Rate Reduction	Utility (PG&E)	Residential PG&E Consumers	PG&E offers discounted residential Time-of-Use rates for electricity used to charge battery electric vehicles (EVs), plug-in hybrid electric vehicles, and natural gas vehicle (NGV) home fueling appliances. Special rates are also available for natural gas that residential customers compress using home fueling appliances.	Unknown	http://www.pge.com/myhome/environment/whatyoucando/electricdrivevehicles/rateoptions/	
T6	High Occupancy Vehicle (HOV) Lane Exemption	State Govt (California Department of Motor Vehicles)	Operators of qualified low-emission vehicles	Compressed natural gas (CNG), hydrogen, electric, and plug-in hybrid electric vehicles (PHEVs) meeting specified California and federal emissions standards and affixed with a California Department of Motor Vehicles Clean Air Vehicle sticker may use HOV lanes regardless of the number of occupants in the vehicle.	1/1/2015	http://www.arb.ca.gov/msprog/carpool/carpool.htm	
T7	Advanced Transportation Financing	State Govt (California Alternative Energy and Advanced Transportation Financing Authority)	Advanced transportation developers	Financing offered for property used to develop and commercialize advanced transportation technologies that reduce pollution and energy use and promote economic development. Eligible advanced transportation technologies include electric vehicles, fuel cells, and ultra low emission vehicles. CAEATFA may provide financial incentives in the form of sales and use tax exclusions on qualified property. See the CAEATFA website for information about current incentives.	Unknown	http://www.treasurer.ca.gov/caeatfa/incentives.asp	
T8	Clean Air Funds	Private (Yolo-Solano Air Quality Management District)	Commercial and Municipal	Grants are offered for projects designed to reduce emissions from motor vehicles. Projects awarded Clean Air Funds include replacing or retrofitting diesel trucks and off-road equipment that do not qualify for other regional programs, new electric vehicles, construction of pedestrian and bicycle facilities, transit projects and public information and education programs. Proposals can be made in one of three categories: clean technologies and low-emission vehicles; alternative transportation; transit; and public education.	Unknown	http://www.ysaqmd.org/clean-air-funds.php	
T9	Lower-Emission School Bus Program	State Govt (California Air Resource Board)	Public school districts in California that own buses; Private school transportation providers that contract with public school districts in California	Grants are available for the retrofitting of old school buses. It must be proved that the new air pollution control device reduces particulate matter emissions by at least 85% for each retrofitted school bus.	Unknown	http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm	
T10	Moyer Voucher Incentive Program (VIP)	Private (Sacramento Metropolitan Air Quality Management District)	On-road heavy-duty diesel vehicle owners based anywhere in California	Vouchers are offered through AQMD-approved dealerships for the replacement of on-road heavy-duty diesel vehicles that have 2002 or older engines with cleaner emission vehicles. Applies to truck fleets with 3 or fewer vehicles that operated at least 75% in California in the past 24 months.	Until funds are depleted	http://www.airquality.org/mobile/moyeronroadvip/index.shtml	
T11	Moyer Voucher Incentive Program (VIP)	Private (Sacramento Metropolitan Air Quality Management District)	Commercial heavy duty off-road vehicle owners	Substantial business grants to help fund projects that will upgrade emission controls on heavy duty off-road vehicles. Projects eligible include emission control upgrades of agricultural equipment (tractors, balers, irrigation pumps) and construction equipment (tractors, backhoes).	Until funds are depleted	County Program Information: http://www.ysaqmd.org/moyer.php For Application: http://www.airquality.org/mobile/moyer/index.shtml	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
T12	Yolo-Solano Mower Exchange	Private (Yolo-Solano Air Quality Management District)	Gas-powered lawn mower owners that are Yolo or Solano county residents	A $100 discount is provided on a new rechargeable lawn mower when residents recycle (ie exchange) an old gas-powered mower at one of Yolo-Solano AQMD's eight partner sites. There are a limited number of mowers available, so interested residents are encouraged to register as soon as possible.	Until funds are depleted	http://www.ysaqmd.org/MowerExchange2012.php	
TC1	Attic Insulation Rebate	Utility (PG&E)	Residential PG&E Consumers	Rebate offers $0.15 per sq. ft. of living space installed with new insulation. Final attic insulation level must be at least R-19 for flat or low-pitched roofs and at least R-38 for all other roofing.	12/31/2012	http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC2	Wall Insulation Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $0.50 per sq. ft. of living space installed with new wall insulation. Rebate applies when installing insulation with a rating of R-13 or higher. Additional requirements and exclusions exist; see source for more information.	12/31/2012	Business: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/appliances_generalimprovements_catalog_final.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC3	Window Film Rebate	Utility (PG&E)	Municipal and Commercial	Rebate offers $1.35 per sq. ft. of windows with newly installed window film. Rebate applies when installing window film onto clear single-pane glass which have either a SHGC (Solar Heat Gain Coefficient) of at least 0.39; or have a SHGC value of at least 0.47 and a Visible Transmittance (VT) /SHGC ratio greater than 1.3.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/appliances_generalimprovements_catalog_final.pdf	
TC4	Energy Efficient Cool Roof Rebate	Utility (PG&E)	Residential PG&E Consumers	Rebate offers $0.20 per sq. ft. of qualifying cool roofing installed on low slope or level 1 steep slope roofs and $0.10 per sq. foot. installed on level 2 steep slopes. In order to apply, PG&E customers must have a central AC system or must be installing one concurrently. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC5	Whole House Fan Rebate	Utility (PG&E)	Residential PG&E Consumers	Rebate offers $100 per unit replaced or new installation with a qualifying energy efficient model. Additional requirements exist, see source for more information. Fan must move air at 1000 CFM or greater and must be permanently installed. Additional requirements exist, see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC6	Replacement VSM Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $50 per single speed motor replaced. Rebate applies to motors with a 10 hp capacity or less. Additional requirements and exclusions exist; see source for more information.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hvac_catalog_final.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC7	ENERGY STAR Room Air Conditioner Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $50 per room air conditioner replaced with a new ENERGY STAR model.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/appliances_generalimprovements_catalog_final.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
TC8	HVAC Variable Frequency Drive Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $80 per hp of fans installed. Rebate only applies to existing HVAC supply or return air fans. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
TC9	AC Quality Care Program	Utility (PG&E)	Residential PG&E Consumers	Program provides residents with a comprehensive AC system and natural gas appliance assessment through local contractors. The contractor will evaluate the energy efficiency efficiency of resident's current AC system and appliances and then recommend work to be done in order to increase efficiency. Contractor will make use of PG&E rebates in order to offset the associated costs.	12/31/2012	http://www.pge.com/acqualitycare/	There are no contractors currently signed up for this in Woodland or Winters. Before residents can partake in rebates, the cities would need local HVAC contractor participation.
TC10	Package Terminal Air Conditioner (PTAC) and Package Terminal Heat Pump (PTHP) Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $100 per unit replaced qualifying energy efficient models. Additional requirements exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
TC11	Central Natural Gas Furnace Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $150 per central natural gas furnace with an AFUE rating of 94-95.9% and $250 for a unit with an AFUE rating >95.9%. Additional requirements exist; see source for more information.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hvac_catalog_final.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC12	Central Natural Gas Furnace with Built-In VSM Rebate	Utility (PG&E)	PG&E Consumers	Rebate offers $200 per central natural gas furnace with an AFUE rating of 94-95.9% and $300 for a unit with an AFUE rating >95.9%.	12/31/2012	Commercial & Municipal: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hvac_catalog_final.pdf Residential: http://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/ee_residential_rebate_catalog.pdf	
TC13	Large Domestic Hot Water Boiler Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $1.50 per MBtuh of qualifying hot water heaters installed. Hot water heaters must have an input of 75,000 Btuh and have a minimum thermal efficiency of 84%.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
TC14	Space Heating Boiler Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $1.00 per MBtuh of qualifying space heating boilers installed. Types of space heating boilers include small water boilers, small steam boilers, and large water or steam boilers. Additional requirements exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
TC15	Process Boiler Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $2.00 per MBtuh of qualified Boilers installed. Additional requirements and exclusions exist; see source for details.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	

ID #[1]	Rebate Title[2]	Financing / Organizing Entity	Eligible Consumer	Description[2]	Expiration Date	Source(s)	Special Notes
TC16	Steam Trap Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $50 for commercial steam traps, $100 for industrial low pressure (<15PSIG) steam traps, and $290 for industrial high pressure steam traps (>15PSIG) when replacing an old or failed steam trap. Additional requirements and exclusions exist; see source for more information.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
TC17	Commercial Pool and Spa Heater Rebate	Utility (PG&E)	Commercial & Municipal PG&E Consumers	Rebate offers $2.00 per MBtuh of qualifying heaters installed. Qualifying heaters include those that have a thermal efficiency of at least 84 percent, have an "on/off" switch and have no pilot light.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/boilers_waterheating_catalog_final.pdf	
WC1	Low Pressure Sprinkler Nozzle Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $1.15 per high pressure sprinkler nozzle replaced with a qualifying low pressure sprinkler nozzle. Qualifying sprinkler nozzles include permanent and "hand move" models. Sprinkler system must operate at 50 psi and have an overall pumping efficiency of at least 45%.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/agricultureandfoodprocessing_catalog.pdf	
WC2	Sprinkler to Drip Irrigation Conversion Rebate	Utility (PG&E)	Commercial PG&E Consumers	Rebate offers $44 per irrigated acre switched from sprinkler to drip-irrigation systems with operating pressures of at least 50 psi. Rebate can be applied to Vegetable Fields, Vineyards, and Deciduous Trees.	12/31/2012	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/agricultureandfoodprocessing_catalog.pdf	
WC3	Agricultural Water Enhancement Program (AWEP)	Federal Govt (United States Department Agriculture Natural Resources Conservation Service)	Agricultural Producers Using Lands That Do Not Already Utilize Existing USDA Conservation Programs	Financial and technical assistance is offered in the form of program contracts with agricultural producers to implement agricultural water enhancement activities on agricultural land. Activities must aim to conserve surface and ground water and/or improve water quality. AWEP is part of the Environmental Quality Incentives Program (EQIP), and utilizes program contracts with producers to carryout conservation practices in project areas established through partnership agreements.	Unknown	http://www.ca.nrcs.usda.gov/programs/awep.html	

Notes:

1. ID Lettering represents the following types of rebates: A = Appliances, C = Comprehensive Improvements, L = Lighting, R = Renewable Energy, T = Transportation, TC = Temperature Control, WC = Water Conservation.

2. AFUE = Annual Fuel Utilization Efficiency, ASTM = American Society for Testing Materials, CEE = Consortium for Energy Efficiency, CFM = Cubic Feet per Minute, EF = Energy Factor, PSIG = Pounds per Square Inch Gauge, R-Value = Thermal resistance rating for insulation, SHGC = Solar Heat Gain Coefficient, VSM = Variable Speed Motor, VT = Visible Transmittance.

Technical Appendix IV: Participation Curves

Participation Curves

A number of participation curves have been developed for all community strategies and for municipal transportation strategies. The results of these initial simulations illustrate the various levels of target achievement for each strategy and the resulting GHG reductions.

To calculate the GHG reductions, a variety of assumptions are required. The assumptions used to estimate the GHG reductions are documented in each sector's corresponding datasheet (electronic Appendices IV1 – IV4, see Figure 6). Implementation costs have not been included on these graphs and should obviously also be assessed alongside the GHG reduction estimates.

There may also be strategies, which when combined, produce greater or fewer reductions than estimated by a single strategy. These combined benefits (or disbenefits) have not been assessed.

Residential Curves

CFL (1A-1)

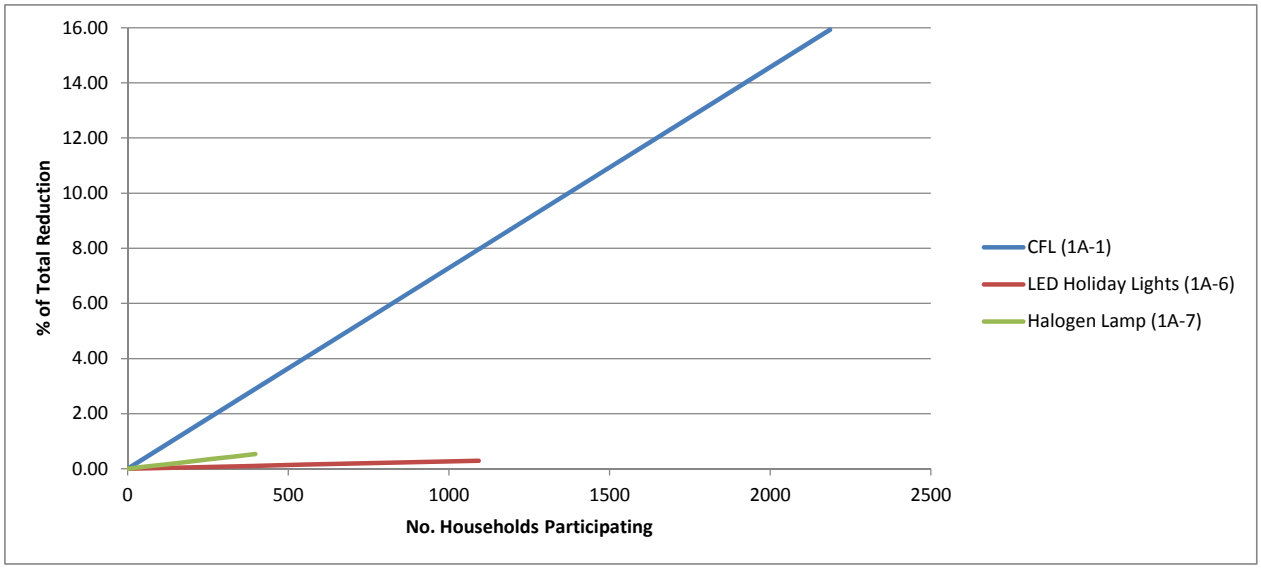
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.65	364	153
5.31	729	306
7.96	1093	459
10.62	1457	612
13.27	1822	765
15.92	2186	918

LED Holiday Lights (1A-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.05	182	3
0.10	364	6
0.15	547	8
0.19	729	11
0.24	911	14
0.29	1093	17

Halogen Lamp (1A-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.09	66	5
0.18	133	10
0.27	199	15
0.36	265	20
0.44	332	26
0.53	398	31



Eff Computer (1B-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.27	290	16
0.54	580	31
0.81	870	47
1.08	1160	62
1.34	1450	78
1.61	1740	93

Eff Monitor (1B-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.03	208	2
0.07	415	4
0.10	623	6
0.13	831	8
0.17	1038	10
0.20	1246	12

Eff Printer (1B-3)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.35	240	20
0.70	481	40
1.05	721	60
1.40	962	81
1.75	1202	101
2.10	1443	121

Eff Fridge (1B-5)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.65	364	38
1.31	729	76
1.96	1093	113
2.62	1457	151
3.27	1822	189
3.93	2186	227

Eff Dishwasher (1B-6)

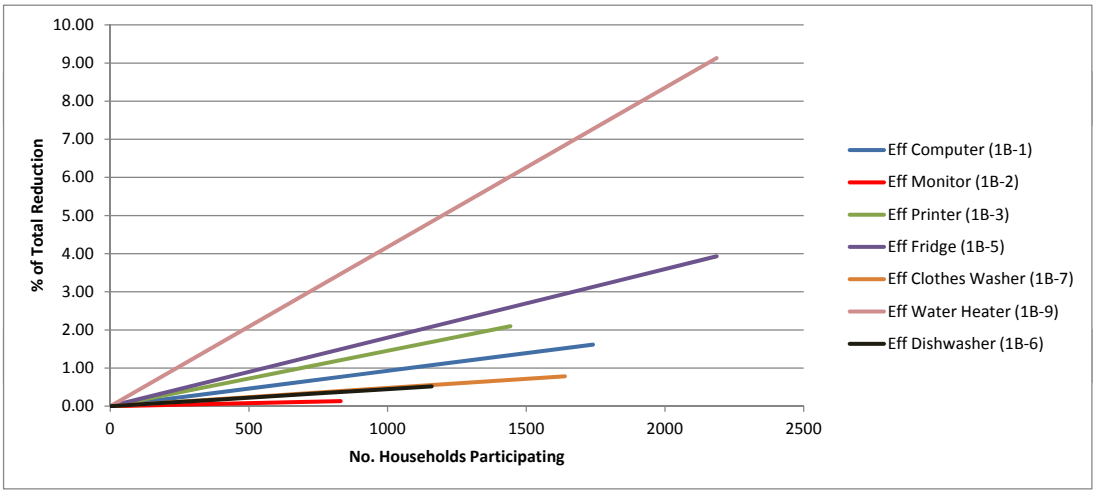
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.09	193	5
0.17	386	10
0.26	579	15
0.34	772	20
0.43	965	25
0.52	1159	30

Eff Clothes Washer (1B-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.13	273	8
0.26	547	15
0.39	820	23
0.52	1093	30
0.65	1366	38
0.78	1640	45

Eff Water Heater (1B-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.52	364	88
3.04	729	175
4.57	1093	263
6.09	1457	351
7.61	1822	439
9.13	2186	526



Retro Commissioning (1C-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
12.21	364	704
24.42	729	1408
36.64	1093	2112
48.85	1457	2817
61.06	1822	3521
73.27	2186	4225

Energy Conservation EDU (1C-3)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
4.28	364	247
8.57	729	494
12.85	1093	741
17.14	1457	988
21.42	1822	1235
25.70	2186	1482

Energy Efficiency Retrofits (1C-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
8.25	364	476
16.51	729	952
24.76	1093	1428
33.02	1457	1904
41.27	1822	2380
49.53	2186	2856

TOS Energy Upgrades[1] (1C-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.06	4	3
0.12	8	7
0.18	13	10
0.24	17	14
0.30	21	17
0.36	25	21

New Construction Energy Code (1C-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.65	9	37
1.29	17	74
1.94	26	112
2.58	35	149
3.23	43	186
3.87	52	223

Res. Energy Code[1] (1C-11)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.10	9	6
0.19	17	11
0.29	26	17
0.38	35	22
0.48	43	28
0.57	52	33

Efficient Affordable Housing (1C-13)

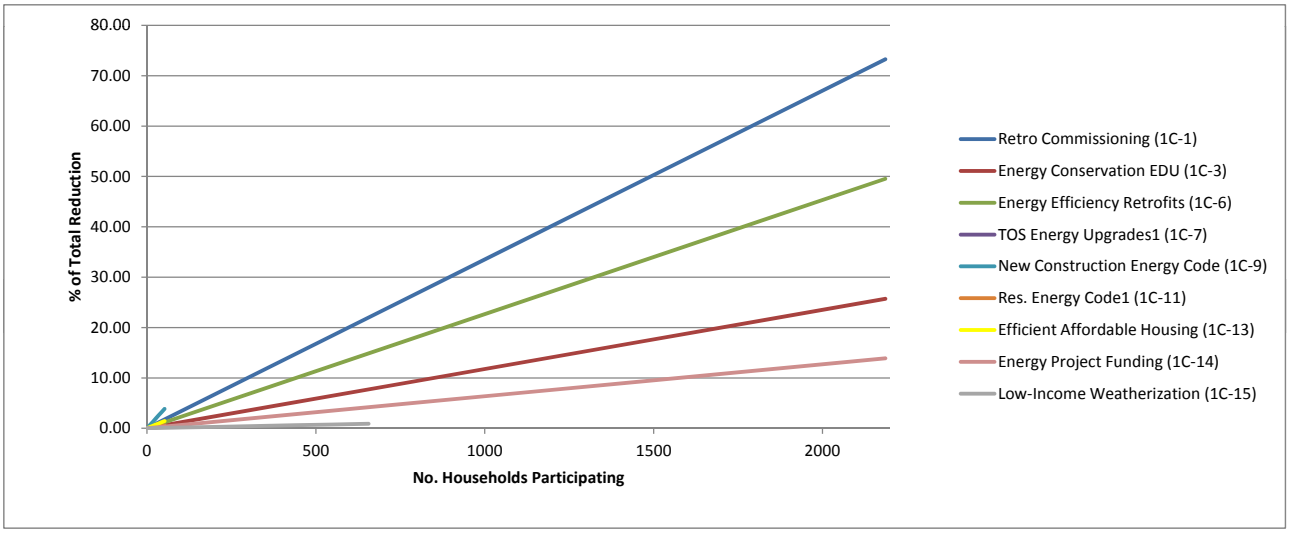
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.24	9	14
0.48	17	28
0.72	26	41
0.96	35	55
1.19	43	69
1.43	52	83

Energy Project Funding (1C-14)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.32	364	133
4.63	729	267
6.95	1093	400
9.26	1457	534
11.58	1822	667
13.89	2186	801

Low-Income Weatherization (1C-15)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.15	109	9
0.30	219	17
0.45	328	26
0.60	437	34
0.75	547	43
0.90	656	52



Notes:

1. The graph does not show the lines for TOS Energy Upgrades and Res. Energy Code due to their relatively small % reduction potential.

Window AC Replacement (1D-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.03	58	1
0.05	117	3
0.08	175	4
0.10	233	6
0.13	291	7
0.15	350	9

HVAC Fan Upgrade (1D-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.02	364	116
4.04	729	233
6.06	1093	349
8.08	1457	466
10.10	1822	582
12.12	2186	699

Natural Gas Heating (1D-7)

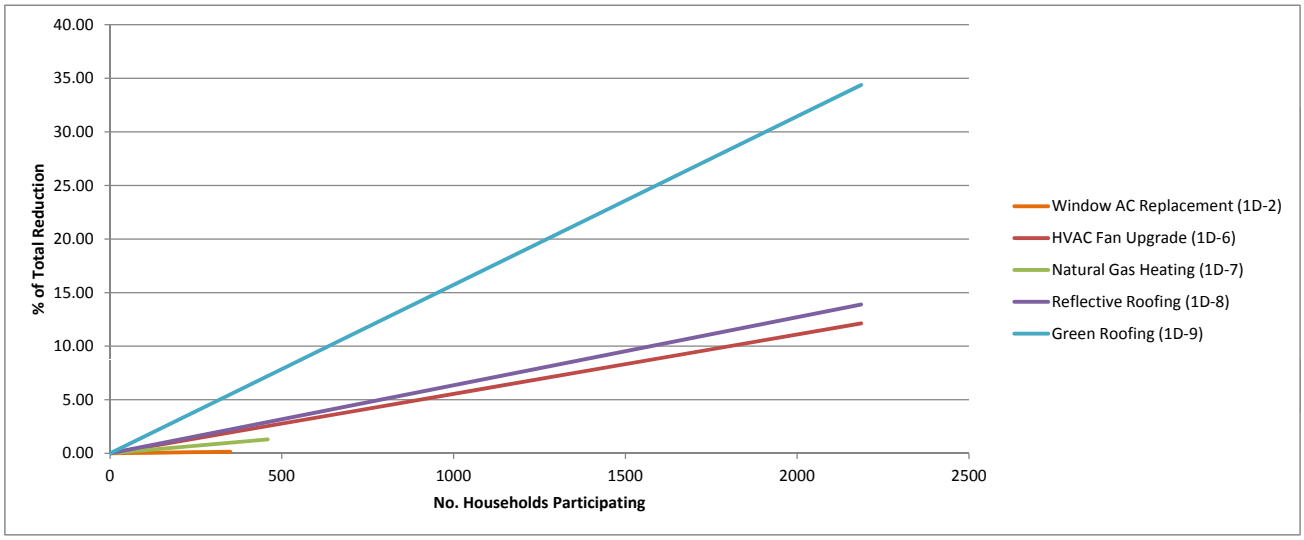
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.22	77	13
0.44	153	25
0.65	230	38
0.87	306	50
1.09	383	63
1.31	459	75

Reflective Roofing (1D-8)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.31	364	133
4.63	729	267
6.94	1093	400
9.26	1457	534
11.57	1822	667
13.89	2186	801

Green Roofing (1D-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
5.73	364	330
11.46	729	661
17.19	1093	991
22.92	1457	1321
28.64	1822	1652
34.37	2186	1982



Geothermal Heat Pumps (2-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
3.44	364	198
6.87	729	396
10.31	1093	595
13.75	1457	793
17.19	1822	991
20.62	2186	1189

PV Panels (2-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
8.42	182	485
16.84	364	971
25.26	547	1456
33.68	729	1942
42.10	911	2427
50.52	1093	2913

Solar Water Heaters (2-3)

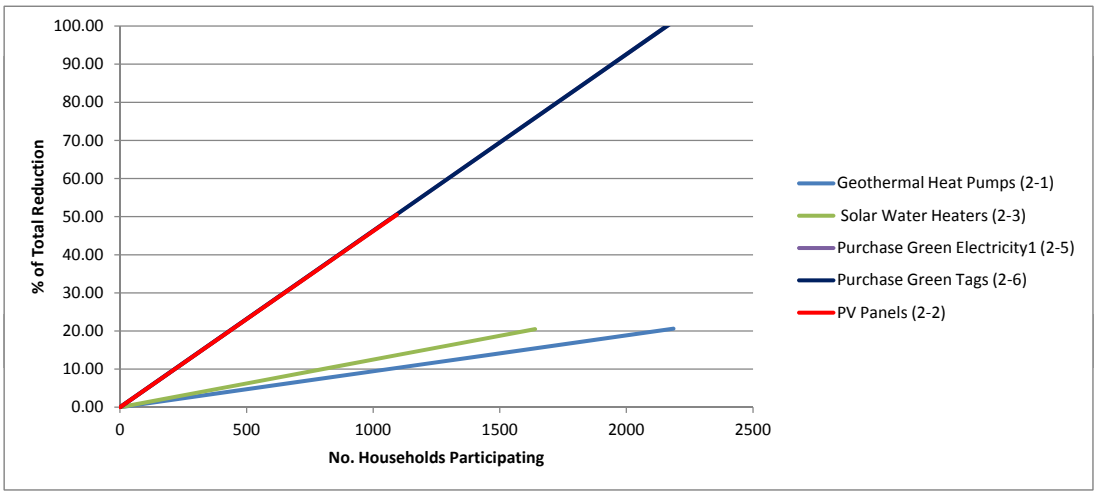
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
3.41	273	197
6.82	547	393
10.24	820	590
13.65	1093	787
17.06	1366	984
20.47	1640	1180

Purchase Green Electricity[1] (2-5)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
16.87	364	972
33.73	729	1945
50.60	1093	2917
67.46	1457	3890
84.33	1822	4862
101.19	2186	5835

Purchase Green Tags (2-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
16.87	364	972
33.73	729	1945
50.60	1093	2917
67.46	1457	3890
84.33	1822	4862
101.19	2186	5835



Notes:

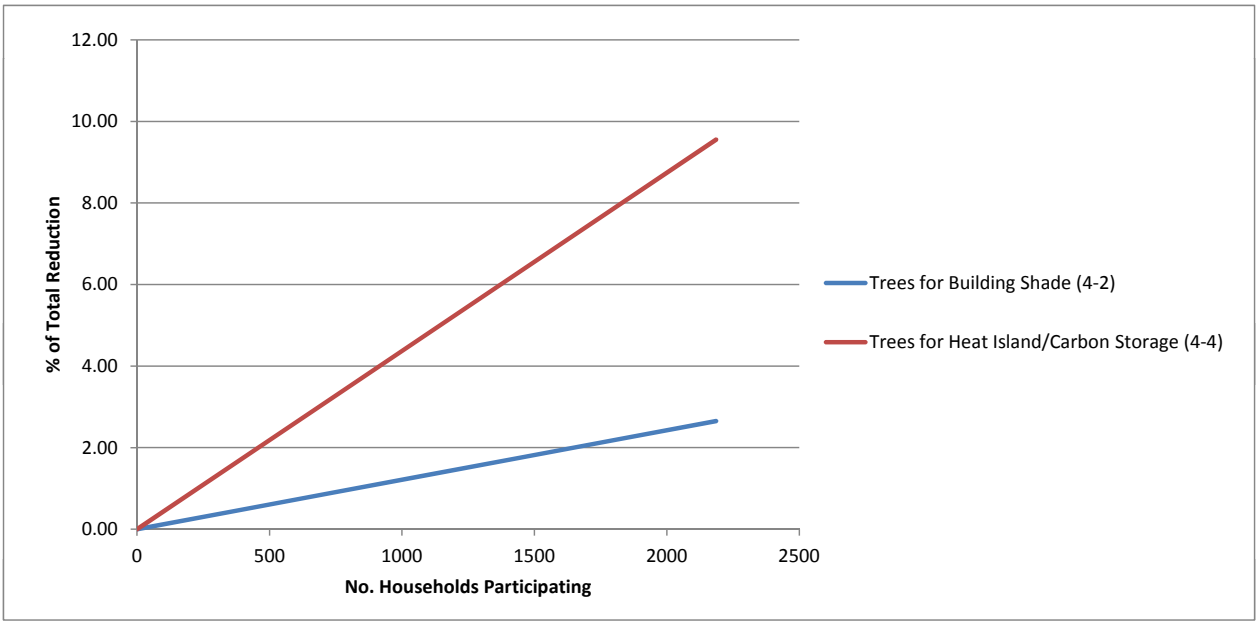
1. The graph does not show the line for Purchasing Green Electricty because the % reduction and Square Footage is the same as for Purchasing Green Tags.

Trees for Building Shade (4-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.44	364	26
0.88	729	51
1.33	1093	77
1.77	1457	102
2.21	1822	128
2.65	2186	153

Trees for Heat Island/Carbon Storage (4-4)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.59	364	92
3.18	729	184
4.78	1093	275
6.37	1457	367
7.96	1822	459
9.55	2186	551



Commercial Curves

LED Exit Signs (1A-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.06	125000	3
0.12	250000	7
0.17	375000	10
0.23	500000	13
0.29	625000	17
0.35	750000	20

Occupancy Sensors (1A-3)

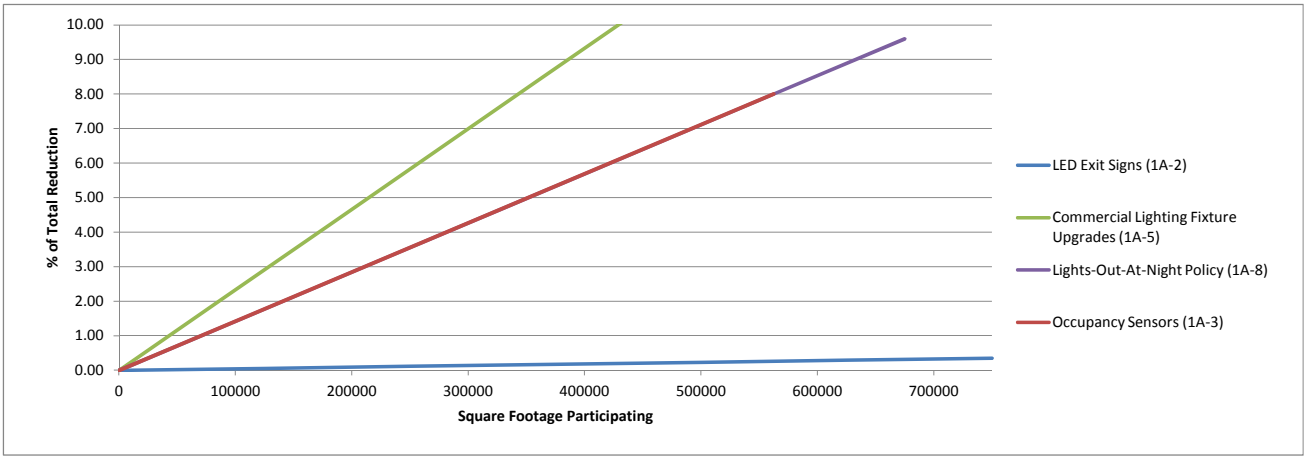
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.33	93750	77
2.67	187500	154
4.00	281250	231
5.33	375000	308
6.67	468750	384
8.00	562500	461

Commercial Lighting Fixture Upgrades (1A-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
2.11	90460	122
4.22	180919	243
6.33	271379	365
8.43	361839	486
10.54	452298	608
12.65	542758	730

Lights-Out-At-Night Policy (1A-8)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.60	112500	92
3.20	225000	185
4.80	337500	277
6.40	450000	369
8.00	562500	461
9.60	675000	554



Eff Computer (1B-1)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.03	43000	2
0.05	86000	3
0.08	129000	5
0.11	172000	6
0.14	215000	8
0.16	258000	9

Eff Monitor (1B-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.01	42500	0
0.01	85000	1
0.02	127500	1
0.03	170000	2
0.04	212500	2
0.04	255000	3

Eff Printer (1B-3)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.01	36500	0
0.01	73000	1
0.02	109500	1
0.02	146000	1
0.03	182500	2
0.03	219000	2

Eff Photocopier (1B-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.00720	35500	0
0.01	71000	1
0.02	106500	1
0.03	142000	2
0.04	177500	2
0.04	213000	2

Eff Refrigerators (1B-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.01	41000	1
0.03	82000	1
0.04	123000	2
0.05	164000	3
0.06	205000	4
0.08	246000	4

Eff Water Cooler (1B-8)

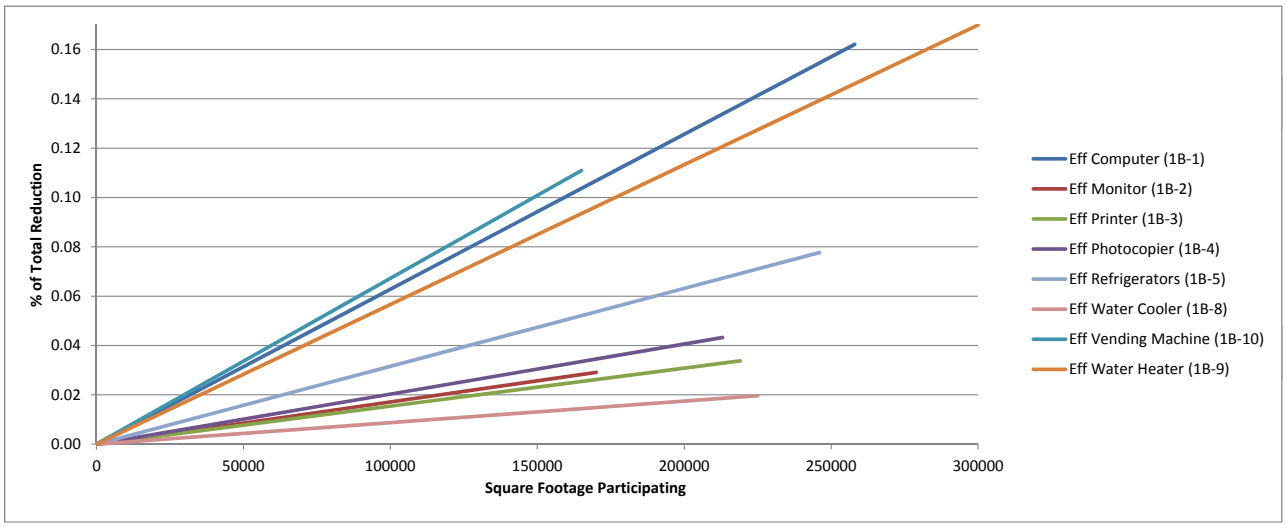
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.00	37500	0
0.01	75000	0
0.01	112500	1
0.01	150000	1
0.02	187500	1
0.02	225000	1

Eff Water Heater (1B-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.03	50000	2
0.06	100000	3
0.08	150000	5
0.11	200000	7
0.14	250000	8
0.17	300000	10

Eff Vending Machine (1B-10)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	27500	1
0.04	55000	2
0.06	82500	3
0.07	110000	4
0.09	137500	5
0.11	165000	6



Retro Commissioning (1C-1)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.76	125000	101
3.51	250000	203
5.27	375000	304
7.02	500000	405
8.78	625000	506
10.54	750000	608

Energy Conservation Campaigns (1C-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.65	125000	95
3.30	250000	190
4.94	375000	285
6.59	500000	380
8.24	625000	475
9.89	750000	570

Green Building Practices[1] (1C-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.05	1725	3
0.11	3450	6
0.16	5175	9
0.22	6900	13
0.27	8625	16
0.33	10350	19

Energy Efficient Retrofits (1C-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.66	52500	38
1.33	105000	77
1.99	157500	115
2.66	210000	153
3.32	262500	192
3.99	315000	230

New Construction Energy Code[1] (1C-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.05	1725	3
0.11	3450	6
0.16	5175	9
0.22	6900	12
0.27	8625	16
0.32	10350	19

Commercial Energy Code[1] (1C-10)

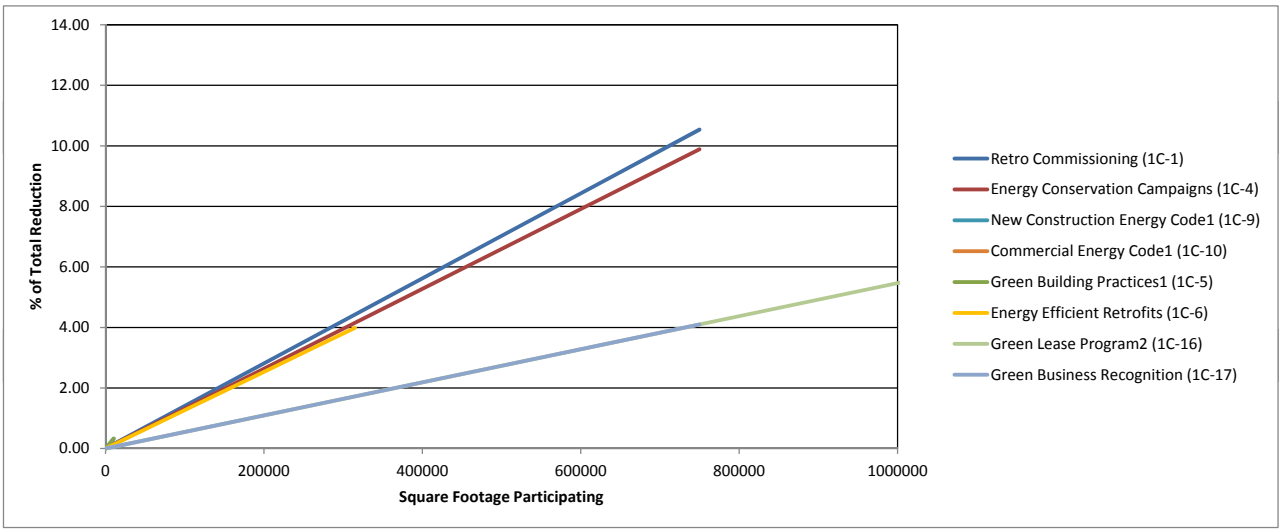
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	1725	1
0.04	3450	3
0.07	5175	4
0.09	6900	5
0.11	8625	6
0.13	10350	8

Green Lease Program[2] (1C-16)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
2.37	434650	137
4.75	869299	274
7.12	1303949	411
9.50	1738599	548
11.87	2173248	685
14.25	2607898	821

Green Business Recognition (1C-17)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.68	125000	39
1.37	250000	79
2.05	375000	118
2.73	500000	158
3.41	625000	197
4.10	750000	236



Notes:

1. The lines for Green Building Practices, Commercial Energy Code, and New Construction Energy Code are not visible due to their relatively small % reduction values.
2. The maximum % reduction that can be attained for Green Lease Program is higher than what is shown on the graph; See table above graph for the maximum % reduction.

Window AC Replacement (1D-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.0000	0	0
0.0003	8500	0
0.0007	17000	0
0.0010	25500	0
0.0014	34000	0
0.0017	42500	0
0.0021	51000	0

Efficient Boiler Replacements (1D-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	16000	1
0.04	32000	2
0.06	48000	3
0.08	64000	5
0.10	80000	6
0.12	96000	7

Efficient Chiller Replacements (1D-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.21	28500	12
0.43	57000	25
0.64	85500	37
0.86	114000	50
1.07	142500	62
1.29	171000	74

HVAC Fan Upgrades (1D-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.30	27038	17
0.60	54075	34
0.90	81113	52
1.20	108150	69
1.49	135188	86
1.79	162225	103

Natural Gas Heating Conversion[1] (1D-7)

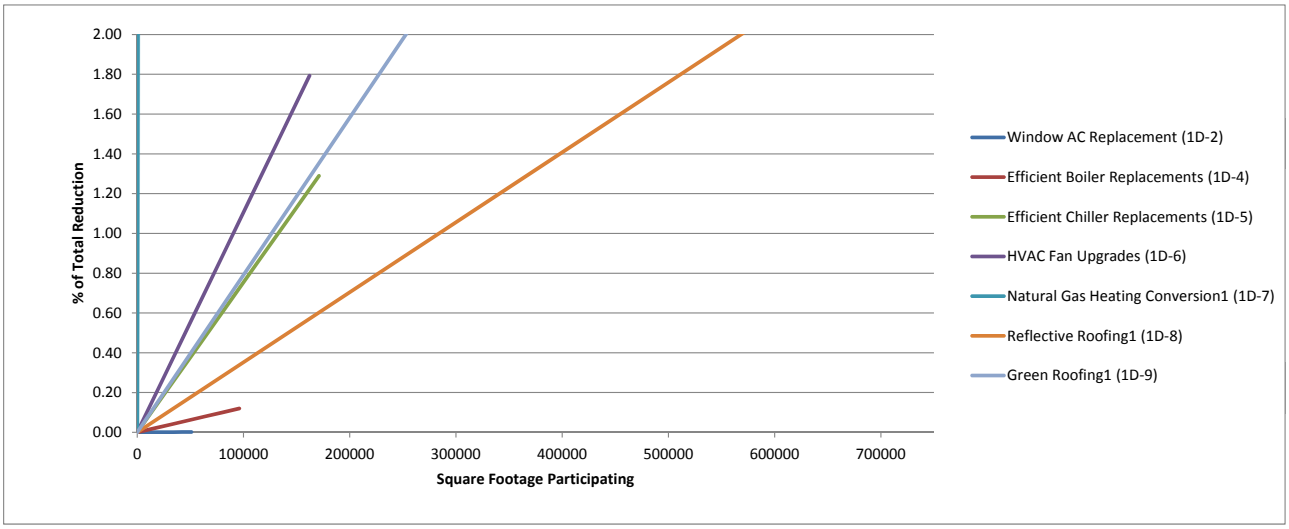
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
4.74	1667	273
9.48	3333	547
14.22	5000	820
18.96	6667	1093
23.70	8333	1367
28.44	10000	1640

Reflective Roofing[1] (1D-8)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.44	125000	25
0.88	250000	51
1.32	375000	76
1.76	500000	101
2.20	625000	127
2.64	750000	152

Green Roofing[1] (1D-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.99	125000	57
1.98	250000	114
2.97	375000	171
3.95	500000	228
4.94	625000	285
5.93	750000	342



Notes:

1. The maximum % reduction that can be attained for Natural Gas Heating Conversion, Reflective Roofing, and Green Roofing is higher than what is shown on the graph; See tables above graph for the maximum % reduction.

Solar Panels (2-2)

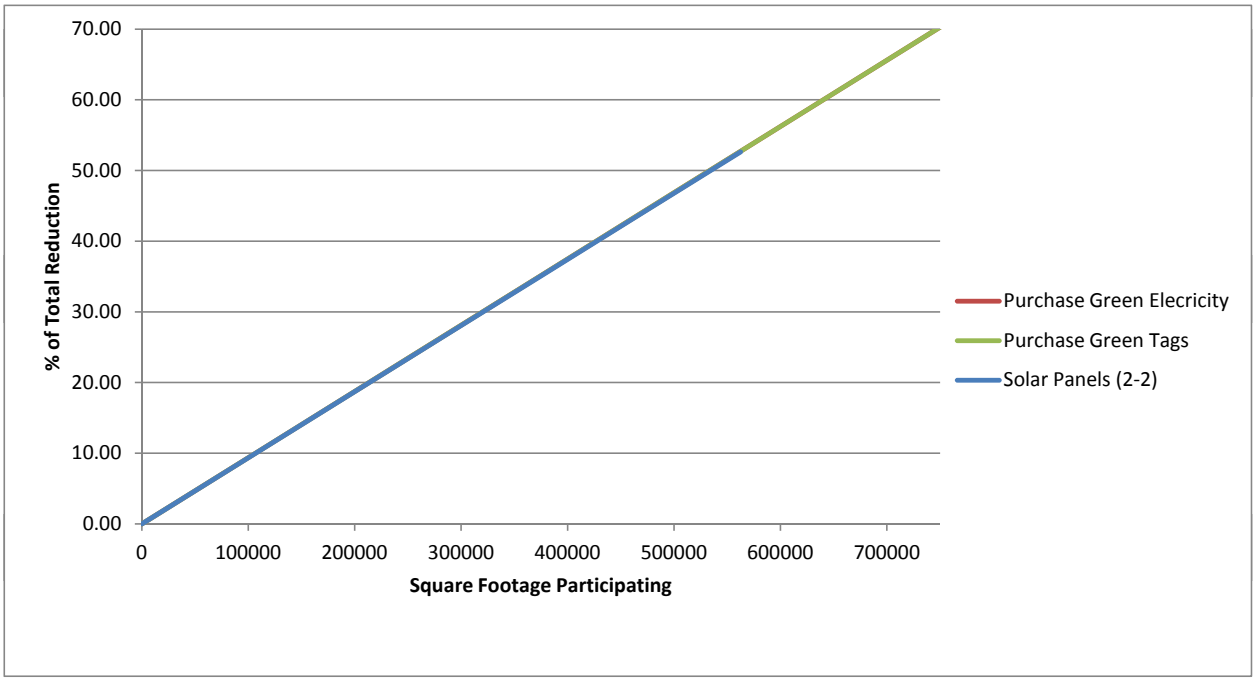
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
8.77	93750	506
17.55	187500	1012
26.32	281250	1518
35.09	375000	2023
43.87	468750	2529
52.64	562500	3035

Purchase Green Electricity[1] (2-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
11.72	125000	676
23.43	250000	1351
35.15	375000	2027
46.86	500000	2702
58.58	625000	3378
70.29	750000	4053

Purchase Green Tags[1] (2-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
11.72	125000	676
23.43	250000	1351
35.15	375000	2027
46.86	500000	2702
58.58	625000	3378
70.29	750000	4053



Notes:

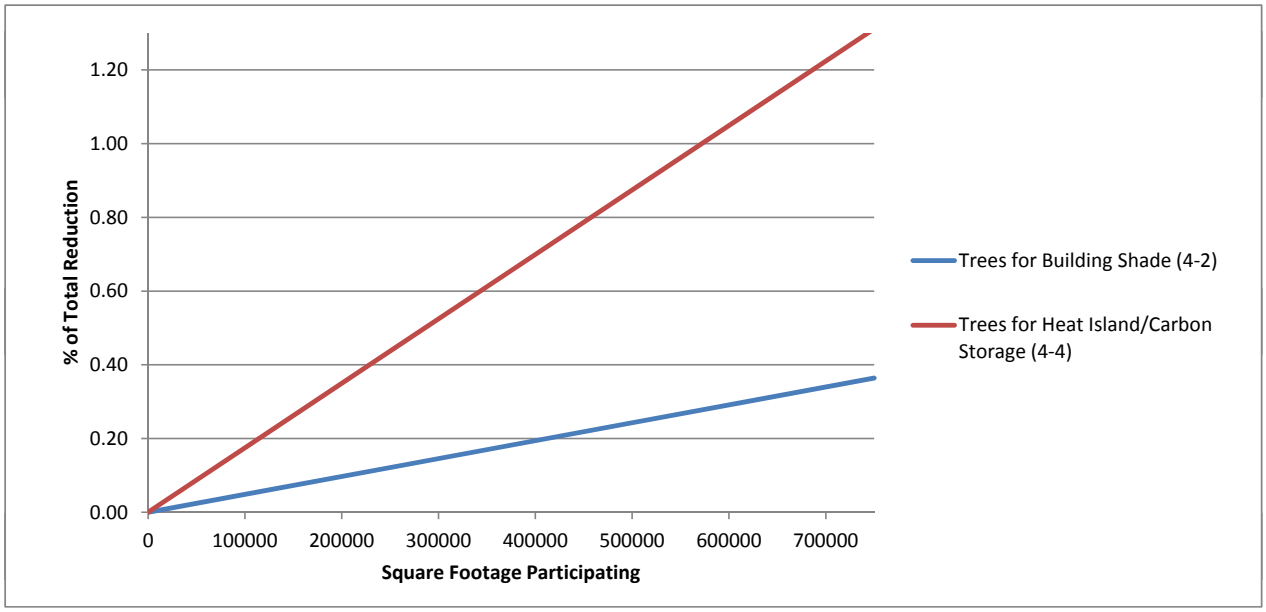
1. The graph does not show the line for Purchasing Green Electricty because the % reduction and square footage is the same as for Purchasing Green Tags.

Trees for Building Shade (4-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.06	125000	4
0.12	250000	7
0.18	375000	11
0.24	500000	14
0.30	625000	18
0.36	750000	21

Trees for Heat Island/Carbon Storage (4-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.22	125000	13
0.44	250000	25
0.66	375000	38
0.87	500000	50
1.09	625000	63
1.31	750000	76



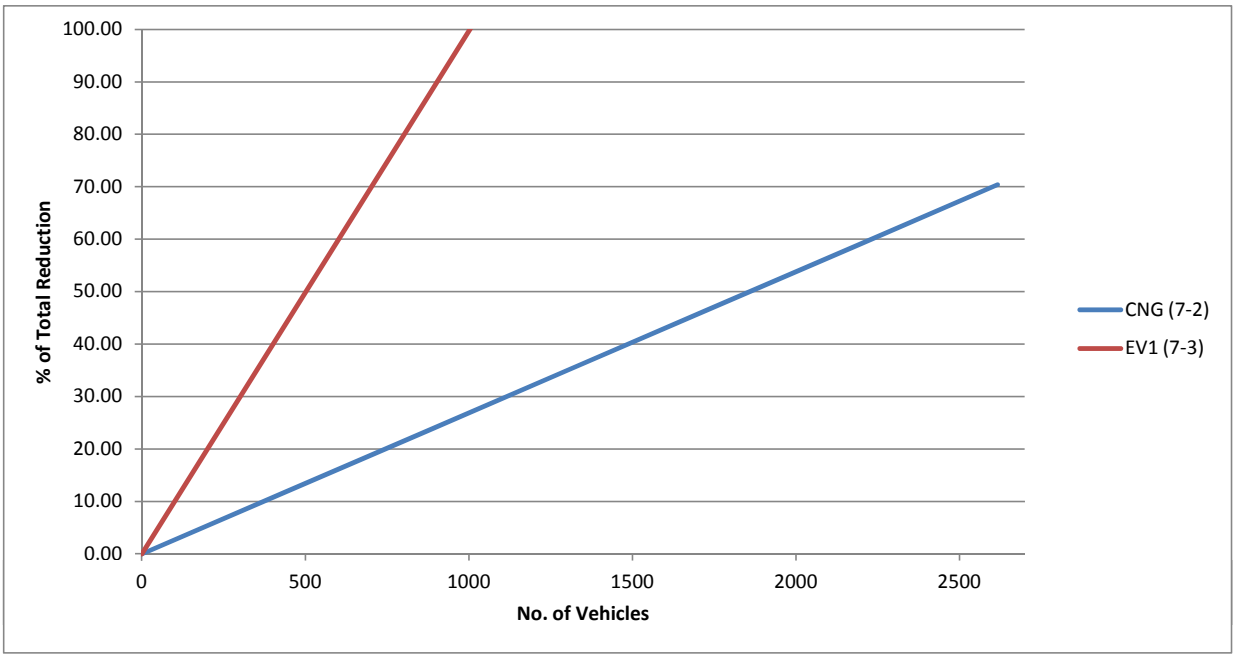
Community Transportation Curves

CNG (7-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
11.73	436	676
23.46	872	1353
35.20	1308	2029
46.93	1745	2706
58.66	2181	3382
70.39	2617	4059

EV[1] (7-3)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
43.51	436	2509
87.03	873	5018
130.54	1309	7527
174.06	1745	10036
217.57	2182	12545
261.09	2618	15054



Notes:

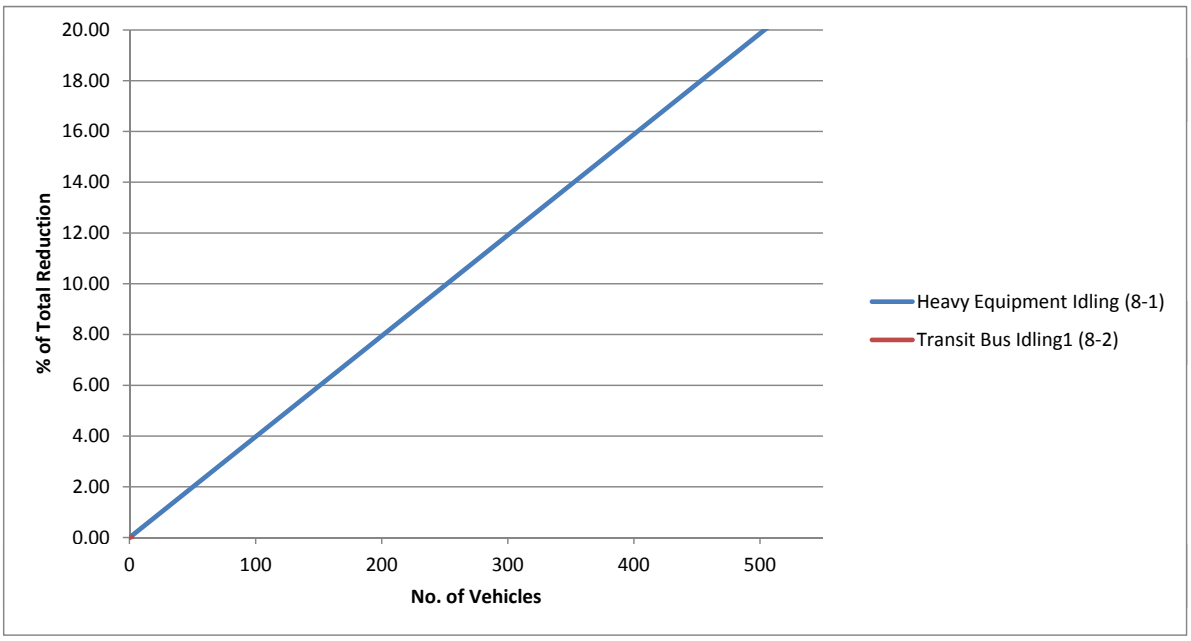
1. The maximum % reduction that can be attained for EV is higher than what is shown on the graph; See table above graph for the maximum % reduction.

Heavy Equipment Idling (8-1)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
3.46	87	200
6.92	174	399
10.38	261	599
13.84	349	798
17.31	436	998
20.77	523	1197

Transit Bus Idling[1] (8-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.00	0	0
0.01	1	1
0.01	1	1
0.02	1	1
0.02	2	1
0.03	2	2



Notes:

1. The line for Transit Bus Idling is not visible due to the relatively small % reduction potential.

Low Carbon Transp. EDU (9-1)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
4.00	877	231
8.00	1753	461
12.00	2630	692
16.00	3507	922
20.00	4383	1153
24.00	5260	1384

Mass Transit Ridership[2] (9-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
20.36	877	1174
40.72	1753	2348
61.07	2630	3522
81.43	3507	4695
101.79	4383	5869
122.15	5260	7043

Bus Ridership (9-3)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
8.42	873	485
16.84	1746	971
25.26	2619	1456
33.67	3492	1942
42.09	4365	2427
50.51	5238	2912

Transit Bike Policy (9-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
14.08	175	812
28.16	351	1624
42.24	526	2435
56.32	701	3247
70.39	877	4059
84.47	1052	4871

Free Student Bus Passes (9-6)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
1.19	98	68
2.37	195	137
3.56	293	205
4.74	391	273
5.93	488	342
7.11	586	410

Provide Bicycles (9-7)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.58	960	33
1.16	1921	67
1.74	2881	100
2.32	3841	134
2.90	4802	167
3.48	5762	201

Safe Routes to School[1] (9-8)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.21	181	12
0.43	363	25
0.64	544	37
0.86	725	49
1.07	907	62
1.28	1088	74

Expand Bus Service (9-9)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
5.30	873	306
10.60	1746	611
15.90	2619	917
21.20	3492	1222
26.50	4365	1528
31.80	5238	1833

Pedestrian Infrastructure (9-10)

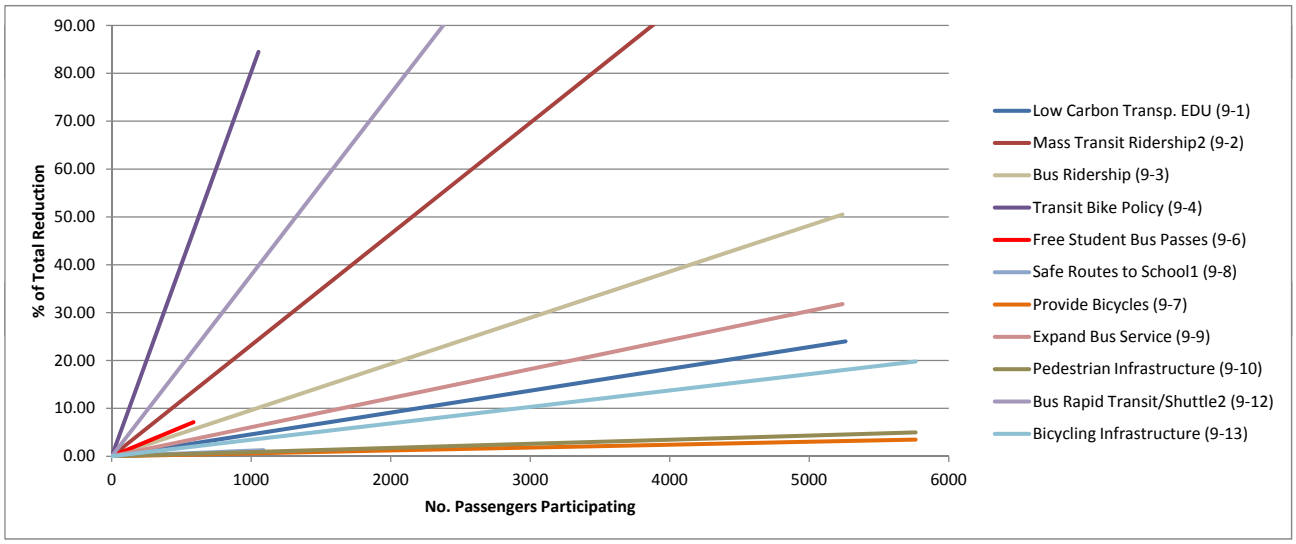
% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.83	960	48
1.67	1921	96
2.50	2881	144
3.33	3841	192
4.16	4802	240
5.00	5762	288

Bus Rapid Transit/Shuttle[2] (9-12)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
33.21	877	1915
66.41	1753	3829
99.62	2630	5744
132.82	3507	7659
166.03	4383	9573
199.23	5260	11488

Bicycling Infrastructure (9-13)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
3.30	960	190
6.60	1921	380
9.89	2881	570
13.19	3841	761
16.49	4802	951
19.79	5762	1141

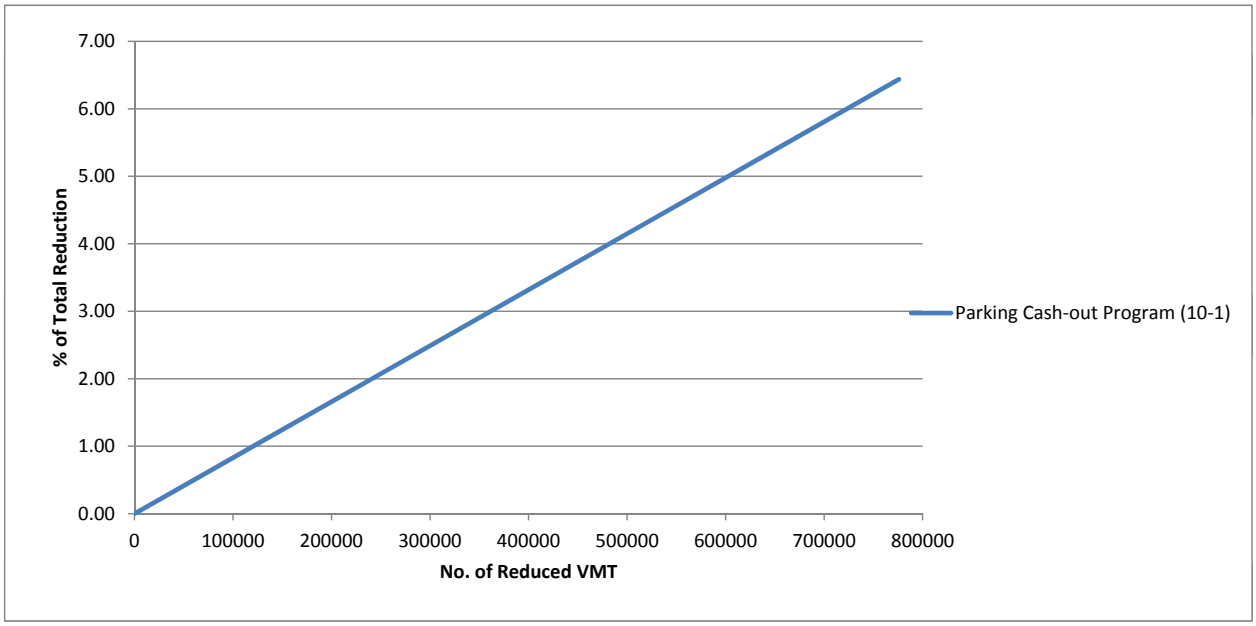


Notes:

1. The graph does not show the lines for Safe Routes to School due to the strategy's relatively small % reduction potential.
2. The maximum % reduction that can be attained for Bus Rapid Transit/Shuttle and Mass Transit Ridership is higher than what is shown on the graph; See tables above graph for the maximum % reduction.

Parking Cash-out Program (10-1)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
1.07	129313	62
2.15	258626	124
3.22	387939	186
4.29	517252	247
5.36	646565	309
6.44	775878	371

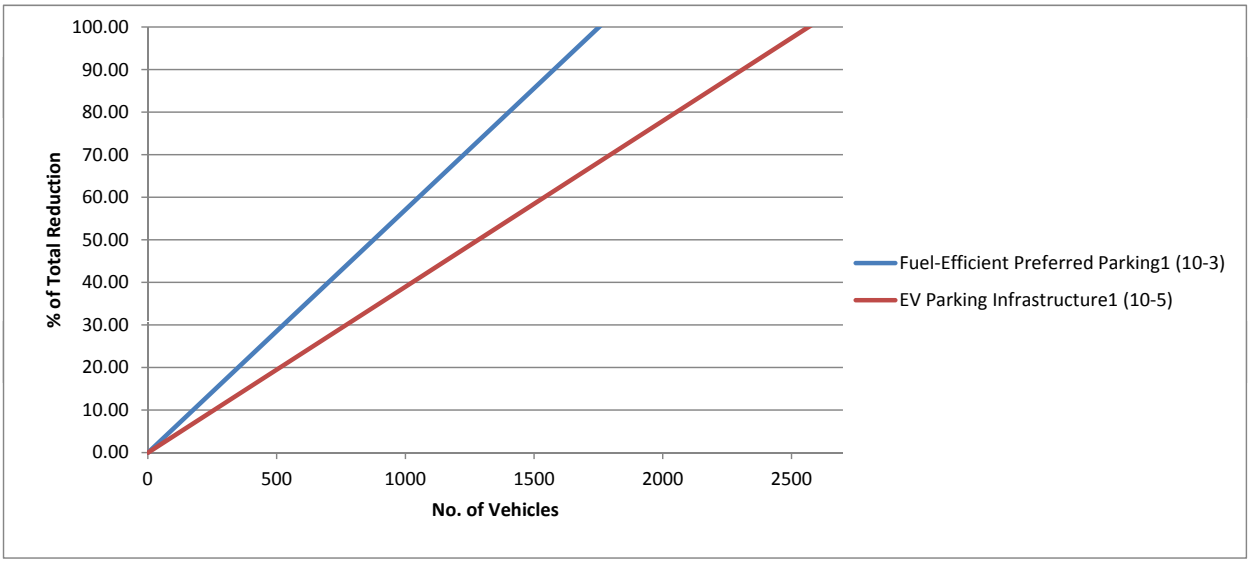


Fuel-Efficient Preferred Parking[1] (10-3)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
24.90	436	1436
49.80	873	2871
74.69	1309	4307
99.59	1745	5743
124.49	2182	7178
149.39	2618	8614

EV Parking Infrastructure[1] (10-5)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
17.00	436	981
34.01	873	1961
51.01	1309	2942
68.02	1745	3922
85.02	2182	4903
102.03	2618	5883



Notes:

1. The maximum % reduction that can be attained for Fuel-Efficient Preffered Parking and EV Parking Infrastructure is higher than what is shown on the graph; See table above graph for the maximum % reduction.

Municipal Transportation Curves

EV Conversion (18-1)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.38	4	22
0.76	8	44
1.15	12	66
1.53	15	88
1.91	19	110
2.29	23	132

Ethanol (E85) Conversion (18-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.33	4	19
0.65	8	37
0.98	12	56
1.30	15	75
1.63	19	94
1.95	23	112

CNG Conversion (18-3)

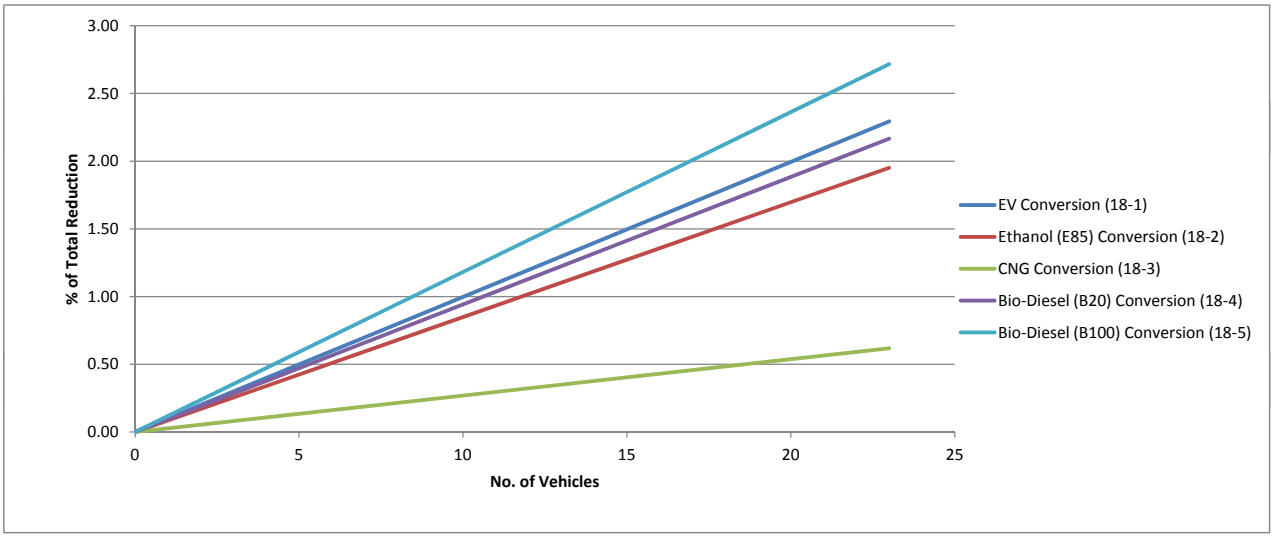
% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.10	4	6
0.21	8	12
0.31	12	18
0.41	15	24
0.52	19	30
0.62	23	36

Bio-Diesel (B20) Conversion (18-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.36	4	21
0.72	8	42
1.08	12	62
1.44	15	83
1.80	19	104
2.17	23	125

Bio-Diesel (B100) Conversion (18-5)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.45	4	26
0.91	8	52
1.36	12	78
1.81	15	104
2.26	19	131
2.72	23	157

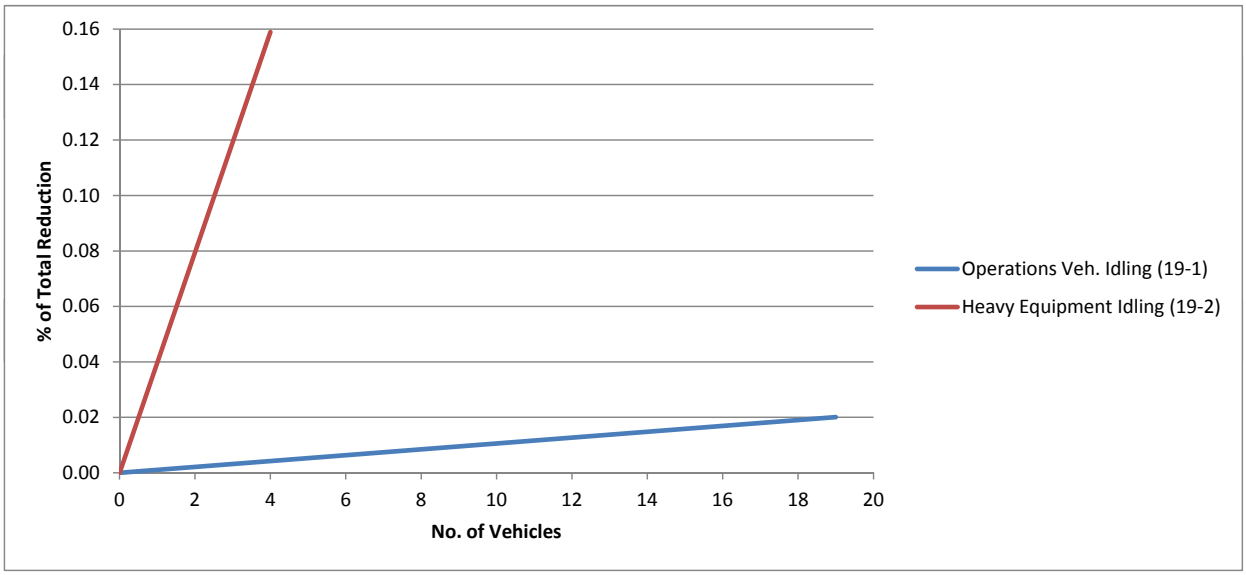


Operations Veh. Idling (19-1)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.00	3	0
0.01	6	0
0.01	10	1
0.01	13	1
0.02	16	1
0.02	19	1

Heavy Equipment Idling (19-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.03	1	2
0.05	1	3
0.08	2	5
0.11	3	6
0.13	3	8
0.16	4	9

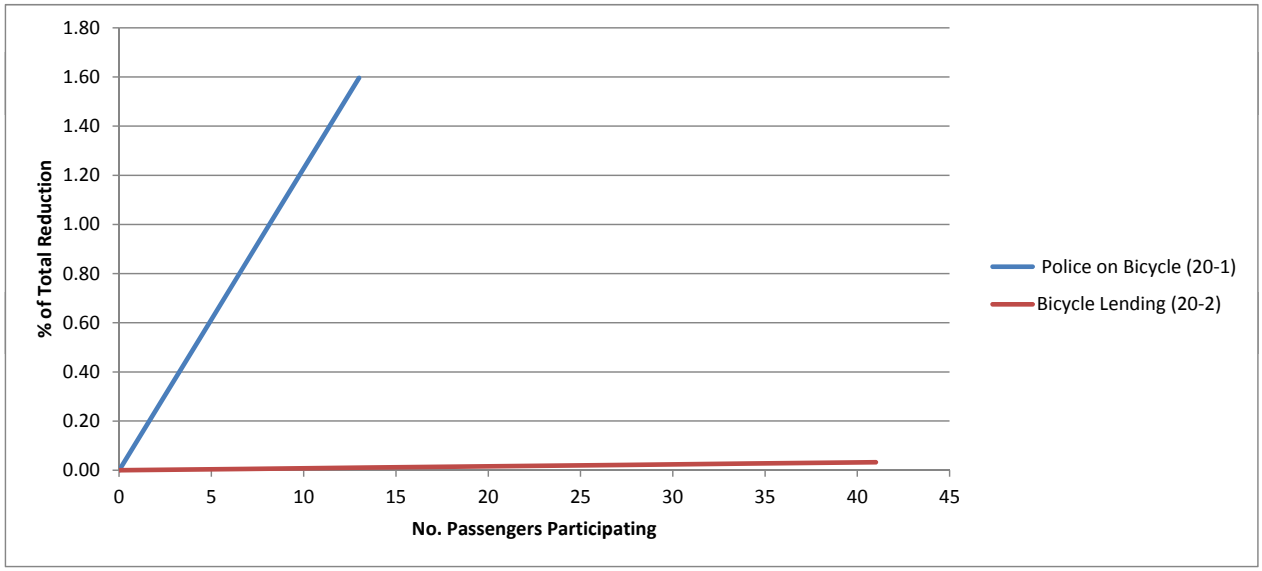


Police on Bicycle (20-1)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.27	2	15
0.53	4	31
0.80	7	46
1.06	9	61
1.33	11	77
1.60	13	92

Bicycle Lending (20-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.01	7	0
0.01	14	1
0.02	21	1
0.02	27	1
0.03	34	2
0.03	41	2

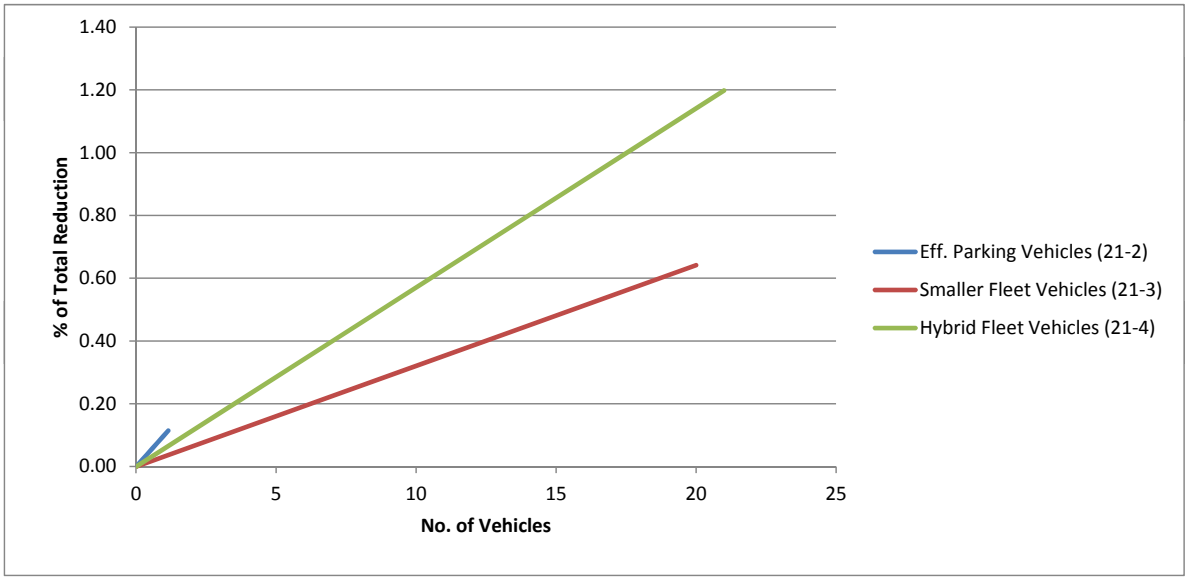


Eff. Parking Vehicles (21-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.02	0	1
0.04	0	2
0.06	1	3
0.08	1	4
0.10	1	6
0.11	1	7

Smaller Fleet Vehicles (21-3)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.11	3	6
0.21	7	12
0.32	10	19
0.43	13	25
0.53	17	31
0.64	20	37

Hybrid Fleet Vehicles (21-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.20	4	12
0.40	7	23
0.60	11	35
0.80	14	46
1.00	18	58
1.20	21	69