City of Woodland

Final Climate Action Plan

Technical Appendices

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Appendix A

Community Suggestions

Adopted May **2017**

Appendix A:

Community Suggestions

A listing of all community suggestions provided during the CAP development process through August 2012

Energy

New construction

- Require attic radiant barrier insulation on all new construction that is not part of the title 24 mandated insulation calculations; it would bring most attics up to R-50+.
- Require all new construction to incorporate 18-inch rafter tails above south and west windows to increase shade and reduce heat-producing solar gains.
- Cool roofs on all new construction.
- Set a date for zero carbon footprint in new homes and commercial buildings.
- Adopt energy-efficiency *standards for new construction* growth; the distances community members need to travel for essential services; and the ease or difficulty of different modes of travel.

Energy audits and retrofits

- Require older homes/businesses to become more energy efficient, and consider making low-interest loans available for upgrades.
- If a mandatory energy-efficiency policy is adopted, it should apply to all properties, including those that were built before 1978, rather than using property sale as a trigger. Form an AB 811 voluntary assessment district to provide a funding mechanism for energy-efficiency improvements.
- Program for retrofitting energy efficiency in existing buildings - insulation, appliances, lighting, etc.
- 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. Trained volunteers do home visits, install CFLs, turn down thermostats on hot water heaters, install electronic thermostats and go through a 20-point checklist on ways the homeowner can increase water and energy efficiency.
- With PG&E, develop an energy audit program for businesses that is tied to the city's business license program or is voluntary and promoted as a marketing tool for landlords. Create a repository for energy audit reports, searchable by property, to help with marketing of properties.
- Expand energy efficiency programs.
- Encourage commercial and residential uses to accomplish energy-use footprint/inventory and create reduction strategies.

Alternative building energy

- Encourage solar and wind installations.
- Encourage city and commercial businesses to use solar panels for power.
- Move toward a requirement or strong incentive to place photocells on homes and businesses.
- Rooftop solar on residential homes, apartments, etc. and commercial (private) buildings.

New construction - solar

- Require increasing percent of solar in new construction, both homes and commercial, with final goal being 100% of new construction to have solar.

- Solar required on all new homes or in new home developments.
- Solar ready homes.

Solar water heaters

- Solar water heater incentives.
- Solar water heaters for all!
- Solar hot water heaters required on new commercial/residential development.
- Solar water heaters available.
- Encourage solar hot water heater installations and or tankless/Point of Use hot water heaters for residents and businesses through rebate programs and negotiated purchases with manufacturers to utilize the economy of scale to reduce prices.

Large solar arrays

- Require solar on all new parking lots.
- Work with PG&E to install solar panels over car lots for auto dealers or other large parking lots that lack shade trees. By shading the sales lot, people will be more comfortable while browsing through a lot of new cars during the heat of the summer and shielded from rain during the rainy season.
- Work with PG&E to install solar panels on big box stores. These large horizontal surfaces could be put to beneficial use by having solar panels. Installing panels on the roof will benefit the store by shading the roof and therefore reducing the need for cooling the store in the summer.
- Have community solar facilities within Woodland. Allow apartment and other residents who can't have solar to participate in community solar.
- Conduct feasibility study for a city solar farm on city-owned property. Contributions for construction could be subsidized by subscription by interested homeowners. Participants would share in the benefits of generated electricity, including offsets to their electric bill. This will enable homeowners whose homes are not optimally configured for solar panels to invest in solar electricity and share the benefits. A city-owned solar farm could also be used to generate electricity for ball field lighting and other municipal uses.

City facilities and operations

- Require solar panels for shade structures in City-operated facilities, including parking lots.
- Sewer system solar farm.
- Install solar generation panels on Community Center roofs.
- Upgrade City structures with double-pane windows.
- City - Verify SEER rating of City AC units and, if below 14, consider replacement.
- Take advantage of PG&E subsidies for HVAC maintenance contracts in city buildings.
- Include demonstration installations at parks, shopping centers, etc.

Lighting

- Perform a comparative analysis of the modern ball field lights at Lee School and the existing lights at Clark Field. Upgrade the Clark Field light plant as needed to improve efficiency.
- Change city sign rules to encourage LED signs.
- Require certain percent of all lighting to come from natural light in buildings.

Landscaping equipment

- Incentives to change from gas to electric lawn equipment (battery).
- Incentives for commercial lawn care business to switch to electric.
- Some reward for using electric/battery-powered lawn mowers.
- Encourage commercial landscapers to switch from mow and blow to rake and sweep.

Permits and fees

- Building permits cheaper for energy-efficient new construction - and *much* more expensive for those that are not.
- Tax on gasoline.
- Permit process that expedites energy-conserving improvements.
- Adopt fees that encourage energy conservation.

Other

- Encourage PG&E to make more data available to homeowners from Smart Meters, such as real-time energy usage data.
- Suggest Pacific Coast Producers consider a small cogen that would power the operation and provide hot water for preheating existing heating sources.
- Promote radio use over television.

Transportation

Biking and walking

- More bike paths and green belts.
- More green belts: Create a whole secondary circulation system to get people out of, and away from, their cars.
- Make East Main Street walkable and bikeable.
- Improve downtown alleys to encourage walking and biking.
- Make the downtown area more attractive for walking/bicycling.
- Ensure that busy streets have safe pedestrian and bike crossings.
- Provide walking and bike routes to destinations such as malls, theaters, etc.
- Increase pedestrian safety and accessibility.
- To encourage walking, put signs in walking areas stating how far different destinations are.
- Make Main Street walkable: (a) All intersections have walk buttons to activate; (b) All intersections 4-way to encourage slow driving, increase business, and walking.
- Encourage pedestrian activity between downtown and nearby residential areas through reform of the downtown traffic pattern: 4-way stop signs, diagonal parking, enhancement of public space through streetscape improvements and promotion of a city square.
- Work with the Historic Woodland Downtown Business Association and the Chamber of Commerce to create a Park & Walk zone in the downtown.
- Work with school districts to encourage walking kids to school rather than driving kids to school.
- Stop driving kids to school.
- School busing in town is now being eliminated due to budget cuts. This is an opportunity to return to bicycle riding or walking to school.
- Require measures to increase biking/bikeability. Include: (i) Increased bike lanes (high class - esp. Class A) within the city, (ii) Complete off-road bike path between Woodland and Davis, (iii) Safe routes to schools, (iv) Bicycle safety instruction.
- Make our streets bikeable! - Designated bike paths, more bike parking and air stations, more 4-way stops and traffic calming, parallel streets one-way (e.g., Third and College), safe bike crossings.
- Create bikeway along south side of town as part of new water project (necessary to put in new water infrastructure to get water to southwest part of town).
- Bike path between Davis and Woodland.
- Where's the bike path between Woodland and Davis?
- Non-road bike path to Davis.
- Make bicycling safer.
- Better bike lanes and bike paths to make the town more bike friendly.
- Create more bike-friendly travel lanes to improve biking safety.
- Improved bike paths - more green belt/bike pathways to work and shopping areas.
- Create bike routes around town to foster the use of bicycles.
- Bike lanes.
- Bike-safe streets (lanes everywhere).
- Bike friendly - reconfigure one-way streets.
- Make Woodland more bike friendly.
- Dedicated bike paths.
- Create true off-street bike lanes.
- Make Woodland more bike friendly by installing more bike lanes and more racks.

- Provide more bicycle racks at retail to encourage bicycling.
- Bike racks required at commercial facilities.
- Recycle bikes that are dropped off at the dump.
- Create community programs to encourage bicycle recycling.
- Have how-to workshops for bike repairs.
- Reward bike riders $$ from gas-guzzler cars.
- Incentives for seniors to buy 3-wheeled bikes.
- Bike helmet give-away or discount to encourage bike use.
- Encourage Woodland elementary and junior high bicycle days.
- Promote an economic development collaboration with Davis for development of a bicycle trailer that can function like a car trunk for secure storage of items.
- Create a non-profit bicycle lending organization to operate with municipal assistance.

Mass transportation

- Light rail: Woodland to Sacramento. Amtrak: Woodland to Davis.
- Bus routes that connect easily to other public transport - i.e., one directly to Amtrak in Davis.
- Provide more public transit/buses.
- Additional bus routes that connect with shopping areas (especially at edges of town!).
- More public buses and routes and frequency.
- Redevelop bus routes & bus size to maximize use.
- Prioritize on basis of cost effectiveness.
- More "express" bus routes into Sacramento, at more varied times.
- Increase bus route variety.
- Promote mass transit use!
- Fund school buses.
- Resume bus service for school kids to provide alternative to parents driving their kids to school.
- Community shuttles to supplement buses.
- As our population ages, we will need some ways to help elders with shopping - shuttles for group trips?
- How about churches? Lots of traffic on Sunday mornings.

Other vehicle trip reduction

- Reduce duplicate traffic of public safety vehicles - one call often equals 4-5 vehicles.
- Encourage & reward carpool participants.
- Encourage less driving (organize city-sponsored bike fairs, alternative transport BBQ, etc.).
- Raise awareness - public relations campaign to encourage walking, biking, bus taking for doing errands, going to work, etc.
- Constrain or reduce parking.
- Increase connectivity for all modes of transportation.
- Have Zipcars (or something like that) to encourage people to reduce the number of vehicles they own.

Public fleets

- More electric vehicles for park and school maintenance.
- Encourage more alternative fuel usage for city partners or public safety vehicles (if available).
- City - buy smaller vehicles instead of hybrids. Use hybrids only if the vehicle gets high use.

Idling reduction

- Time lights on Main Street.
- Identify techniques to keep cars moving rather than idling at stop signs or lights. Introduce round-abouts.
- More traffic circles rather than 4-way stops.

Electric vehicles

- Find and encourage electric vehicle dealerships to locate in Woodland, provide incentives - i.e., reduce or eliminate city sales and property taxes for these businesses. Electric cars, trucks, bikes, scooters, etc.
- Electric car-charging stations.
- Electric bus transportation to UCD.
- Electric Vehicle charging stations throughout the city.

- Provide 'priority parking' for NEVs (Neighborhood Electric Vehicles) at businesses and on public streets.

Land Use

Compact and mixed-use development

- More mixed-use development where possible to reduce vehicle trips.
- Increase development density (especially along major transit routes).
- Compact mixed-use transit-oriented development.
- Revise commercial zoning to encourage development where residents get "what they need" nearer to home.
- Increase residential density in the downtown area – i.e., change zoning to encourage apartment units above commercial buildings.
- Encourage housing above retail (mixed use) to reduce travel.
- Encourage TRUE mixed use (housing over/near commercial, retail, public amenities).
- Incentivize high-density development and integrate related policies into an updated general plan housing element.

Commercial

- Create an innovation center as part of Woodland Business Park in northeast part of town.
- Put a grocery store on south side – e.g., at the mall.
- Develop downtown rather than relocating core business area.

Infill/redevelopment/centralization

- Infill development.
- Build homes on vacant lots and not outside of town on farmland.
- City policy to redevelop first. All incentives go to redevelopment. Decreased sprawl-related issues of export and water/waste movement.
- Reduce periphery development. Especially retail development since this would reduce long-distance trips.
- Encourage conversion of "poor" commercial centers to compact residential.
- Enforce the urban limit line (treat it as a long-term growth boundary, not a build-to line).
- Encourage businesses to have centralized locations rather than building on the edges of town.
- Encourage retail development in central areas of city (downtown) to help decrease trip length and encourage use of alternative forms of transportation, like biking and walking.
- Emphasize infill, especially near existing or planned public transit corridors – i.e., Transit Priority Areas within ½-mile walking distance to transit.
- Redevelop West Woodland to shorten the average trip time for residents.
- Shift housing development to smaller dwellings.
- Promote and enhance neighborhood commercial uses within both new and infill developments.

Transit-oriented development

- Discourage auto-centric development.
- Plan all new development with bus routes.
- Promote and enhance public transportation, such as Yolobus.

Energy-efficiency policies

- Update the zoning ordinance to provide standards for energy-efficient development.
- Look at industrial and commercial uses and development for energy-efficiency improvements; these types of land use can be a much greater source of pollution and energy consumption and therefore have the potential to achieve a much greater savings than housing.
- Provide incentives for live/work business licenses.

Non-building land uses

- Designate land for community gardens in new high-density developments.
- Community gardens in vacant lots.

- Put aside some land within the city for present and future renewable energy. Could be solar, biomass, some as yet undetermined method – Don't fill it all in with houses and buildings.
- Discourage installation of solar panels in place of vegetation. Green space helps to prevent climate change by removing CO_2. Installing solar panels where vegetation would otherwise exist are not as beneficial as solar panels over buildings or other hardscapes.

Other

Increased tree canopy

- Increase the requirements for tree coverage in parking lots.
- Plant and maintain trees in all currently unplanted street medians.
- More trees.
- Work with Woodland Tree Foundation to promote the City tree rebate program to increase the number of street trees.
- Be proactive in encouraging homeowners to plant trees in planting strips.
- Require all new home construction to include 2 shade trees per home on the east, west, or south face of the home to provide the most energy savings.
- Increase the requirements for street trees to shade asphalt and parked cars – cooler cars produce lower emissions, shaded asphalt requires less maintenance.
- Allow companies to plant trees as a means of carbon offset or donate funds to support Yolo County tree programs such as Woodland Tree Foundation, Sacramento Tree Foundation, City tree operations, Yolo RCD, etc.
- "City of Trees" should redouble its 70-year-old tree-planting program; City and Chamber should promote.
- Increase tree canopy to 40-50% of community (land mass) (recent city "canopy study" indicates 14% canopy).
- Partner with PG&E and Woodland Tree Foundation on major shade-tree program for homeowners to reduce energy consumption.
- City should heavily promote its $75 tree rebate program.
- More tree canopy will encourage more people to walk & ride bikes, reducing car trips and greenhouse gas emissions.
- Improve and fund Code Enforcement efforts for landscape and tree plantings in commercial developments.
- Become the best "Tree City" in California.
- Plant City surplus property in trees (Woodland Tree Foundation would donate some materials and labor).
- Focus on maintenance of mature trees that already provide energy benefits vs. planting new trees that will provide no benefit for many years.
- Tree planting for both cooling and sequestration of greenhouse gases.
- Adopt urban forestry program to sequester carbon in growing trees.
- Increase tree canopy: (a) Maintain current trees, (b) Plant and maintain new trees, (c) Design parking lots better to provide shade and/or solar energy, (d) Encourage trees growing near residences to increase shade and decrease air conditioning needs.
- Adopt urban forestry.
- Explore adopting urban forestry program to sequester carbon and selling of emissions offsets when cap and trade program is adopted.

Water-efficient landscaping

- Transition street plantings from grass to water-efficient ground covers such as *Myoporum parvifolium* or other drought-resistant plants to reduce water and maintenance.
- Require all city trees and plantings to be water wise, preferably California natives.
- Master tree list should be more appropriate for our climate. Why are redwoods recommended?
- Allow people to remove large, grassy lawns and replace with appropriate low-water using plants and shrubs.
- In all new construction, only allow XXX% of landscaping to be grass.

- Reduce water usage and energy associated with water pumping by emphasizing native landscaping (drought-tolerant) at city-owned property. [This suggestion was seconded.]
- Water conservation to reduce energy use. Use of low-water-use landscaping or irrigation efficiency and plant selection.

Other water conservation and reuse

- City and school irrigation improvements.
- Require purple pipes to be installed in all new construction.
- Begin the process of how to use this better (2016) water as gray water.
- Use recycled and gray water for irrigation.
- New construction to include wise use and recycling of gray water.
- Rainwater capture: Require certain percentage of all water in new buildings to come from rainwater capture.
- Wasted shower water plumbed directly to toilets and landscape irrigation.

Reduced stormwater pumping

- Require permeable materials in all new parking lots.
- Use permeable paving such as pavers on sand, in street repairs at crosswalks and elsewhere.
- Maximize plantings in storm water basins.
- Encourage city and commercial buildings to install roof gardens.

Incentives for energy- and water-efficient practices

- Find a way to link valuation of homes to how much water is needed to maintain the landscape.
- Conduct voluntary water-audit programs and issue a certificate upon completion to property owners that can be used in marketing a property.
- Real estate agents and Chamber of Commerce create programs to promote the green certified program and help businesses become certified.
- Use permit streamlining, reduced fees, and other inducements to encourage voluntary adoption of green building standards, such as LEED and Build It Green, and to realize energy-efficiency goals.
- Expedite and reduce permit cost for south and west patio covers that shade windows or interior walls as well as low-e window replacements.
- Allow development fee offsets for additional insulation in new construction.
- Waive permit fees for additional insulation in new construction.
- Streamline approval process for facilities and projects that will result in reduced greenhouse gas emissions.
- Offer incentives for City departments that reduce energy use by a specified amount (5, 10, or 15 percent).

Waste reduction

- Encourage more residential composting.
- Encourage composting.
- Green waste composting.
- Ban plastic bags.

Buy local

- Provide economic development money for more stores on Main Street; diverse good to sell!!
- Woodland scrip to encourage local purchases.
- Encourage consumption of locally produced goods, services, food and fiber to reduce "miles travelled to the market" by providing on-line "shopping tool." "Woodland scrip"?
- Emphasize purchase of locally produced products, especially food.

Energy-upgrade financing

- Allow homeowners to pay off solar installation through a surcharge on their property tax assessments or utility bills to spread out the cost over a number of years and ease the financial burden.

Education

- Raise awareness about the need to promote alternative transportation modes: Ask community leaders to announce in public forums "in an effort to help reduce CO_2 emissions, I biked/walked/rode the bus/car pooled to this meeting today." Tie it to doing a civic duty to help the community. Encourage the newspaper to write about this. Hand out stickers (similar to "I voted") to all who used alternative transportation. Hand them out at shopping centers, etc.
- Include school district to look at education and projects for K-12 regarding CO_2 projects. Additional classroom outreach to teach children sustainable life principles.
- Education (posters) (speakers) at schools, Fourth of July. Make it a patriotic thing to use less fossil fuels. [This suggestion was seconded.]
- More workshops on drought-tolerant plants.

Miscellaneous

- Encourage drive-through restaurants to reconfigure procedures: From the car, you place an order, pay the bill, and take a number; then, park and wait for the food to be brought to you in a special waiting area.
- Do away with fireworks and the associated pollution.
- We seriously have to crack down on 'gross polluters' - autos that have either had their catalytic converters removed or on which maintenance is not being done. Same goes for landscaping equipment, especially leaf blowers.
- Developer fees to pay for bike routes, bus lines.
- Reduce population.
- Stop voting for politicians who support energy wars.
- Restore existing buildings instead of removal and replacement.
- Create community gardens to promote healthy living, organic micro farming and community involvement.

Appendix B

2020 Climate Action Plan Technical Report

Adopted May **2017**

Climate Action Plan
Technical Report
City of Woodland

FINAL REPORT

DECEMBER 2012

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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 (GHG) 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 GHG emissions to 15% below the 2005 baseline by 2020.

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 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, water supply and wastewater treatment, wastewater reuse, and transportation. 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]

Warming of the atmosphere is known as the greenhouse effect and the heat-trapping gases are known as greenhouse gases. 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

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

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 GHG-related 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 of projects 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: CO_2, 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 Chapter 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 Area Council of Governments (SACOG), the United States Census Bureau (US Census), and the City of Woodland. 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 – IA5 (Baseline Inventory) and IB1 – IB6 (BAU Forecast Inventory).

2 Baseline Inventory, 2005

In 2005, the City emitted approximately 680,224 metric tons of CO_2e, including all emissions estimated[2] across five sectors: residential/commercial energy use; transportation; water and wastewater; municipal energy use and transportation, and wastewater reuse. Of those, 544,145 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*
- *Emissions from wastewater reuse*

- 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. The emissions from these activities are outside the scope of the inventories included in this report because the City has limited control over landfill practices, which are the major source of solid waste-related GHG emissions and are already addressed in Yolo County's climate action plan. However, because the City has

[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.

an important role in influencing solid waste generation by promoting conservation and recycling measures, these efforts are included in the City's overall climate action strategy, as discussed in later sections of this report.

In 2005, of the total reportable community-wide emissions, the residential and commercial energy use and transportation related sectors accounted for just over 98% of emissions, with municipal emissions (from municipal energy use and water and wastewater treatment) comprising just under 2% of emissions (Figure 1, Table 2). Transportation emissions generated by vehicle travel (gasoline and diesel) constituted by far the most significant portion of reportable emissions (68%).

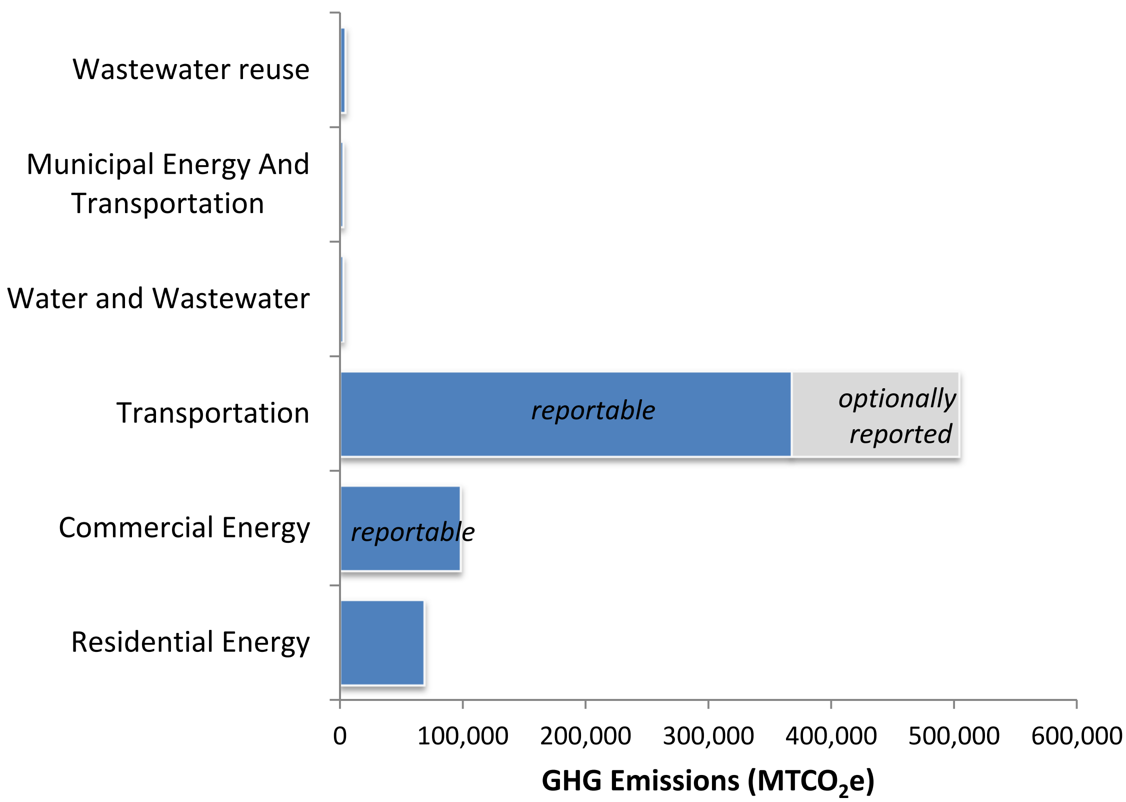


Figure 1. 2005 GHG Inventory

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

Sector	$MTCO_2e$	%
Residential Energy Use Commercial Energy Use	68,704 98,155	30.7
Transportation (excl optionally reported emissions)	367,567	67.5
Water and Wastewater	2,666	<1%
Municipal Energy Use and Transportation	2,676	<1%
Wastewater Reuse	4,377	<1%
Total GHG Emissions	**544,145**	

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).

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	1.10%
US Census	1.61%
SACOG	0.94%

Technical details can be found in Appendix 1B.

Box 1. Population Scenarios

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 lower than either the US Census estimate or the estimate provided by DOF. Using higher population estimates is a more conservative approach; if population growth is lower, GHG emissions will also typically be lower. However, the results presented in this Chapter are based on estimates of future population derived from SACOG data. This approach maintains consistency with other City planning documents and with regional estimates, which is particularly important 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 3.5%, from 544,145 $MTCO_2e$ to 562,987 $MTCO_2e$ (Tables 2 and 3). The share of the total reportable community emissions inventory comprising transportation GHG emissions declines slightly from 67.5% of to about 63.9%, as reportable transportation emissions decrease by approximately 7,919 $MTCO_2e$ (Figure 2, Table 3). The GHG emissions for residential/commercial energy use and municipal energy use increase as do emissions for water and wastewater and wastewater reuse. On a per capita basis, GHG emissions decrease slightly from 10.4 $MTCO_2e$ per person to 9.0 $MTCO_2e$ per person. This is consistent with expectations from regional analyses and 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.

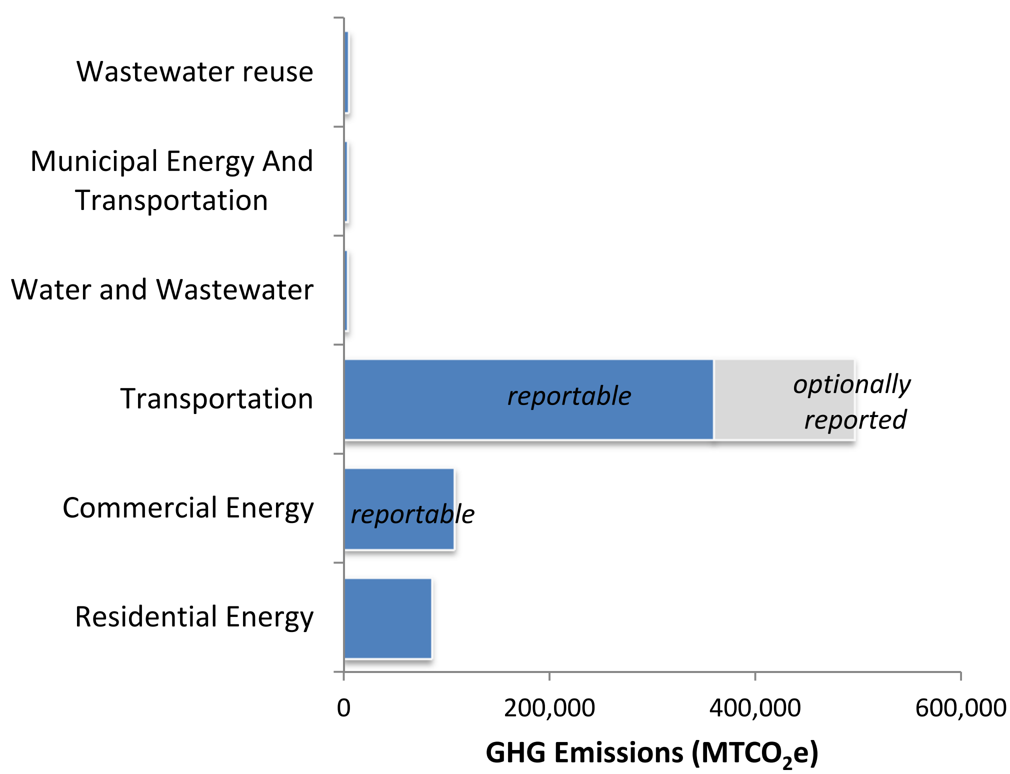


Figure 2. 2020 GHG Inventory

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

Sector	$MTCO_2e$	%
Residential Energy Use	85,131	33.9
Commercial Energy Use	106,955	
Transportation (excl optionally reported emissions)	359,648	63.4
Water and Wastewater	3,349	<1
Municipal Energy Use and Transportation	3,345	1.4
Wastewater Reuse	4,559	<1
Total GHG Emissions	**562,987**	

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.

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

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 yields a reduced emissions target of 462,523 $MTCO_2e$, which is 18% 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 have already been incorporated into the transportation 2020 BAU projection; both measures affect the emissions generated by light duty vehicles.[8]

[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

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 60,165 $MTCO_2e$ (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)	**544,145**
1990 Target (15%<2005)	*462,523*
BAU Forecast (2020)	**562,987**
Adjustment for RPS (State)	*-40,298*
Net Reduction Required	**60,165**

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 the formulation of potential climate action strategies that might be suitable for implementation. The 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, we also collected information on costs and potential savings. 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).

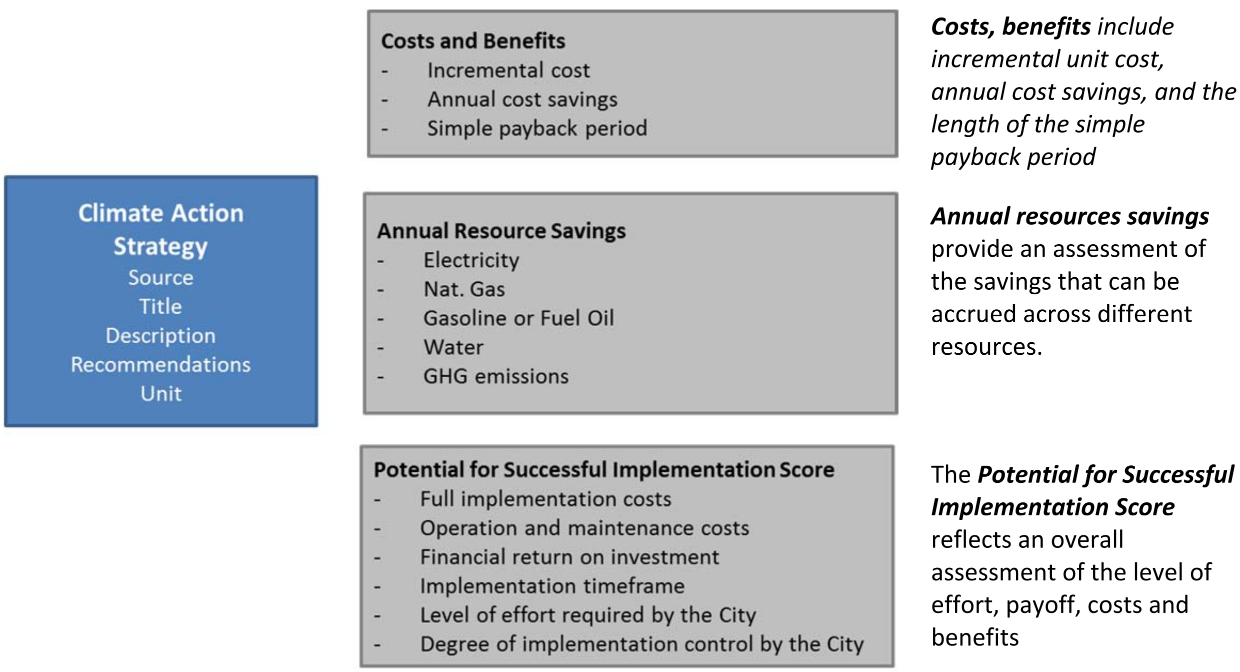


Figure 3. Evaluation information available for each strategy in the electronic Appendix II1.

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

ID	Source	Title	Strategy Description	Community Recommendatic	Definition of Unit	Incremental Cost[2] ($/unit)	Annual Cost Saving[3] ($/unit/yr)	ple Payback Period[4] (yrs)	Electricity (kWH/unit/yr)	Natural Gas (therm/unit/yr)	GasolineFuel Oil (gal/unit/yr)	er (gal/unit/yr)	GHG emission[5] (mtCO2e/unit/yr)	al Implementation Cost[6]	ration & Maintenance Cost[7]	ancial Return on Investment[8]	lementation Timeframe[9]	el of Effort Required by City[10]	of Implem. Control by City[11]	erage Potential Score[12]
Reduction Strategy						**Costs & Benefits[13]**			**Annual Resource Savings[13]**					**Potential for success[13] (5 = Desirable**						
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	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 =
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	
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	

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 particaption 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 Woodland 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)
Residential and Commercial Energy Use	Increase use of low-carbon energy sources	Electricity Generation and Procurement (2)
Residential and Commercial Energy Use	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)
Transportation Energy Use	Reduce vehicle miles traveled	Transit and Bike/Ped (9), Parking (10), Land Use (11), Carpool and Rideshare (12)
Transportation Energy Use	Increase use of low-carbon energy sources	Transportation Fuels (7)
Municipal Emissions Reductions[10]		
Municipal Energy Use	Reduce building energy consumption	Lighting (15A), Appliances (15B), Comprehensive Improvements (15C), Temperature Control (15D), Miscellaneous (14)
Municipal Energy Use	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)
Municipal Transportation Energy Use	Reduce vehicle miles traveled	Transit and Bike/Ped (20), Miscellaneous Transport (22)
Municipal Transportation Energy Use	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)
Municipal Water Supply and Wastewater Treatment	Reduce emissions from wastewater treatment and reuse wastewater	Wastewater (24)

Figure 7. Bundles and corresponding sectors and objectives.

[10] A waste reduction bundle has also been prepared, however, since waste was not included within the scope of the report (see page 8), it is not included in the table.

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 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 <u>not</u> 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:

- <u>PG&E Data and Reports:</u> 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 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.

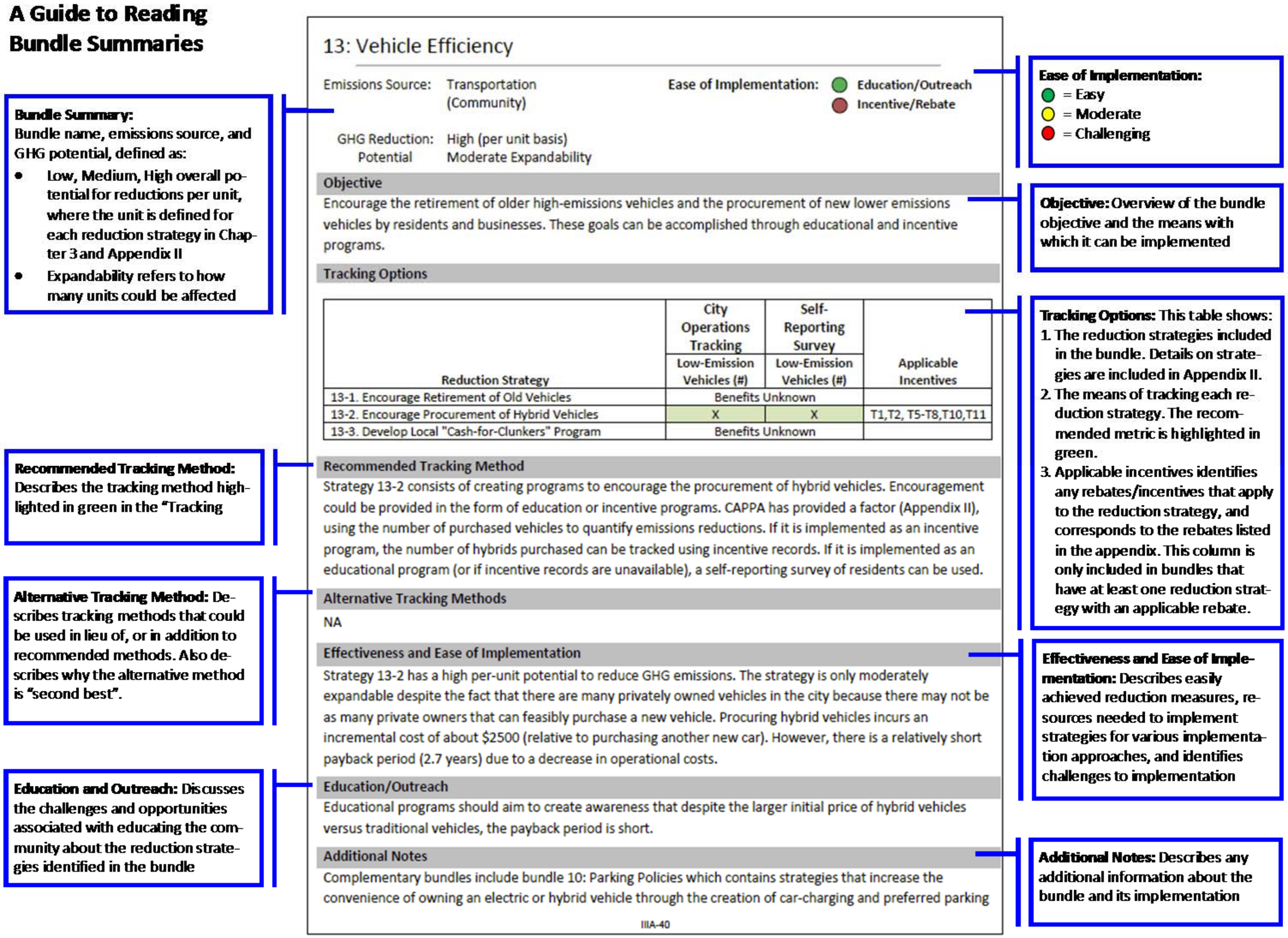
Whichever metrics the City collects, it is desirable to track each metric initially and regularly over time. An initial measure can provide a baseline before additional action is taken, and as the City takes action future measures of the same metric can provide a time trend that can inform the City and 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.



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

IIIA-40

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 target. 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 (16-4, 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), and aeration system retrofits (24-5).

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 and 9-14), 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 (12-3), 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 22: Transportation Miscellaneous: Strategy related to telecommuting and non-asphalt pavements
- 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.

List of Electronic Appendices

Appendix IA: 2005 Baseline Inventory:

Appendix IA1: 2005 Inventory Municipal Energy Calculations

Appendix IA2: 2005 Inventory Residential/Commercial Energy Calculations

Appendix IA3: 2005 Inventory Transportation Calculations

Appendix IA4: 2005 Inventory Water and Wastewater Calculations

Appendix IA5: 2005 Inventory PCP Calculations

Appendix IB: 2020 BAU Forecast:

Appendix IB1: 2020 BAU Municipal Energy Calculations

Appendix IB2: 2020 BAU Residential/Commercial Energy Calculations

Appendix IB3: 2020 BAU Transportation Calculations

Appendix IB4: 2020 BAU Water and Wastewater Calculations

Appendix IB5: 2020 Population Calculations

Appendix IA6: 2005 Inventory PCP Calculations

Appendix II: Reduction Strategies:

Appendix II1: Reduction Strategies

Appendix IV: Participation Curves:

Appendix IV1: Residential Tradeoff Worksheet

Appendix IV2: Commercial Tradeoff Worksheet

Appendix IV3: Community Transportation Tradeoff Worksheet

Appendix IV4: Municipal Transportation Tradeoff Worksheet

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 Woodland 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 Woodland City limits with the exception of Yolo County operational emissions, which we exclude because they are tracked and controlled by the County. The full Woodland 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 Woodland. *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.

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[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 Woodland, with the exception of Woodland 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 Woodland. 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 dataset 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 Woodland in 2005[2] and the number of businesses in Woodland in 2007 (US Census Bureau 2012). These numbers are on the same order of magnitude, differing by 3% and 50% for

[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 – 2007 average household size for Woodland from the US Census American Community Survey [US Census Bureau (2007). ACS Demographic and Housing Estimates: 2005 - 2007. 2005 -2007 American Community Survey 3-Year Estimates]

residential and commercial units respectively. We perform a similar check for natural gas use, yielding 11% 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.

We note that electricity use declined by about 8% from 2009 to 2010, primarily due to declines in commercial use. According to PG&E, this is largely attributable to a decline in the number of commercial customers (rather than a decline in usage per customer)[3] (pers. comm. from Jillian Rich of PG&E 2012).

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. per kilowatt-hour of electricity produced or therm of natural gas used). 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[4]	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	1/2204.64	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

[3] The number of Agricultural Manufacturing and Transportation, High Tech, Healthcare, Hospitality, Food Processing, and Retail customers dropped from 2009 to 2010.
[4] 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[5]

Year	Annual Electricity Use (kWh)				Electricity Emissions Factor (lb CO_2/kWh)	Annual Natural Gas Use (therms)				Natural Gas Emissions Factor (lb CO_2/therm)
	Residential		Commercial			Residential		Commercial		
	Non-Government	District	Non-Government	District		Non-Government	District	Non-Government	District	
2003	127,588,039	0	179,934,287	9,343,979	0.62	7,307,765	0	9,470,058	262,890	11.7
2004	133,002,148	0	176,280,736	9,912,890	0.566	7,785,214	0	10,418,576	276,364	11.7
2005	**133,260,950**	**0**	**178,242,924**	**10,484,550**	**0.489**	**7,311,220**	**0**	**10,171,817**	**343,411**	**11.7**
2006	139,045,120	1,575	181,904,154	10,148,722	0.456	7,514,460	177	10,523,809	461,296	11.7
2007	136,153,807	5,863	177,979,122	10,756,865	0.6357	7,428,621	481	10,679,227	467,361	11.7
2008	141,024,621	6,758	176,753,861	10,307,617	0.641	7,749,985	488	10,947,260	538,389	11.7
2009	144,905,739	8,672	177,597,575	8,968,777	0.575	8,021,204	547	11,227,089	366,061	11.7
2010	138,015,024	9,059	158,359,474	6,946,198	0.559	8,128,861	704	11,358,908	275,622	11.7

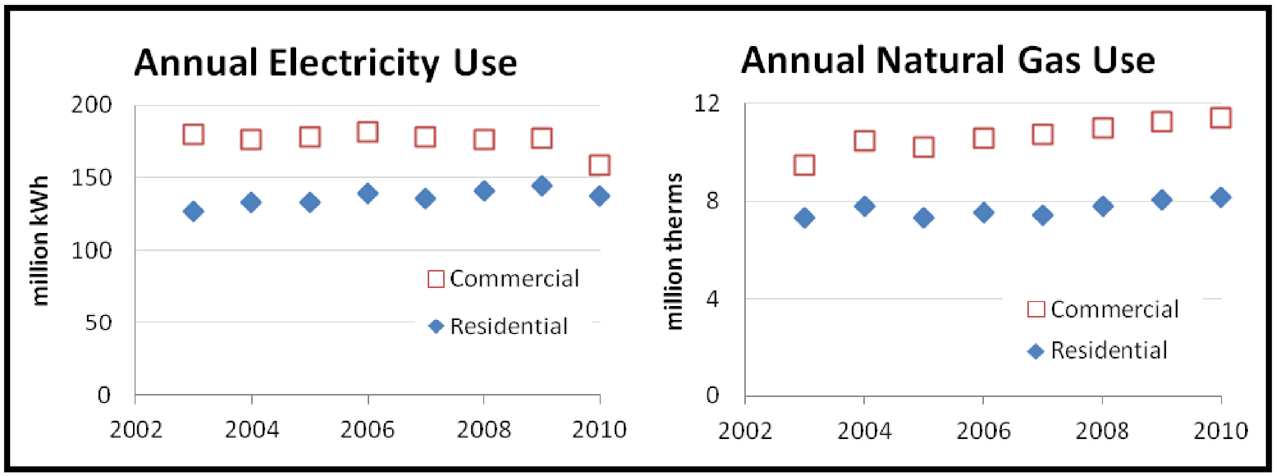

Figure 1: Historical electricity and natural gas use in the City of Woodland.

[5] This table shows summaries of information provided by PG&E [pers. comm. from John Joseph (2011). Community Wide Inventory Report City of Woodland 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.

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

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	MT N_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 those estimates which are calculated by PG&E and provided to communities. Our estimated 2005 CO_2 emissions are nearly identical to those provided by PG&E.

Table 2: 2005 baseline results for residential and commercial electricity and natural gas use by residents, businesses, and district governments[6]

	Electricity (kWh)		Natural Gas (therms)	
	Residential	Commercial	Residential	Commercial
Total energy use (kWh or therms)	133,260,950	188,727,474	7,311,220	10,515,228
Emissions factor (lbs CO_2/kWh or lbs CO_2/therms)	0.489	0.489	11.7	11.7
PG&E reported CO_2 emissions ($MTCO_2$)	29,558	41,862	38,801	55,806
CO_2 emissions ($MTCO_2e$)	29,558	41,861	38,801	55,805
N_2O emissions (MTCO2e)	206	292	23	33
CH_4 emissions (MTCO2e)	38	54	77	110
Total emissions (MTCO2e)	**29,803**	**42,207**	**38,901**	**55,948**

Comparative Analysis

To check for egregious estimation errors, we compare the magnitude of emissions from the City of Woodland to emissions from a city of a comparable size: Menlo Park, CA, located in San Mateo County.

[6] Calculations are in the "Calc.EnergyAndEmissions" tab of the "AppendixIA2_2005Invenory_ResidentialCommercial_WD.xlsx" file, hereafter referred to as the Residential and Commercial energy excel file.

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 population of Menlo Park in 2005 was 30,355, or roughly 60% of Woodland's 52,474 (California Department of Finance 2011). Therefore the residential emissions are approximately 1.3 and 1.8 $MTCO_2e$/person in Woodland and Menlo Park respectively. According to the US Census Bureau quick facts, the number of firms in Woodland in 2007 was 4,194 (US Census Bureau 2012), while in Menlo Park it was 4,691. Thus, the commercial emissions in Woodland and Menlo Park (assuming that the firm counts were similar in 2005) are roughly 23.4 and 31.5 $MTCO_2e$/ firm respectively. On a per unit basis, the emissions of Menlo Park residents and businesses are roughly 29% and 26% (respectively) greater than those of Woodland. Menlo Park's Climate Change Action Plan does not provide detail about how the inventory numbers are calculated, making it difficult to engage in more detailed comparisons of the methods employed.

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 are unable to obtain local rail emissions data so we exclude it from the inventory. We also 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[7] into vehicle types described in SEEC guidance (Statewide Energy Efficiency Collaborative 2011). We also add a "Non-Transit buses[8]" 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[9] (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[10] 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

[7] As shown in the tab titled "calc.OnRoad_VehicleCategories" in the AppendixIA3_2005Inventory_Transportation_WD.xlsx excel file, hereafter referred to as the Transportation excel file.
[8] Includes school buses, motor coaches, and motor homes.
[9] Data from EMFAC is available in the tabs titled "raw&calc.OnRoad_EMFAC 2011", and "calc.OnRoad_EMFAC 2007" in the Transportation excel file.
[10] 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.).

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 presents this information.

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 Woodland, their miles accrued and compressed natural gas (CNG) consumed[11]

Route #	Miles accrued per week [12] (miles/ week)	Miles accrued per year [13] (miles/ year)	Fuel Efficiency [14] (miles/ therm)	CNG Consumed [14] (therm/ year)[15]	CNG Consumed [14] (ft^3 / year)[16]
42a	923	47,996	3.76	12,765	1,242,930
42b	975	50,700	3.76	13,484	1,312,954
210	744	38,688	3.76	10,289	1,001,885
211	1,166	60,611	3.76	16,120	1,569,620
215	536	27,846	3.76	7,406	721,115
216	28	1,435	3.76	382	37,167
217	19	998	3.76	266	25,855
242	69	3,588	3.76	954	92,917
45	473	24,570	3.76	6,535	636,278
Total:		**256,433**			**6,640,722**

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

12 We estimate weekly mileage using route information from the Yolobus website for all local and pass through routes through the City of Woodland. We exclude route 212 and 214 because they were inactive in 2005, as per personal communication with Erik Reitz (ereitz@yrcd.org), Associate Transport Planner, Yolo County Transportation District.

13 $Miles\ accrued\ per\ week * \left(\frac{52\ weeks}{year}\right) = Miles\ accrued\ per\ year$

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

15 $\frac{(Miles\ accrued\ per\ year)}{(Fuel\ Efficiency)} = CNG\ Consumed\ \left[\frac{therms}{year}\right]$

16 $\frac{therms}{year} * \frac{100{,}000BTU}{therms} * \frac{1000ft^3}{1.027*10^6BTU} = 97.371\frac{ft^3}{year}$

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). This information is shown in Table 6.

Aircraft Use

We estimate emissions from aircraft use by Woodland 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"[17]

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

[17] 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 [18]

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

Table 8: Airport to/from trips summary[19]

From \ To	Sacramento International Airport	
	Daily Trips	Trip Ratio[20]
All TAZs within SACOG	24,229	-
City of Woodland	842	3.48%

Table 9: Airport ground support equipment emissions data for Sacramento County[21]

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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[18] 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.

[19] 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 Woodland traffic analysis zones (TAZs) to SMF TAZs. We then calculate the ratio of Woodland trips to SMF versus all trips to SMF in the "Detailed Woodland Airport Trips" table at the bottom of the "calc.Aircraft" tab of the Transportation excel file.

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

[21] 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 Woodland	
Light Trucks				
Motorcycles				
Heavy Trucks				
Non-Transit Buses				
Transit Buses[22]				
On-Road (Well to Pump)				
On-road well to pump (except transit) [23]			(Implicit: Yolo County to Woodland)	
Off-Road (Pump to Wheel)				
Agricultural Equipment		Yolo County to Woodland		
Construction and Other Commercial Equipment	Cities of Woodland, Davis, Winters, & West Sacramento to Woodland			
Lawn and Garden Equipment				
Recreational Equipment				
Aircraft Use				SACOG area to Woodland
Airport Ground Support Equipment				

[22] We do not use a scaling factor for transit buses because emissions are calculated at the city level.
[23] 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 Woodland[24]

	SACOG Area	Yolo County	Cities of Woodland, Davis, Winters, & West Sacramento Combined	City of Woodland
Area (square miles)[25]	-	-	48	13
Agricultural Area (acres)[26]	-	451,048	-	2,514
VMT (miles/day) [27]	-	3,287,759	-	912,591
Trips to Sacramento International Airport (trips/day)[28]	24,229	-	-	842

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[29], 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

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[24] The "calc.ScalingFactors" and "calc.Aircraft" tabs of the Transportation excel file show calculations of all scaling data.

[25] 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.

[26] For the City of Woodland, we approximate the area from Google Earth imagery. For Yolo County, we obtain data from http://www.yolocounty.org/Modules/ShowDocument.aspx?documentid=4807.

[27] $VMT\left[\frac{miles}{day}\right] = VMT\ per\ household * Number\ of\ households$. We estimate the number of 2005 households by dividing the 2005 population from the California Department of Finance (above) by the 2005 – 2007 average household size from the US Census American Community Survey, which equal 2.76 for Woodland and 2.78 for Yolo County [US Census Bureau (2007). ACS Demographic and Housing Estimates: 2005 - 2007. 2005 -2007 American Community Survey 3-Year Estimates] We obtain VMT generated per household for the City (48 VMT/HH/day) and County (49 VMT/HH/day) from SACOG modeling outputs 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.

[28] 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.

[29] 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[30]. 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[31]	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:

30 See the "calc.OnRoad_CO2&N2O" tab of the Transportation excel file for more details.

31 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[32]	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[33]

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[34]	[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

[32] We show input values and calculations in the tabs entitled "raw.OnRoad_N2OEmissionsFactors" and "calc.OnRoad_ControlTechnology" in the Transportation excel file.
[33] All emission factors used are summarized in "calc.OnRoad_EmissionsFactors" in the Transportation excel file.
[34] 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.

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

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

Where:

Term	Description	Value[35]	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 $\left(\frac{912{,}591}{3{,}287{,}759} = 0.278\right)$ 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.

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

[35] 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[36]	kg/cubic foot
EF_{N_2O}	N_2O emission factor	0.175[36]	g/mile
EF_{CH_4}	CH_4 emission factor	1.966[36]	g/mile
E_{CO_2}	CO_2 emissions	359[37]	metric ton/year
E_{N_2O}	N_2O emissions	0.04[37]	metric ton/year
E_{CH_4}	CH_4 emissions	383[37]	metric ton/year
FC	annual fuel (CNG) consumption	6,640,722[38]	cubic feet/ therms
VMT	vehicle miles traveled	256,433[38]	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 recreational water body within the city limits of City of Woodland. 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.

[36] 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.

[37] See the "calc.Transit" tab in the Transportation excel file for calculations and route-specific values.

[38] See Table 5.

[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 Woodland, we use a ratio of the City of Woodland area to the sum of the areas of Woodland, Davis, Winters, and West Sacramento $\left(\frac{13}{48} = 0.271\right)$. For agricultural equipment, we use the ratio of city to county agricultural land $\left(\frac{2,514}{451,048} = 0.006\right)$ to scale emissions to the City level. 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 actual emissions. However, we compare all the results to other entities' GHG estimates in the Comparative Analysis section to identify any egregious differences.

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 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 Woodland's 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}	Woodland air travel CO_2 emissions	4.3	45,310	MT/year
E_{N_2O}	Woodland air travel N_2O emissions	0.00006	1.5	MT /year
E_{CH_4}	Woodland air travel CH_4 emissions	0.004	1.3	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 Woodland to SMF divided by trips from all the TAZs within the SACOG region to SMF	3.48		%
a	Unit conversion	10^3		kg/MT
b	Unit conversion	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

[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

airport used by Woodland 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.

$$E_{CO_2}' = E_{CO_2} * TR \quad [14]$$
$$E_{N_2O}' = E_{N_2O} * TR \quad [15]$$
$$E_{CH_4}' = E_{CH_4} * TR \quad [16]$$

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 Woodland's share of CO_2 emissions from SMF airport ground support equipment	422	MT / year
E_{N_2O}'	City of Woodland's share of N_2O emissions from SMF airport ground support equipment	0.05	MT/ year
E_{CH_4}'	City of Woodland's share of CH_4 emissions from SMF airport ground support equipment	0.1	MT/ year
TR[45]	Trip ratio: trips from City of Woodland to SMF divided by trips from all the TAZs within the SACOG region to SMF	3.48	%

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 Woodland in 2005 equals 503,645 $MTCO_2e$. Of those, 73% (367,567 $mtCO_2e$) are scope 1 emissions, or direct emissions occurring within the geographical boundaries of City of Woodland. On-road mobile

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

[45] See
Table 8

sources constitute the majority of the direct as well as indirect emissions: 95% of the direct (scope 1), and 66% 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.

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	104,408	7.79	13.79	107,112
Light-duty Trucks	133,850	9.64	14.74	137,150
Motorcycles	514	0.03	1.38	551
Heavy-duty Trucks	102,831	2.44	5.07	103,693
Non-Transit Buses	1,937	0.10	0.00	1,967
Transit Buses	359	0.04	0.50	383
Off-Road (Pump to Wheel)				
Agricultural Equipment	481	0.01	0.10	484
Construction and Other Commercial Equipment	14,345	0.50	4.66	14,597
Lawn and Garden Equipment	726	0.56	1.31	928
Recreational Equipment	420	0.40	7.55	702
Total Scope 1 (Direct) Emissions	**359,870**	**22**	**49**	**367,567**
On-Road (Well to Pump)				
On-road well to pump (except transit)	87,979	5.38	9.35	89,844
Off-Road (Pump to Wheel)				
Aircraft Use	45,314	1.47	1.28	45,796
Airport Ground Support Equipment	422	0.05	0.10	439
Total Scope 3 (Indirect) Emissions	**133,715**	**7**	**11**	**136,079**

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

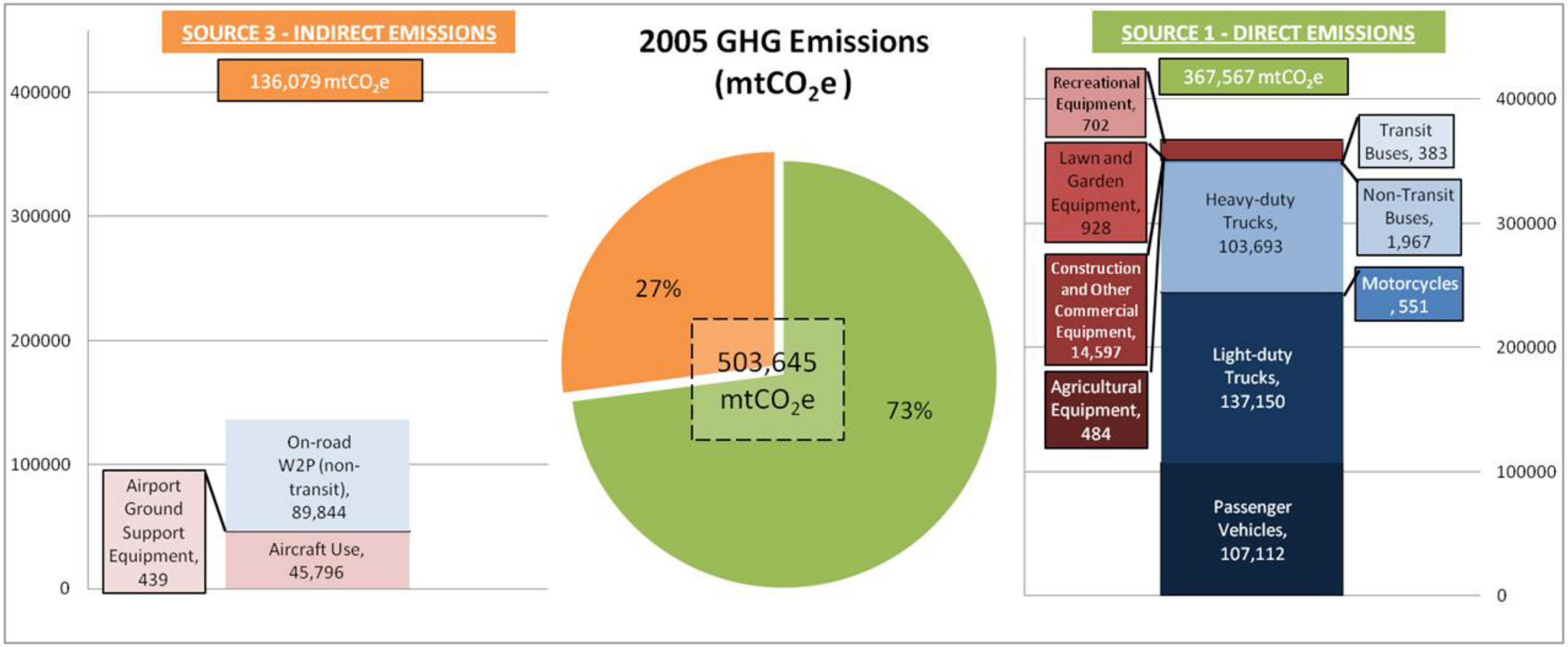

Figure 2: Baseline year 2005 transportation GHG emissions by source and scope.

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 Petaluma's Climate Action Plan (CAP). 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 Petaluma for comparison because it is roughly the same size as the City of Woodland. 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 Woodland. 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 Woodland are above the statewide average and the City of Petaluma’s estimates and below the City of Denver's estimates. For aircraft operations, the per capita emissions estimate for the City of Woodland 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 are similar for all three entities - City of Woodland, State of California, and City of Denver, with the City of Woodland falling below the state and above the City of Denver. Well to pump emissions are lower for the City of Woodland than for the City of Denver on a per capita basis. Lastly, agricultural equipment emissions per acre from the City of Woodland 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., there might be methodological differences and differences in estimating emissions), the results provided in the tables below fall within the same order of magnitude for each emissions source.

Table 15: 2005 GHG emissions for various entities

		City of Woodland	City of Petaluma[47]	State of California[48]	City of Denver[49]	University of California, Davis
2005 Population[50]		52,474	55,973	35,869,173	570,578	-
Agricultural Land (acres)[51]		2,514	-	-	-	3,743
GHG Emissions (mtCO2e/ year)	**On-Road**	350,836	358,100	170,820,000	4,345,000	-
	Aircraft Operations	45,796	-	32,991,649	1,011,273	-
	Airport Ground Support	439		321,282	3,091	
	Well to Pump	89,844	-	-	1,100,000	-
	Agricultural Equipment	484	-	-	-	-

[47] Source of emissions estimates: http://cityofpetaluma.net/cdd/pdf/general-plan-green-house-gas.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 Woodland, 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 Woodland	City of Petaluma	State of California	City of Denver	University of California, Davis[52]
GHG emissions per capita (mtCO2e/year/capita)[53]	On-Road	6.7	6.4	4.8	7.6	-
	Aircraft Operations	0.87	-	0.92	1.8	-
	Airport Ground Support	0.0084		0.0090	0.0054	
	Well to Pump	1.7	-	-	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 Woodland 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

The City of Woodland provided municipal vehicle fuel and mileage data (pers. comm. from Marshall Echols 2011). We use PG&E 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 a mix of water and other based on the 'business activity', ‘service address’, and 'premise type' listed in the raw PG&E data and from information provided by the City of Woodland. In this section of the inventory we analyze only meters categorized as “other” or a combination of water and other.

The “other” data includes streetlights, traffic signals, public park lights and facilities, and municipal buildings that are owned and operated by the city of Woodland. These buildings are City Hall, Community Development, Municipal Service Center (MSC), Senior Center, Fire Stations 1 and 2, Library, and Police Department. 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).

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 Woodland Municipal Electricity and Natural Gas Use[56]

Year	Electricity		Natural Gas	
	Use (kWh)	Emissions Factor (lb CO_2/kWh)	Use (therms)	Emissions Factor (lb CO_2/therm)
2003	3,695,610	0.620	86,571	11.7
2004	4,581,506	0.566	112,290	11.7
2005	**4,652,583**	**0.489**	**90,807**	**11.7**
2006	4,737,828	0.456	65,864	11.7
2007	5,481,668	0.6357	83,818	11.7
2008	5,447,828	0.641	70,216	11.7
2009	5,659,380	0.575	89,253	11.7
2010	5,416,345	0.559	87,436	11.7

Vehicles

We use 2010 vehicle and stationary vehicle fueling data supplied by the City of Woodland (pers. comm. from Marshall Echols 2011). The 2005 vehicle data was not used because the city at that time used several systems for recording vehicle fueling, and the completeness of the available records is questionable. Instead, the fuel records from 2010 are used to establish the baseline because this is the first year in which a card-lock system was consistently used. Despite the higher standard of accuracy of the 2010 data, there are some inconsistencies in the records and apparent inconsistencies between the fuel usage accounts and total amount of miles traveled. Therefore, the emissions calculations based on the fuel data are not entirely accurate. However, the uncertainties represent a very minor portion of the total emissions estimates, and these data provide for the best available estimate. Table 18 shows the total vehicle fuel usage and mileage driven in the year 2010 by fuel type. The raw data[57] also includes vehicle year and make and model for most of the fuel use, although some fuel use is recorded as fuel card purchases and is not tied to a specific vehicle. The vehicle records include city gasoline vehicles, and all municipal mobile and stationary diesel vehicles. Emissions from non-City vehicles are not included.

Table 18: 2010 Municipal vehicle fuel use and mileage[58]

	Unleaded Gasoline	Diesel
Fuel use (gal)	88,978.41	34,658.55
Mileage (miles)	1,693,300	327,668

[56] As shown in the "Summary.HistoricalEnergyUse" tab of the AppendixIA1_2005Inventory_MunicipalEnergy_WD.xlsx excel file (hereafter referred to as the Municipal energy excel file.)

[57] As shown in the "raw.VehicleData" tab of the Municipal energy excel file.

[58] Calculated from vehicle-specific fuel use and fuel card purchases in data provided by the City of Woodland (pers. comm. from Marshall Echols (2011). 2010 Fuel Report. City of Woodland.)

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_2emissions 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 nearly identical to values in PG&E documents provided by the City of Woodland.

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

Where:

Term	Description	Value[59]	Units
$E_{E\ i}$	Emissions from electricity use	Calculated Value	MT gas
$U_{E\ i}$	Electricity usage	4,652,583[60]	kWh
$EF_{E\ i}$	Electricity emission factor	0.489[60]	lb gas/kWh
C	Unit conversion factor	1/2204.6[61]	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[59]	Units
$E_{NG\ i}$	Emissions from natural gas use	Calculated Value	MT gas
$U_{NG\ i}$	Natural gas usage	90,807[60]	therm
$EF_{NG\ i}$	Natural gas emission factor	11.7[60]	lb gas/therm
C	Unit conversion factor	1/2204.6[61]	MT/lb
i	Greenhouse gas emitted	CO_2, N_2O and CH_4	

Vehicles

We estimate 2010 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:

[59] The "calc.ElectricityNaturalGas" in the municipal energy excel file shows electricity and natural gas usage and emissions calculations.
[60] See Table 17
[61] PG&E raw data provided the unit conversion factor from MT to lbs.

Term	Description	Value	Units
E_D	CO_2 emissions from diesel vehicles	Calculated Value[62]	kg CO_2
U_D	Usage of diesel	34,658.55[63]	gal
EF_D	Diesel emission factor	10.21[64]	kg CO_2/gal

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

Where:

Term	Description	Value	Units
E_G	CO_2 emissions from unleaded gas vehicles	Calculated Value[62]	kg CO_2
U_G	Usage of unleaded gas	88,978.41[63]	gal
EF_G	Unleaded gas emission factor	8.78[64]	kg CO_2/gal

We estimate 2010 vehicle CH_4 and N_2O emissions for various vehicle categories as shown in equation 21. We obtain emissions factors first from the LGO Protocol (California Air Resources Board, California Climate Action Registry et al. 2010) and then from EPA Climate Leaders (US Environmental Protection Agency 2008) and 2012 Climate Registry Emissions Factors (The Climate Registry 2012) to fill in data gaps for motorcycles and for more recent years respectively.

$$E_{VMT\ i} = \sum_j VMT \cdot EF_{VMT\ i} \qquad [21]$$

Where:

Term	Description	Value	Units
$E_{VMT\ i}$	Emissions from vehicle miles traveled per year	Calculated Value[65]	grams gas /year
VMT	Miles traveled per year	Input value[63]	mile/yr
$EF_{VMT\ i}$	Emissions factor	Input value[66]	grams gas/mile
i	Greenhouse gas	N_20 or CH_4	
j	Vehicle model year, type[67], and fuel		

Note that even with the higher standard of data accuracy in 2010, we suspect that the mileage data are inconsistent. There are two entries in which the total miles is a negative value, several starting mileage values are zero, and many of the fuel usage accounts seem inconsistent with the record of miles

[62] We estimate vehicle CO_2 in the tab entitled "calc.Vehicle.CO2" in the municipal energy excel file.
[63] See Table 18.
[64] 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.
[65] N_20 and CH_4 emissions are estimated in the "calc.Vehicle.N20_CH4" tab.
[66] N_20 and CH_4 emissions factors are shown in the "calc.Vehicle_N2O_CH4_EmFact" tab of the municipal energy excel file.
[67] We obtain emissions factors for cars, light trucks, heavy trucks, and motorcycles. We then categorize the vehicle data to fit these classes. Based on page 216 of the LGO Protocol, we assume that light trucks include vans, pickup trucks, and SUVs. To determine whether vehicles are light trucks/cars or heavy duty, we first check fueleconomy.gov listings of cars/light trucks and do conduct additional internet searches of vehicle specifications as needed.

traveled. Therefore the mileage-based emissions estimates (N_20 and CH_4estimates that rely on equation 21) may not be as accurate as desired. However, N_20 and CH_4 emissions generally comprise a much smaller share of overall transportation emissions. Thus, we expect the effect of these data inconsistencies to be small in magnitude, and we include the analysis in order to provide the best estimate given the available data.

Additionally, we note that in the data some fleet vehicle fuel use is recorded as purchases on fuel cards without information tying the purchase to a specific vehicle. This may explain some of the data discrepancies noted above. Because fuel card purchases are for fleet vehicles whose mileage is recorded, N_20 and CH_4 emissions associated with fuel card purchases are built into the estimates derived from equation 21.

Additionally, note that some vehicle fuel records are for purchases made on fuel cards, so we do not know the vehicle type and distance traveled. We assume that these purchases are for fleet vehicles whose mileage is recorded above, so their N_20 and CH_4 emissions are already counted.

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 electricity use contribute the most to the total municipal energy emissions, followed by emissions from gasoline, natural gas, and diesel use. As noted above, we use 2010 data to estimate vehicle fuel use, miles, and usage, as the 2005 data was incomplete.

Table 19: Emissions from municipal operations

	Use		Emissions ($MTCO_2e$)			
	value	**units**	**CO_2**	**N_2O**	**CH_4**	**Total**
Electricity	4,652,583	kWh	1,032	7.20	1.33	**1,041**
Natural Gas	90,807	therms	482	0.28	0.95	**483**
Total Electricity and Natural Gas			1,514	7.48	2.28	**1,524**
Gasoline	88,978 1,693,300	gallons miles	781	16	0.90	**798**
Diesel	34,659 327,668	gallons miles	354	0.5	0.034	**354**
Total Vehicle Fuel			1 ,135	16.3	0.93	**1,152**

Last, we note that some of the electricity emissions are from meters located outside of the Woodland 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 1.572%[68] of electricity is consumed outside the

[68] 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".

City of Woodland, and so 1.572% 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 Woodland in 2005 was 52,474 (California Department of Finance 2011). Yolo County, with a population of 189,078 in 2006 (California Department of Finance 2011), had 3.6 times the population of Woodland. The overall facilities emissions of Yolo County were 5,960 $MTCO_2e$ in the year 2006, which is 3.9 times the emissions as Woodland. 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. Yolo County's 2006 population was 3.4 times Woodland's 2010 population of 55,468 (US Census Bureau 2012). Yolo County's emissions from mobile sources in 2006 were 2,027 $MTCO_2e$, 1.8 times the 2010 emissions for Woodland. 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[69]. We categorize each meter as "water", "wastewater", "other", or a mix of water and other based on the business activity, service address, the premise type, and information provided by a representative of the City of Woodland. In this section of the inventory we analyze only meters categorized as "water" (PWS), "wastewater" (WWT), or a combination of water and other.

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[69] 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).

PWS Data

The PWS inventory includes emissions associated with city irrigation and storm water pumping operations, as well as emissions from the delivery of potable water (see Figure 3). One hundred percent of the city's potable water supply comes from ground water pumping. Currently, nineteen city groundwater wells pump 5.4 billion gallons of water annually[70].

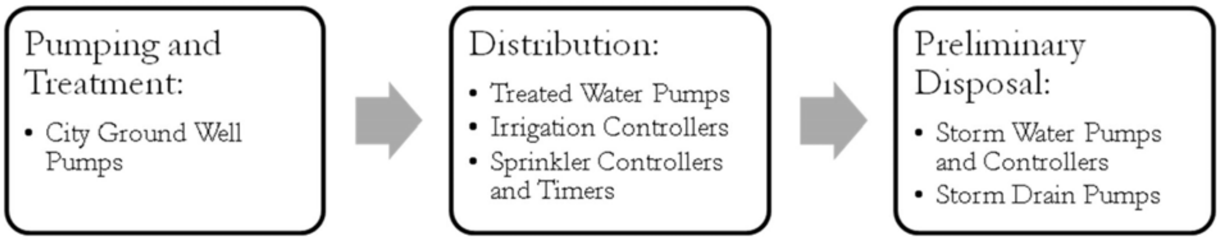

Figure 3: PG&E energy items included in PWS calculations. We include all other PG&E energy items that may be indirectly associated with PWS in municipal electricity and natural gas emissions estimates.

WWT Data

The WWT inventory includes emissions associated with the operation of the sewage lift pump stations, sewage pumps, and wastewater treatment plant (see Figure 4). The City of Woodland owns and operates its Wastewater Treatment Plant (WWTP), which treats wastewater from the City's residential, commercial, and industrial customers. The facility consists of a tertiary (filtration and UV disinfection) treatment system with a 10.4 million gallon per day treatment capacity. Effluent treated at the plant is discharged into Tule Canal. City wastewater treatment infrastructure includes 176 miles of sewer main, 14,859 service connections (77.5 miles of service line), 2,487 sewer maintenances holes, and 2 sewer lift pump stations.[71]

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

Table 20 and Figure 5 show annual electricity use 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.

[70] Utility information is from: http://cityofwoodland.org/gov/depts/pw/areas/infrastructure/utilities/utilities.asp
[71] WWT information is from: http://www.cityofwoodland.org/gov/depts/pw/areas/wastewater/wpcf/default.asp and utility information is from: http://cityofwoodland.org/gov/depts/pw/areas/infrastructure/utilities/utilities.asp

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

Year	Electricity: Use (kWh) PWS	Electricity: Use (kWh) WWT	Electricity: Emissions Factor lb CO_2/kWh
2003	5,709,807	7,965,634	0.620
2004	6,134,192	4,472,857	0.566
2005	**6,013,878**	**4,138,112**	**0.489**
2006	6,137,874	5,215,498	0.456
2007	7,647,142	5,303,358	0.6357
2008	6,494,998	5,575,297	0.641
2009	5,855,762	5,258,253	0.575
2010	5,699,947	5,446,948	0.559

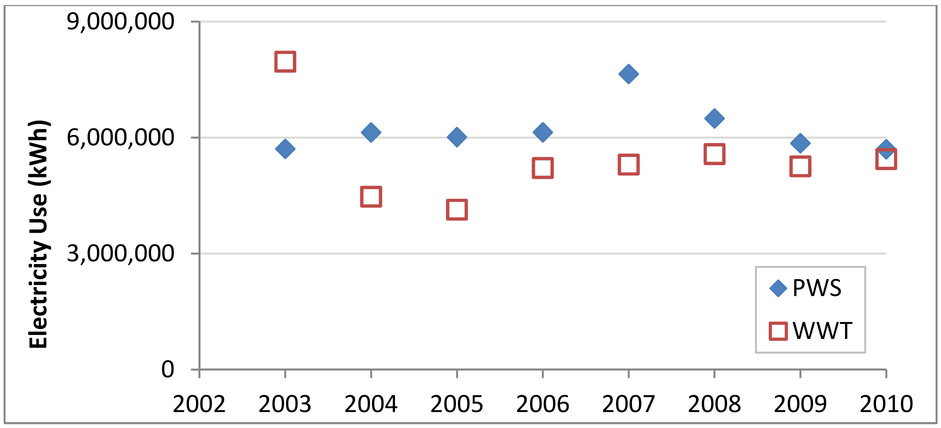

Figure 5: Annual electricity use from PWS and WWT (2003 – 2010)

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, we use 2005 City population data from the California Department of Finance (California Department of Finance 2011). We estimate emissions from nitrogen in wastewater effluent to the Tule Canal using municipal nitrogen-load data (kg of nitrogen per day). The City of Woodland provided this nitrogen-load data based on average 2005 city daily nitrate discharge measurements.

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.

[72]The "Summary.HistoricalEnergyUse" tab of the AppendixIA4_2005Inventory_WaterWastewater_WD.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.

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

Where:

Term	Description	Value	Units
E_i	GHG emitted from electricity use	Calculated Values[73]	MT gas
U	Yearly electricity use	6,013,878[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 22 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 Woodland, we first characterize the WWTP based on Woodland's website[76] and our visit to the WWTP. Woodland operates a tertiary aerobic WWTP without nitrification/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.

Because the plant is a tertiary aerobic facility without 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 WWTP does not use nitrification/denitrification, we estimate process emissions from treatment using an equation specific to plants without nitrification/denitifrication. Last, because nitrogen in effluent is discharged into an aquatic environment (the Tule Canal), we estimate the N_2O process emissions generated in Tule Canal. Because specific N-load data from the City of Woodland for the year 2005 are available, we use a location specific equation to estimate emissions from effluent.

Based on the WWT characteristics of Woodland, we estimate three types of emissions. We estimate emissions from electricity used for WWT as for PWS using equation 22. We also estimate process N_2O emissions from effluent discharge using equation 23[77]. Finally, we estimate N_2O process emissions that occur during treatment using equation 24[77].

$$E_{Eff} = N \cdot \ EF_{Eff} \ \cdot C_2 * C_3 * C_4 \quad [23]$$

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.
76 http://www.cityofwoodland.org/gov/depts/pw/areas/wastewater/wpcf/default.asp
77 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.

Where:

Term	Description	Value	Units
E_{Eff}	Process N_2O emissions from wastewater effluent discharge into aquatic environments	1.07[78]	MTN_2O
N	City of Woodland WWTP effluent N-Load	371.7	kg N/day
EF_{Eff}	Emission factor	0.005	kg N_2O-N/ kg sewage-N produced
C_2	Unit conversion factor	10^{-3}	MT/kg
C_3	Unit conversion factor	44/28	mol N_20/mol N
C_4	Unit conversion factor	365.25	Day/year

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

Where:

Term	Description	Value	Units
E_{Treat}	Process N_2O treatment emissions from a WWTP without Nitrification/Denitrification	0.21[78]	MTN_2O
P	Population served by WWTP	52,474[79]	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 1,345 $MTCO_2e$. These emissions are solely due to electricity use. The total estimated WWT emissions generated in 2005 is 1,321 $MTCO_2e$. These emissions are from electricity usage, the N_2O from wastewater treatment and the N_2O created from discharge of treated effluent to the Tule Canal. Table 21 shows emissions estimates.

[78] Calculations are shown in "calc.WWT_ProcessEmissions" tab of the Water/wastewater excel file.
[79] 2005 Woodland population: California Department of Finance (2011). E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts.

Table 21: Estimated 2005 emissions from PWS and WWT for the City of Woodland.[80]

	Emissions ($MTCO_2e$)			
	CO_2	N_2O	CH_4	Total
Potable Water Supply (PWS)				
Electricity	1,334	9.3	1.7	1,345
Total PWS	**1,334**	**9.3**	**1.7**	**1,345**
Wastewater Treatment (WWT)				
Electricity	918	6.4	1.2	925
Process: treatment	0	65	0	65
Process: effluent	0	331	0	331
Total WWT	**918**	**402**	**1**	**1,321**
Total PWS and WWT	**2,252**	**411**	**3**	**2,666**

Last, we note that some of the electricity emissions are from meters located outside of the Woodland 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 4.417% of PWS electricity and 4.412% of WWT electricity[81] is consumed outside the City of Woodland, and so 4.417% of PWS and 4.412% of WWT of electricity emissions listed above should be excluded from the community inventory.

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 Woodland to the City of Petaluma, which is of comparable size. Woodland's emissions from PWS and WWT are 0.051 $MTC0_2e$/person while Petaluma's are 0.043 (see Table 22). The fairly small difference in total emissions between the two cities is most likely due to the differences in WWT systems and the length of pipeline for potable water. The city of Petaluma has 190 mile of main sewer pipeline while the City of Woodland only had 176 miles.

The WWT processing emissions could also be a source for differences. To compare WWT activities, we compare the N-load value for the City of Woodland WWT processing with N-load values from Watsonville and Whittier, two California cities with similar WWTPs. These WWTPs do not use either nitrification or denitrification and the N-load values compared are solely from the nitrate effluent. The other WWTPs use BOD removal but this would not affect the nitrate values. The per capita N-load value for the City of Woodland is between the values for Watsonville and Whittier as shown in Table 22.

[80] The "Summary.Emissions" tab of the Water/wastewater excel file gives emissions estimates.
[81] 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".

Table 22: Comparison of Woodland PWS and WWT emissions and N-load to cities of a similar size

	Year	Population[82]	PWS and WWT emissions		N-load	
			MTCO2e	per capita	kg N/day	per capita
Woodland	2005	52,474	2,666	0.051	371.7	0.0071
Petaluma	2005	55,973	2,400[83]	0.043	-	-
Watsonville	2010	51,199	-	-	305.2[84]	0.0060
Whittier	2010	85,331	-	-	631.2[84]	0.0074

Wastewater Reuse Emissions

In this section we describe the estimation of wastewater reuse emissions that are generated by Pacific Coast Producers (PCP) primarily as a result of tomato washing, processing and canning.

Data Sources

The wastewater is used to irrigate 695 acres of tomato fields on land owned by the City of Woodland. In 2011 the irrigation water contributed 277 pounds of total Kjeldahl nitrogen (TKN) per acre (thus 113 tons applied for the year).[85]

Methods

Soil Mineralization

Tomato process wastewater is applied to fields using both sprinkler and surface irrigation. The fields are then harvested and the amount of nitrogen left in the soil is usually assumed to volatilize into the atmosphere as nitrous oxide (N_2O) after the organic nitrogen mineralizes in the soil. Brown and Caldwell (2011) estimated that 13 tons of nitrogen was removed in the harvested crop (out of the 113 tons applied), leaving approximately 100 tons of nitrogen in the soil. The method used for calculating the total N_2O mass emissions for the remaining 100 tons is shown in equation 25.

$$N_2O\ Emissions = [(C_N * C_2 * V * C_1) - N_{OUT} + N_{WASTE}] * GWP * C_3 * EF \qquad [25]$$

Where:

[82] 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.

[83] cityofpetaluma.net/cdd/pdf/revised-deir-ghg.pdf

[84] http://cfpub.epa.gov/dmr/facility_search.cfm?n=0

[85] Brown and Caldwell. *2011 Annual Monitoring and Groundwater Assessment Report*. Rep. Pacific Coast Producers, 2011

Term	Description	Value	Units
N_{OUT}	Total Mass of Nitrogen Removed Through Harvest	12.8[86]	Tons/yr
C_N	Concentration of Total Nitrogen in Liquid	87[87]	mg/L
V	Liquid Volume Used per Season	210[87]	Mgal/yr
N_{WASTE}	Mass of N From Wet Waste	37[87]	Tons N/yr
GWP	Global Warming Potential	310[88]	N/A
C_1	Conversion Factor #1	3.78E+06	L/Mgal
C_2	Conversion Factor #2	1.10E-09	tons/mg
C_3	Conversion Factor #3	0.91	MT/ ton
EF	Calculated SEEC Emission Factor	0.015[89]	kg N_2O-N/kg N [unitless]

BOD Emissions

Throughout the growing season, the fields are regularly irrigated with byproduct wastewater that includes plant matter that will eventually biodegrade into water, carbon dioxide (CO_2), humic compounds and other minerals. The amount of plant matter can be quantified using an average BOD loading. The most recent (2011) PCP Ground Water Assessment Report estimated the BOD loading rate to be approximately 37.2 lb/acre/day during the canning season (July-Sept). Equation 26 was used to calculate the amount of CO_2 generated by this process.

$$CO_2\ Emissions = (\mathrm{BOD} * \mathrm{A} * \mathrm{T} * C_4)/(C_5 * \frac{BOD_{LOW}}{TOC}) \qquad [26]$$

Where:

Term	Description	Value	Units
A	Total Area Receiving Wastewater	695[86]	Acres
BOD	Monthly BOD Loading Rate (entire site)	37.2[86]	lb/acre/day
T	Load Season (July-Sept)	92[86]	days/ season_year
BOD_{LOW}/TOC	BOD_5 to Total Organic Carbon Ratio Lower Limit	1[90]	N/A
C_4	Conversion Factor #4	0.000454	MT/lbs
C_5	Conversion Factor #5	0.273	ratio of C to CO_2 [unitless]

This equation calculates the total mass of BOD per year generated from the liquid waste and then converts the BOD to an estimated volatized mass of CO_2. For domestic wastewater, the average BOD/TOC value ranges from 1.0 - 1.6 (Bitton 1998). The emissions estimate uses the lower value of 1. In

[86] Brown and Caldwell. *2011 Annual Monitoring and Groundwater Assessment Report*. Rep. Pacific Coast Producers, 2011
[87] Pers. Comm. with Rob Beggs of Brown and Caldwell (2012). Excel file "N2O Emissions for PCP".
[88] California Air Resources Board, California Climate Action Registry, et al. (2010). *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.1
[89] This calculation is shown in the "calc.EmissionFactors" tab in the Field Emissions Excel file.
[90] Bitton, Gabriel. 1998. *Formula Handbook for Environmental Engineers and Scientists*. New York: Wiley pp. 24

addition, the time period for the emissions calculation is assumed equal to the canning season (July-Sept): 92 days.

Results

Approximately 4,300 $MTCO_2e$ are generated as a result of the wastewater application, of which approximately 90% areCO_2 and 10% is N_2O (Table 23). These emissions are generated as the result of the volatilization of ammonia, mineralization of organic nitrogen, and biodegradation of BOD. As noted in the most recent PCP Water Assessment Report, there were no ponding conditions associated with the field, and therefore no CH_4 emissions.

Table 23. Emissions from PCP Tomato Field

Emission Item	Emissions ($MTCO_2e$)		
	N_2O	CO_2	Total
Soil Mineralization	423	-	423
BOD Degradation in Applied Liquid Waste	-	3,954	3,954
Total Field Emissions	**423**	**3,954**	**4,377**

Summary

The total emissions from all sectors for scopes 1, 2, and 3 are shown in Table 24.

Table 24: Summary of baseline inventory emissions

Emissions Source	Emissions ($MTCO_2e$)			
	Scope 1	Scope 2	Scope 1/2 Total	Scope 3
Community				
Electricity: Residential	0	29,803	29,803	0
Electricity: Commercial	0	42,207	42,207	0
Natural Gas-Residential	38,901	0	38,901	0
Natural Gas-Commercial	55,948	0	55,948	0
Transportation	367,567	0	367,567	136,079
Municipal				
Electricity	0	1,041	1,041	0
Natural Gas	483	0	483	0
Vehicle Use	1,152	0	1,152	0
PWS	1,345	0	1,345	0
WWT	1,321	0	1,321	0
Wastewater Reuse		4,377	4,377	0
Total	**466,717**	**77,428**	**544,145**	**136,079**

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Technical Appendix IB: BAU Forecast Calculations, 2020

Appendix IB: 2020 BAU Forecast Inventory Supporting Calculations

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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 Woodland. 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 ($R_{10\_City\_Census}$)	12.85	%
P_F	Final City population in 2010 from US Census	55,468	People
P_I	Initial City population in 2000 from US Census	49,151	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})	0.61	Unitless
R_{city}	City population 10 year growth rate from US Census ($R_{10\_City\_Census}$)	12.85	%
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})	0.61	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})	11.51	%

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})	11.51	%
AR_e	Annual effective city population growth rate from 2010 – 2020 (AR_{20_City})	1.1	%

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})	1.1	%
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 12.85%. 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})	1.29	Unitless
R_{city}	City population 10 year growth rate from US Census ($R_{10\_City\_Census}$)	12.85	%
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})	1.29	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})	17.3	%

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})	17.3	%
AR_e	Annual effective city population growth rate from 2010 – 2020 (AR_{20_City})	1.61	%

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})	1.61	%
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 ($R_{20\_City\_SACOG}$)	11.82	%
P_F	Final city households in 2020 from SACOG	21,565	Households
P_I	Initial city households in 2008 from SACOG	19,286	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 ($R_{20\_City\_SACOG}$)	11.82	%
AR_e	Annual effective city household growth rate from 2008 – 2020 (AR_{20_City})	0.94	%

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	56,122	People
$NHH_{\boldsymbol{N}}$	Total number of households in 2008 from SACOG	19,268	None
PHH	Average household size in the city from U.S. 2010 Decennial Census	2.91	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})	0.94	%
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 1.61% (WCS) is 71% larger than the smallest annual projected growth rate of 0.94% (SGCS).

Table 1: Estimated Annual Population Growth Rates

Estimate	Applicable Years	Annual Projected Growth Rate (%)
WDOF	2010-2020	1.10%
WCS	2010-2020	1.61%
SGCS	2008-2020	0.94%

Table 2: Total Yearly Population by Estimate Type

Year	Estimate		
	WDOF	**WCS**	**SGCS**
2005	52,474	52,474	52,474
2006	51,919	51,919	51,919
2007	52,917	52,917	52,917
2008	54,118	54,118	56,122
2009	54,750	54,750	56,647
2010	55,400	55,400	57,177
2011	56,007	56,290	57,711
2012	56,621	57,194	58,251
2013	57,241	58,113	58,796
2014	57,868	59,046	59,346
2015	58,502	59,994	59,901
2016	59,143	60,958	60,461
2017	59,791	61,937	61,026
2018	60,446	62,932	61,597
2019	61,108	63,943	62,173
2020	61,778	64,970	62,754

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 1.1%, 1.61%, and 0.94% 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 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 2011 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.

[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.

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

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

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

[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.

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 ($MTCO_2e$) with WDOF and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	30,284	43,625	36,106	62,069	172,084
2012	29,342	43,999	34,825	62,235	170,401
2013	28,393	44,375	33,546	62,402	168,715
2014	27,565	44,755	32,421	62,569	167,310
2015	26,552	45,138	31,089	62,736	165,515
2016	25,503	45,525	29,725	62,904	163,657
2017	24,417	45,914	28,331	63,072	161,734
2018	23,294	46,307	26,905	63,241	159,747
2019	22,134	46,704	25,450	63,410	157,697
2020	21,242	47,103	24,314	63,580	156,239

Table 7. Predicted GHG Emissions in ($MTCO_2e$) with WCS and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	30,437	43,845	36,288	62,383	172,953
2012	29,639	44,444	35,178	62,865	172,127
2013	28,825	45,051	34,057	63,352	171,284
2014	28,126	45,666	33,081	63,842	170,715
2015	27,230	46,289	31,882	64,336	169,736
2016	26,286	46,921	30,637	64,834	168,678
2017	25,293	47,562	29,347	65,335	167,538
2018	24,252	48,211	28,012	65,841	166,315
2019	23,160	48,869	26,630	66,350	165,010
2020	22,339	49,537	25,570	66,864	164,309

Table 8. Predicted GHG Emissions in ($MTCO_2e$) with SGCS and RPS Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	30,236	43,556	36,049	61,971	171,811
2012	29,250	43,859	34,715	62,038	169,862
2013	28,258	44,165	33,387	62,106	167,915
2014	27,391	44,472	32,216	62,173	166,253
2015	26,343	44,782	30,843	62,241	164,209
2016	25,262	45,094	29,444	62,309	162,108
2017	24,148	45,408	28,018	62,376	159,950
2018	23,000	45,724	26,566	62,444	157,735
2019	21,820	46,042	25,089	62,512	155,464
2020	20,908	46,363	23,932	62,580	153,783

Without RPS

Table 9. Predicted GHG Emissions in ($MTCO_2e$) with WDOF and (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	34,313	43,625	40,909	62,069	180,916
2012	34,842	43,999	41,353	62,235	182,429
2013	35,380	44,375	41,802	62,402	183,959
2014	35,927	44,755	42,256	62,569	185,506
2015	36,482	45,138	42,714	62,736	187,070
2016	37,045	45,525	43,178	62,904	188,651
2017	37,617	45,914	43,647	63,072	190,250
2018	38,198	46,307	44,120	63,241	191,866
2019	38,788	46,704	44,599	63,410	193,501
2020	39,387	47,103	45,083	63,580	195,153

Table 10. Predicted GHG Emissions in ($MTCO_2e$) with WCS and (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	34,486	43,845	41,116	62,383	181,829
2012	35,195	44,444	41,772	62,865	184,276
2013	35,919	45,051	42,438	63,352	186,760
2014	36,658	45,666	43,116	63,842	189,281
2015	37,412	46,289	43,804	64,336	191,841
2016	38,182	46,921	44,503	64,834	194,439
2017	38,967	47,562	45,213	65,335	197,077
2018	39,769	48,211	45,934	65,841	199,755
2019	40,587	48,869	46,667	66,350	202,474
2020	41,421	49,537	47,412	66,864	205,234

Table 11. Predicted GHG Emissions in ($MTCO_2e$) with SGCS and Constant (No RPS) Projected Emission Factor

Year	Residential		Commercial		Total
	Electricity	Natural Gas	Electricity	Natural Gas	
2011	34,258	43,556	40,844	61,971	180,630
2012	34,732	43,859	41,222	62,038	181,852
2013	35,213	44,165	41,604	62,106	183,087
2014	35,700	44,472	41,989	62,173	184,334
2015	36,194	44,782	42,377	62,241	185,594
2016	36,695	45,094	42,769	62,309	186,866
2017	37,202	45,408	43,165	62,376	188,152
2018	37,717	45,724	43,565	62,444	189,450
2019	38,239	46,042	43,968	62,512	190,761
2020	38,768	46,363	44,375	62,580	192,086

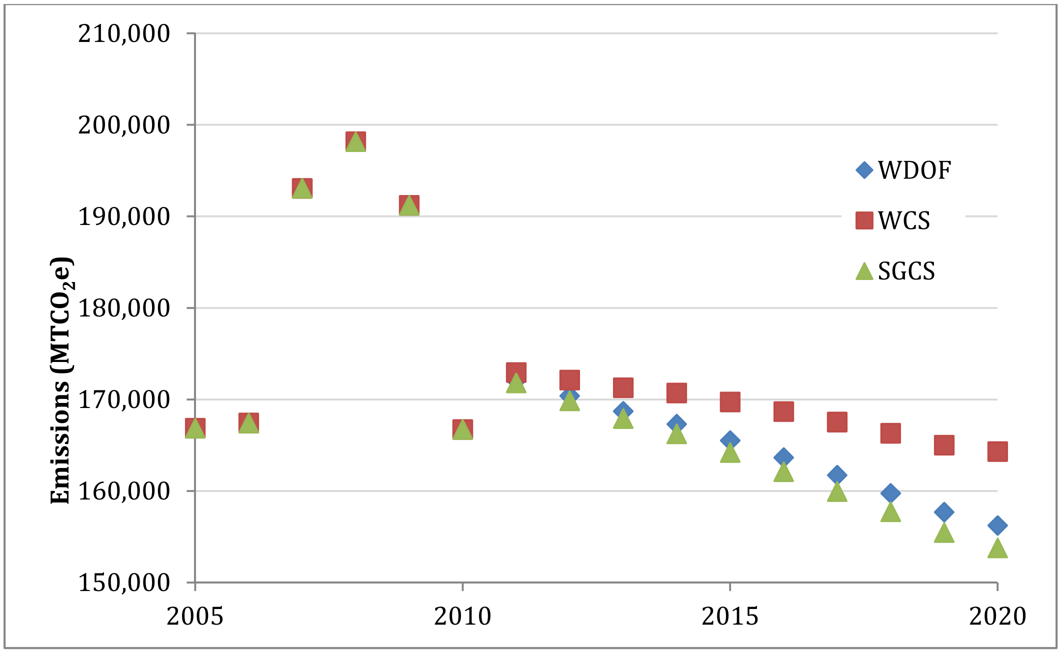

Figure 1: Residential and Commercial Electricity and Natural Gas Emissions Projections: With RPS

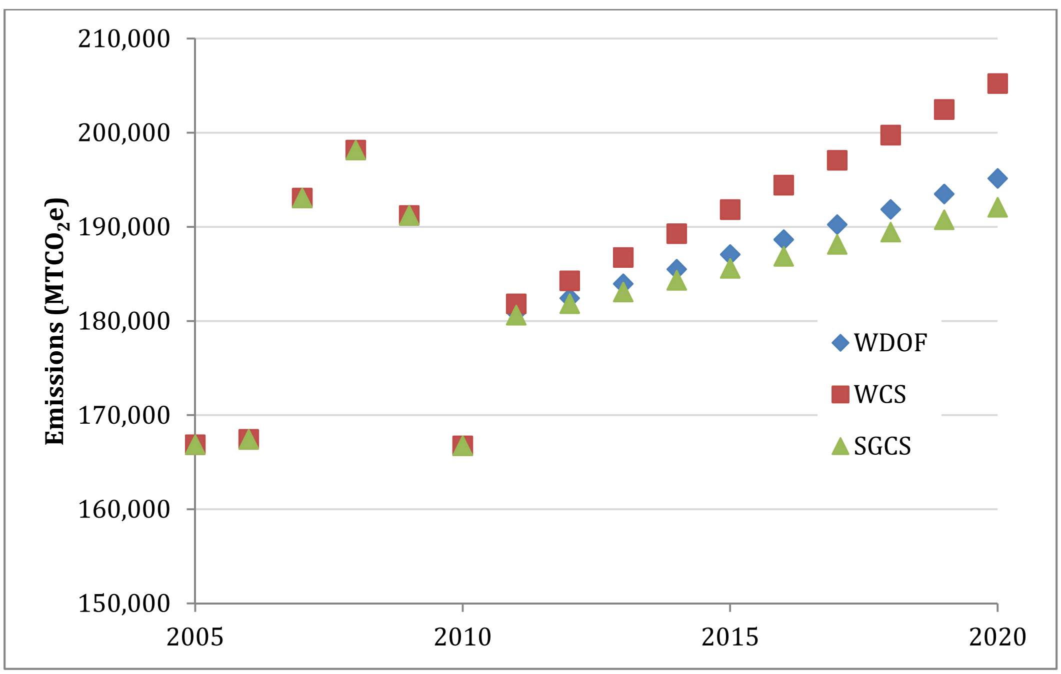

Figure 2: Residential and Commercial Electricity and Natural Gas Emissions Projections: Without RPS

Analysis

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

Table 12: Emissions and population change comparison

		Woodland (RPS)	Woodland (No RPS)	Menlo Park (includes RPS)
Population change from baseline to 2020 (%)		17.7~23.8	17.7~23.8	28.9[8]
2005 Emissions ($MTCO_2e$)	**Residential**	68,704	68,704	55,974
	Commercial	98,155	98,155	118,331
2020 Emissions ($MTCO_2e$)	**Residential**	69,164	87,526	59,971
	Commercial	88,946	109,964	164,835
Net change from Baseline (%)	**Residential**	0.67	27	7.1
	Commercial	-9.4	12	39

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 Menlo Park did not provide detail about the methods used to project emissions. However, based on the assumption that population growth is the primary driver of GHG emissions growth, the higher population growth in Menlo Park may (at least in part) explain the higher growth (compared to Woodland with RPS) in GHG emissions in both sectors.

[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 and two added routes, 212 and 214[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 for the 2005 baseline inventory for years 2012, 2017, and 2022[13].

Well to Pump

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

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[9] Data from EMFAC are available in the tabs titled "raw&calc.OnRoad_EMFAC 2011[2005/2020]"in the Appendix_IB3_2020BAU_Tranpsortation_WD.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.

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 the 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:

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

[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.

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 as 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 Woodland (Figure 3).

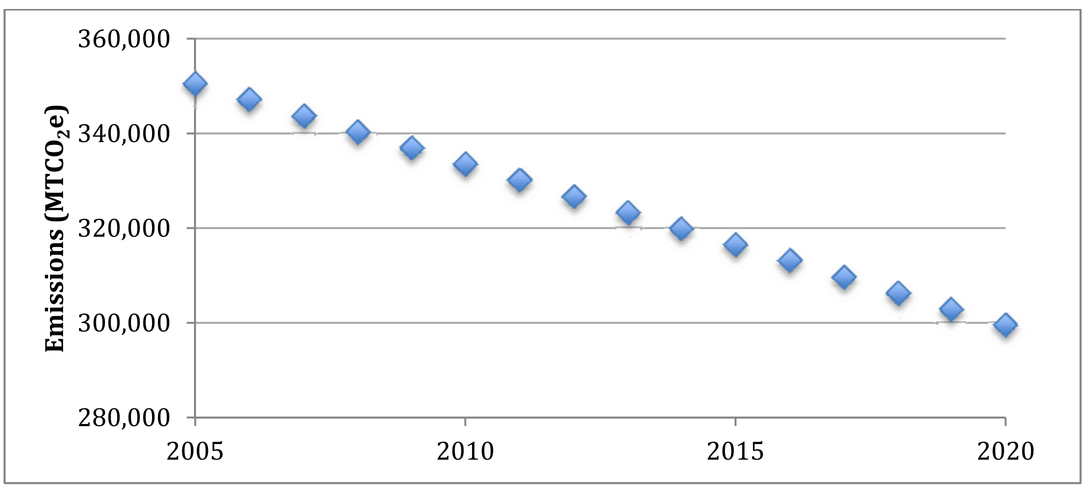

Figure 3: On-road GHG Emissions Projections from 2005 to 2020 [16]

[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 – 2011 out to 2020 (Figure 4).

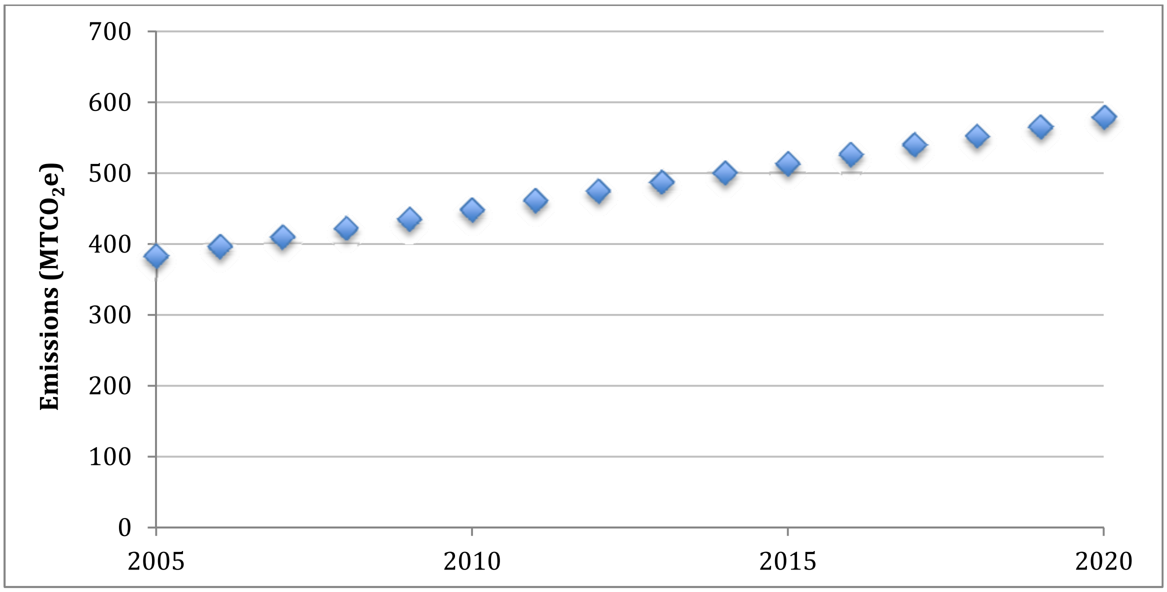

Figure 4: Transit bus GHG Emissions Projections from 2005 to 2020[18]

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.

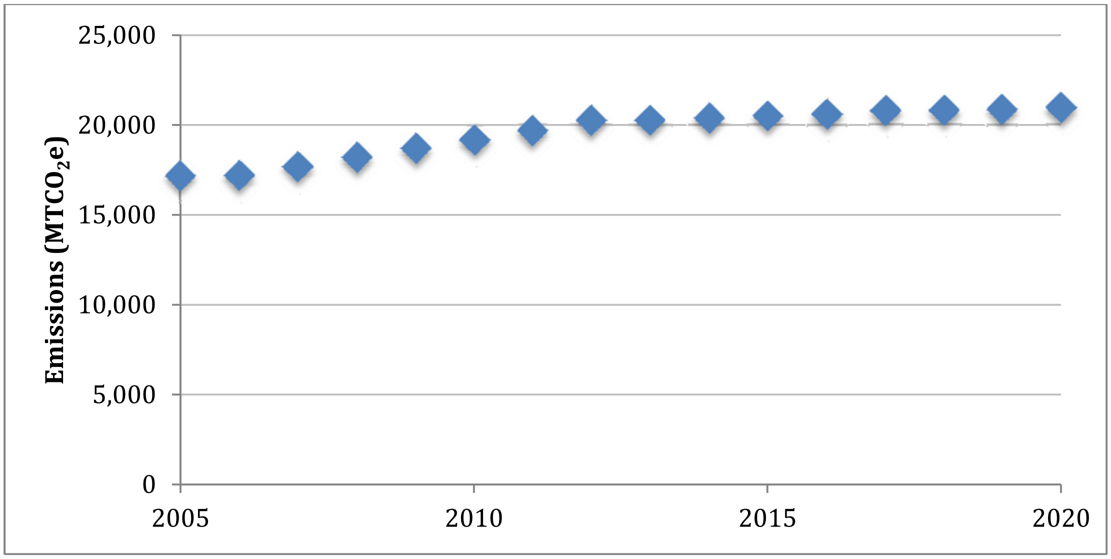

Figure 5: Off-road GHG Emissions Projections from 2005 to 2020 [19]

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.

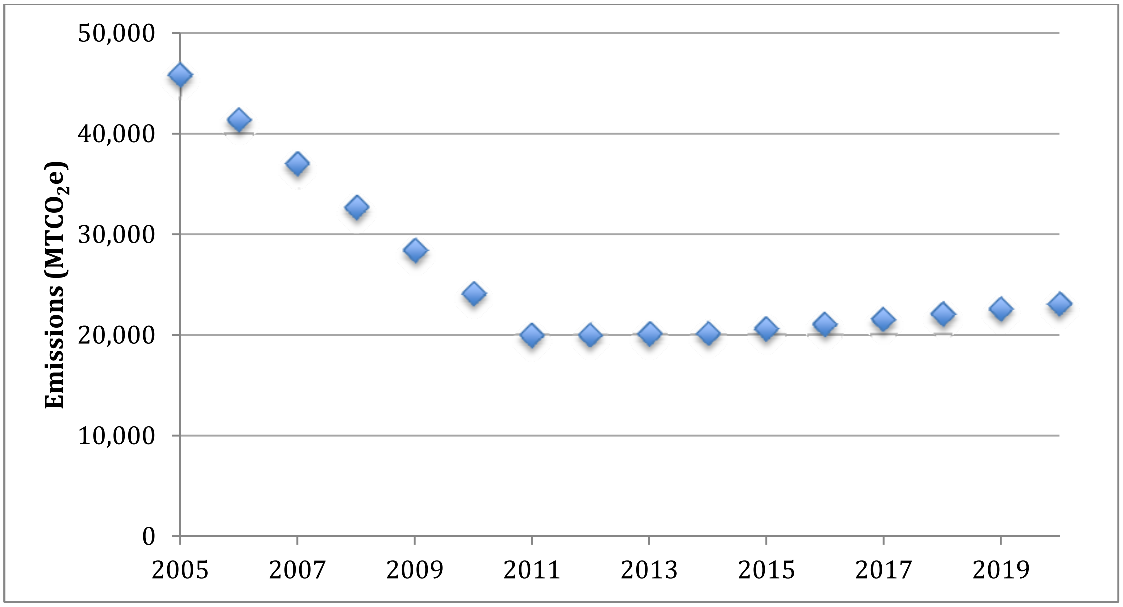

Figure 6: Airplane GHG Emissions Projections from 2005 to 2020 [22]

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).

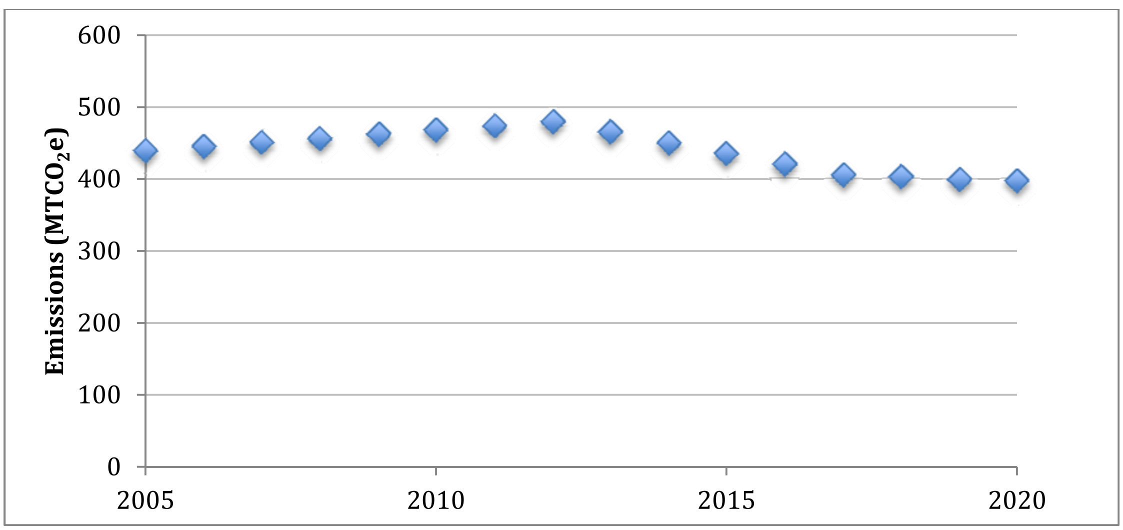

Figure 7: Ground Support GHG Emissions Projected from 2005 to 2020[23]

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[22] Calculations for aircraft projections are shown in the "calc.AircraftProjections" 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).

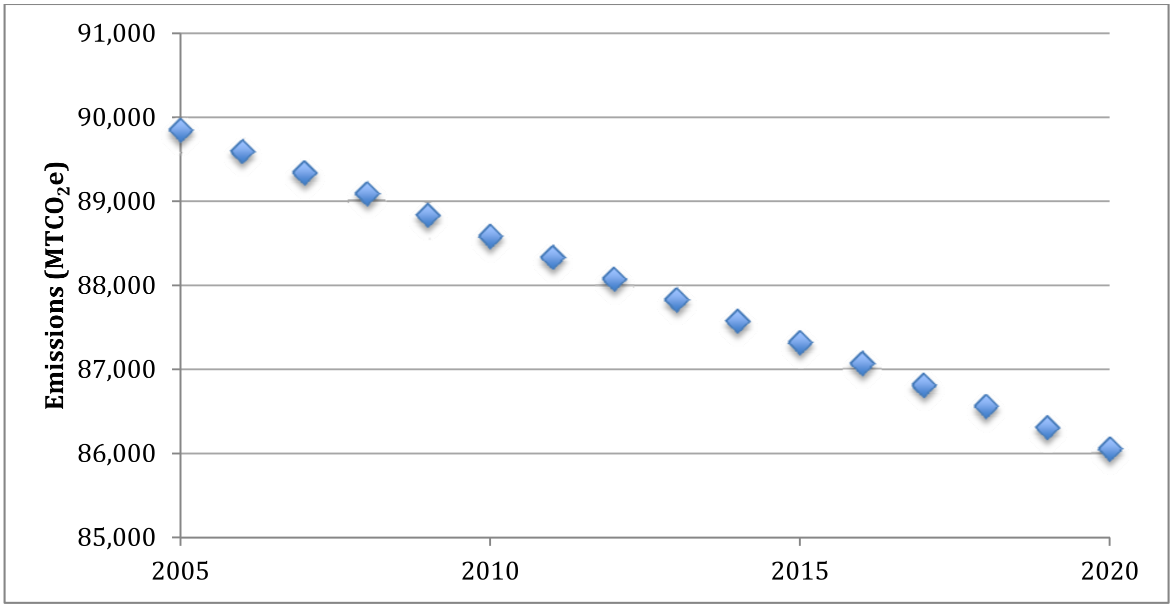

Figure 8: Well to Pump GHG Emissions Projected from 2005 to 2020[24]

[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.

[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

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.

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

	On-Road P2W						Off-Road P2W				
Year	**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**	**Total Scope 1**
2005	107,112	137,150	551	103,693	1,967	383	484	14,597	928	702	**367,567**
2006	106,497	136,165	588	104,429	1,971	396	484	15,013	963	742	**367,249**
2007	105,881	135,180	625	105,166	1,975	409	484	15,430	999	782	**366,931**
2008	105,265	134,196	662	105,902	1,979	422	484	15,846	1,034	822	**366,613**
2009	104,650	133,211	699	106,638	1,983	435	484	16,263	1,069	863	**366,295**
2010	104,034	132,227	736	107,374	1,987	448	484	16,679	1,104	903	**365,977**
2011	103,418	131,242	773	108,111	1,992	461	484	17,096	1,140	943	**365,659**
2012	102,803	130,257	810	108,847	1,996	474	484	17,512	1,175	983	**365,342**
2013	102,187	129,273	847	109,583	2,000	487	484	17,592	1,188	1003	**364,645**
2014	101,571	128,288	884	110,320	2,004	500	484	17,672	1,202	1022	**363,948**
2015	100,956	127,304	921	111,056	2,008	513	484	17,752	1,216	1042	**363,251**
2016	100,340	126,319	958	111,792	2,012	526	484	17,831	1,229	1062	**362,554**
2017	99,724	125,334	995	112,528	2,016	539	484	17,911	1,243	1081	**361,858**
2018	99,109	124,350	1,032	113,265	2,020	552	484	17,964	1,251	1094	**361,121**
2019	98,493	123,365	1,069	114,001	2,024	565	484	18,016	1,259	1107	**360,385**
2020	97,878	122,381	1,106	114,737	2,029	578	484	18,069	1,267	1120	**359,648**

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	45,796	439	89,844	136,079
2006	41,345	445	89,591	131,381
2007	36,949	451	89,338	126,738
2008	32,607	456	89,085	122,149
2009	28,320	462	88,832	117,614
2010	24,088	468	88,580	113,135
2011	19,910	474	88,327	108,710
2012	19,972	479	88,074	108,525
2013	20,034	465	87,821	108,319
2014	20,095	450	87,568	108,113
2015	20,555	435	87,315	108,304
2016	21,024	420	87,062	108,506
2017	21,502	405	86,810	108,716
2018	21,990	402	86,557	108,949
2019	22,489	400	86,304	109,192
2020	22,997	397	86,051	109,444

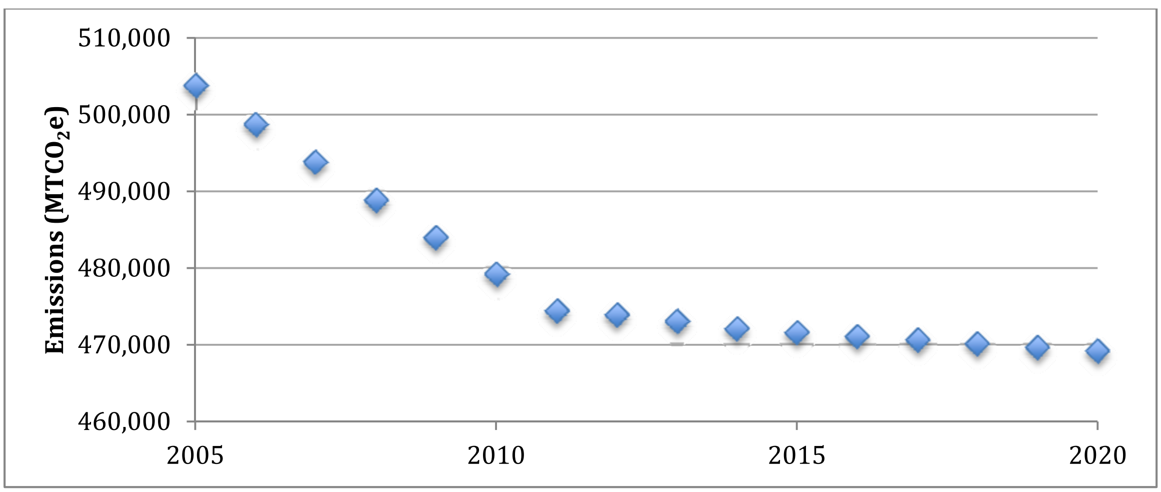

Figure 9: GHG Emissions Projection from Transportation Sources from 2005 to 2020[25]

[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 7 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.

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

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.

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

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.

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

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 ($MTCO_2e$)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
With RPS:										
WDOF	2,883	2,860	2,837	2,819	2,795	2,770	2,744	2,717	2,689	2,672
WCS	2,898	2,889	2,880	2,876	2,866	2,855	2,842	2,829	2,814	2,811
SGCS	2,918	2,891	2,864	2,842	2,814	2,785	2,755	2,725	2,694	2,674
Without RPS:										
WDOF	3,040	3,074	3,107	3,141	3,176	3,211	3,246	3,281	3,317	3,354
WCS	3,056	3,105	3,155	3,205	3,257	3,309	3,362	3,416	3,471	3,527
SGCS	3,075	3,104	3,133	3,162	3,192	3,222	3,252	3,283	3,314	3,345

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

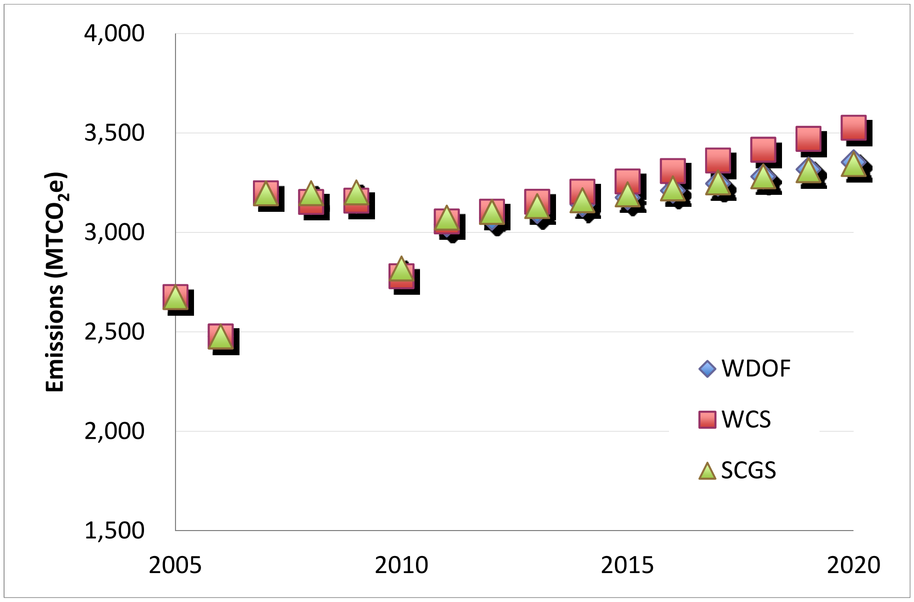

Figure 11: Projected municipal fleet and energy use emissions from 2005 to 2020 without RPS

Analysis

The resulting emissions for Woodland 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	-0.1
WCS with RPS	4.8
SGCS with RPS	-0.1
WDOF without RPS	20.2
WCS without RPS	24.1
SGCS without RPS	20.0

[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.

Methods

For the years 2011-2020 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.

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 both PWS and WWT for 2011 to 2020.

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

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 Values	kWh
P_m	Growth rate for population estimate m (WDOF, WCS, or SCGS)	Input Values (Table 1)	none

[27] Projected BAU emissions estimates do not include the planned switch to Sacramento surface water or plans for a new aerator at the WWTP; these activities are not considered BAU activities.

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 19 by substituting the constant (no RPS) emissions factors for each gas.

$$E_{n,m} = (K_{n,m} * RPS_n) + (K_{n,m} * A * RPS_{CH4}) + (K_{n,m} * B * RPS_{N20}) \qquad [19]$$

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 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

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 20. Population estimates are obtained from the population section of this report.

$$NE_{n,m} = (P_{n,m}/P_m) * NE_b \qquad [20]$$

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)	52,474	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 Woodland are provided in Tables 17 through 22 and in Figures 12 and 13.

Table 17*:* Projected Water and Wastewater Treatment Emissions (MTCO$_2$e) using WDOF with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	1,190	1,148	1,106	1,069	1,025	980	934	887	839	802
PWS Electricity Use	1,148	1,107	1,067	1,031	989	946	901	856	810	774
WWT Process N_2O	69	70	71	72	72	73	74	75	76	77
WWT Effluent Discharge into Aquatic Environments N_2O	353	357	361	365	369	373	377	381	385	390
Total	2,761	2,682	2,605	2,537	2,455	2,372	2,287	2,200	2,110	2,042

Table 18: Projected Water and Wastewater Treatment Emissions (MTCO$_2$e) using WCS with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	1,196	1,159	1,123	1,090	1,051	1,010	968	924	878	843
PWS Electricity Use	1,154	1,119	1,083	1,052	,1014	975	934	891	847	814
WWT Process N_2O	70	71	72	73	74	76	77	78	79	80
WWT Effluent Discharge into Aquatic Environments N_2O	355	361	367	372	378	385	391	397	403	410
Total	2,774	2,710	2,644	2,588	2,518	2,445	2,369	2,290	2,208	2,147

Table 19: Projected Water and Wastewater Treatment Emissions (MTCO$_2$e) using SGCS with RPS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WWT Electricity Use	1,188	1,144	1,100	1,062	1,017	971	924	876	827	789
PWS Electricity Use	1,146	1,104	1,062	1,025	981	937	891	845	798	762
WWT Process N_2O	71	72	73	74	74	75	76	76	77	78
WWT Effluent Discharge into Aquatic Environments N_2O	364	367	371	374	378	381	385	389	392	396
Total	2,770	2,688	2,606	2,534	2,450	2,364	2,276	2,186	2,095	2,025

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	1,348	1,363	1,378	1,393	1,408	1,424	1,439	1,455	1,471	1,487
PWS Electricity Use	1,301	1,315	1,329	1,344	1,359	1,374	1,389	1,404	1,419	1,435
WWT Process N_2O	69	70	71	72	72	73	74	75	76	77
WWT Effluent Discharge into Aquatic Environments N_2O	353	357	361	365	369	373	377	381	385	390
Total	3,072	3,105	3,139	3,174	3,208	3,244	3,279	3,315	3,351	3,388

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	1,355	1,377	1,399	1,421	1,444	1,467	1,491	1,515	1,539	1,564
PWS Electricity Use	1,307	1,328	1,350	1,371	1,393	1,416	1,438	1,462	1,485	1,509
WWT Process N_2O	70	71	72	73	74	76	77	78	79	80
WWT Effluent Discharge into Aquatic Environments N_2O	355	361	367	372	378	385	391	397	403	410
Total	3,087	3,137	3,187	3,238	3,290	3,343	3,397	3,451	3,507	3,563

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	1,346	1,359	1,371	1,384	1,397	1,410	1,423	1,437	1,450	1,464
PWS Electricity Use	1,299	1,311	1,323	1,335	1,348	1,361	1,373	1,386	1,399	1,412
WWT Process N_2O	71	72	73	74	74	75	76	76	77	78
WWT Effluent Discharge into Aquatic Environments N_2O	364	367	371	374	378	381	385	389	392	396
Total	3,080	3,109	3,138	3,167	3,197	3,227	3,257	3,288	3,318	3,349

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

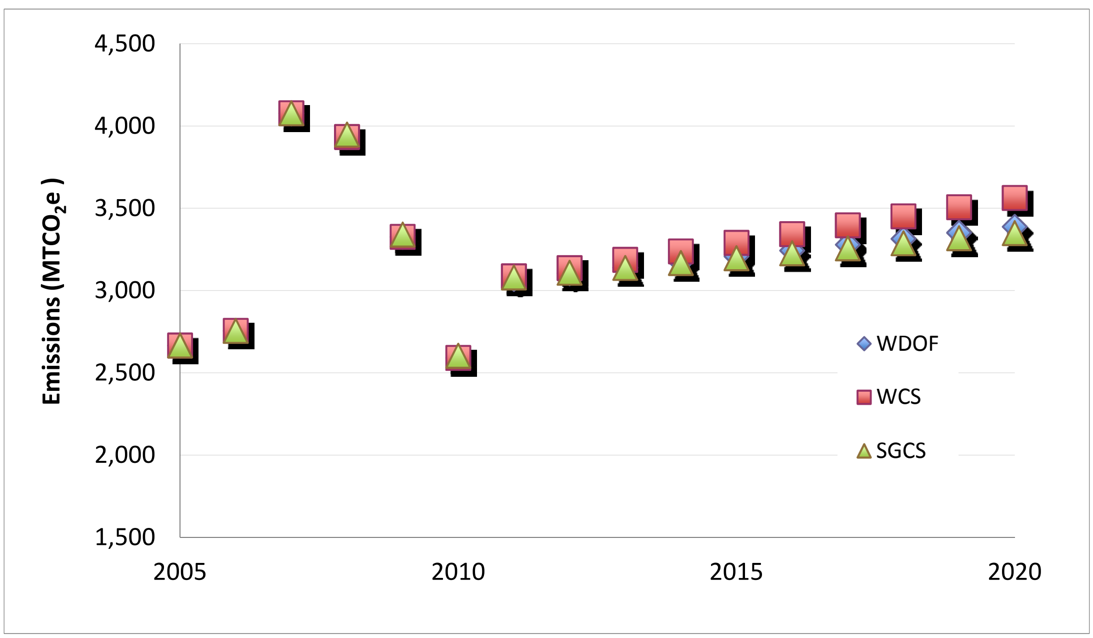

Figure 13: PWS and WWT projected emissions without RPS for 2005 to 2020

Analysis

The resulting PWS and WWT emissions for Woodland 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	Percentage Decrease or Increase from 2005 to 2020[28]
WDOF with RPS	(30.6)
WCS with RPS	(24.2)
SGCS with RPS	(31.7)
WDOF without RPS	21.3
WCS without RPS	25.2
SGCS without RPS	20.4

Wastewater Reuse

This section estimates emissions from Pacific Coast Producers tomato processing activities.

Data Sources

These projections are based on product growth trends provided directly from Pacific Coast Producers. Due to a lack of wastewater reuse data for the baseline inventory, the 2011 emissions were used for the 2005 baseline under the assumption that there were negligible changes in emissions between 2005 and 2011. The projections for wastewater reuse from years 2012-2020 are projected from the 2011 emissions.

Methods

As explained in the baseline inventory, there are two types of emissions result from PCP tomato processing: emissions from biochemical oxygen demand (BOD) and soil mineralization. Both types of emissions were analyzed for the wastewater reuse emissions projections.

Assumptions

To project the emissions growth from tomato processing, it was assumed that the average amount of nitrogen added to the soil for the harvest season remains unchanged in future years. This assumption causes the N_2O emissions from soil mineralization to remain constant for the projected years 2011-2020.

For the BOD emissions, it was assumed that the area receiving wastewater remained the same. The harvest season was also assumed to continue to be 92 days although this may be affected by climate change in the future. Although filtration changes are expected in the tomato processing plant, the amount of organic matter that causes the BOD emissions will only be slightly affected causing negligible changes in the emissions.[29] The one factor that we assume will change is the BOD loading rate, which we assume increases by 0.5% each year after 2011.

Equations

Equation 21 was used to estimate the BOD emissions in year n for years 2011 to 2020.

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[28] Values in parentheses indicate a decrease in emissions over the 2005 to 2020 time interval.
[29] Pers. Comm. from Mona Shulman of PCP (2012).

$$BOD\_E_n = BOD\_E_{n-1} + (K_{BOD} * BOD\_E_{n-1}) \quad [21]$$

Where:

Term	Description	Value	Units
BOD_E_n	BOD emissions released in year n, for years 2011-2020	Calculated Values	$MTCO_2e$
BOD_E_{n-1}	BOD emissions released in year n-1, for years 2011-2020	Input Value	$MTCO_2e$
K_{BOD}	Estimated annual increase in BOD loading rate	0.05	%

Results

The overall projected emissions for wastewater reuse can be found in Table 24 and Figure 14. The change in this projection does not directly depend on population or processing methods but rather on the quantity of the tomatoes processed. The emissions from wastewater reuse are also not the result of electricity use, and therefore the results are not affected by RPS.

Table 24*:* Wastewater Reuse Projected Emissions from 2011 to 2020.

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Soil Mineralization N_2O Emissions ($MTCO_2e$)	423	423	423	423	423	423	423	423	423	423
BOD Degradation in Applied Liquid Waste ($MTCO_2e$)	3,954	3,974	3,994	4,014	4,034	4,054	4,074	4,094	4,115	4,136
Total Emissions ($MTCO_2e$)	4,377	4,397	4,417	4,437	4,457	4,477	4,497	4,517	4,538	4,559

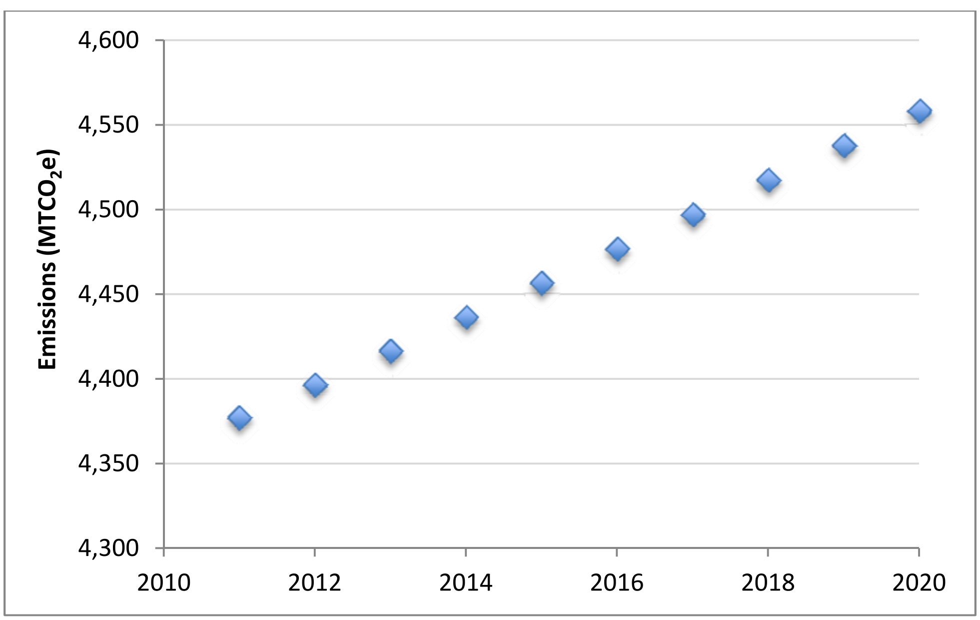

Figure 14: Total Wastewater Reuse Emissions from 2011 to 2020

Analysis

The total emissions are projected to increase by 4.15% from 2005 to 2020. As discussed above, emissions for 2005 to 2011 were assumed to be the same; therefore the 2011 results also reflect the emission values for years 2005 to 2010.

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	680,223	680,223	680,223	680,223	680,223	680,223
2006	675,672	675,672	675,672	675,672	675,672	675,672
2007	698,386	698,386	698,386	698,386	698,386	698,386
2008	698,460	698,460	698,519	698,460	698,460	698,519
2009	686,024	686,024	686,080	686,024	686,024	686,080
2010	655,551	655,551	655,603	655,551	655,551	655,603
2011	656,473	657,371	656,245	665,774	666,718	665,531
2012	654,207	655,988	653,704	666,872	668,781	666,329
2013	651,538	654,189	650,766	667,587	670,483	666,739
2014	649,163	652,677	648,127	668,319	672,222	667,162
2015	646,778	651,133	645,486	669,467	674,400	667,996
2016	644,335	649,514	642,794	670,642	676,628	668,852
2017	641,836	647,820	640,053	671,846	678,907	669,732
2018	639,251	646,021	637,234	673,050	681,210	670,607
2019	636,611	644,146	634,368	674,283	683,566	671,507
2020	634,604	642,918	632,132	675,546	685,975	672,431

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

Year	Total $MTCO_2e$ Emissions					
	With RPS			Without RPS		
	WDOF	WCS	SGCS	WDOF	WCS	SGCS
2005	544,145	544,145	544,145	544,145	544,145	544,145
2006	544,291	544,291	544,291	544,291	544,291	544,291
2007	571,649	571,649	571,649	571,649	571,649	571,649
2008	576,311	576,311	576,370	576,311	576,311	576,370
2009	568,410	568,410	568,466	568,410	568,410	568,466
2010	542,416	542,416	542,468	542,416	542,416	542,468
2011	547,764	548,661	547,535	557,064	558,009	556,821
2012	545,682	547,463	545,179	558,347	560,256	557,804
2013	543,219	545,870	542,447	559,268	562,163	558,420
2014	541,051	544,565	540,015	560,206	564,110	559,049
2015	538,474	542,829	537,181	561,163	566,096	559,691
2016	535,830	541,009	534,289	562,137	568,123	560,347
2017	533,119	539,104	531,336	563,130	570,191	561,016
2018	530,302	537,072	528,285	564,101	572,261	561,658
2019	527,419	534,954	525,176	565,092	574,374	562,316
2020	525,160	533,474	522,688	566,102	576,531	562,987

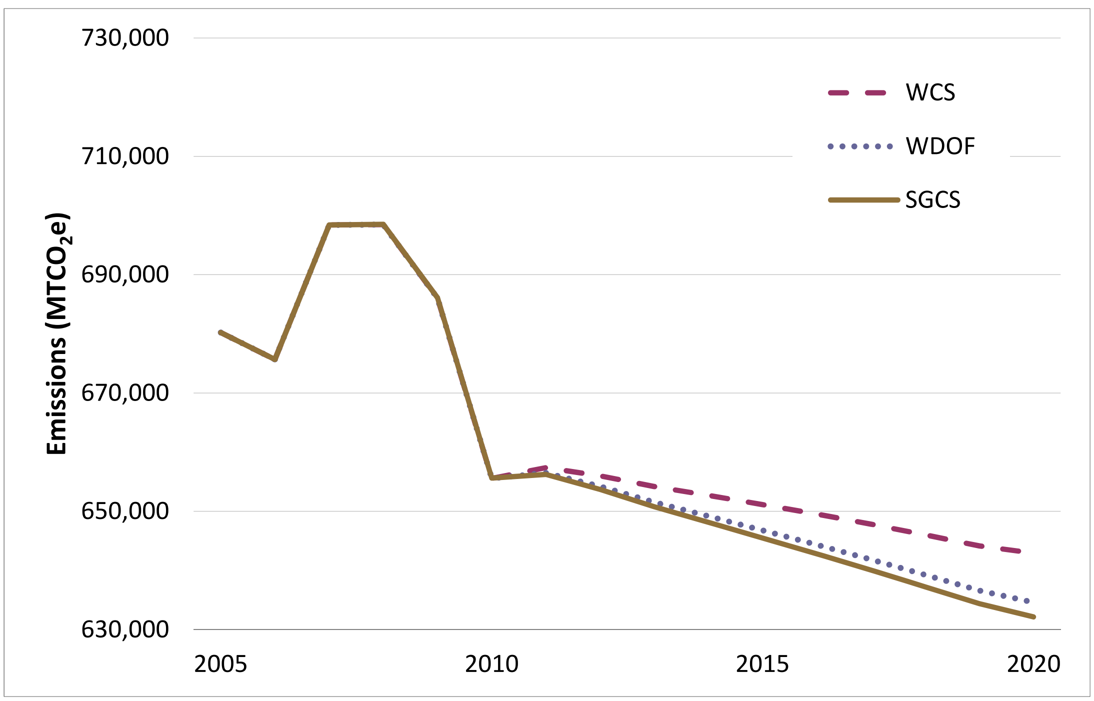

Figure 15: Total Emissions Projections Per Year (with RPS)

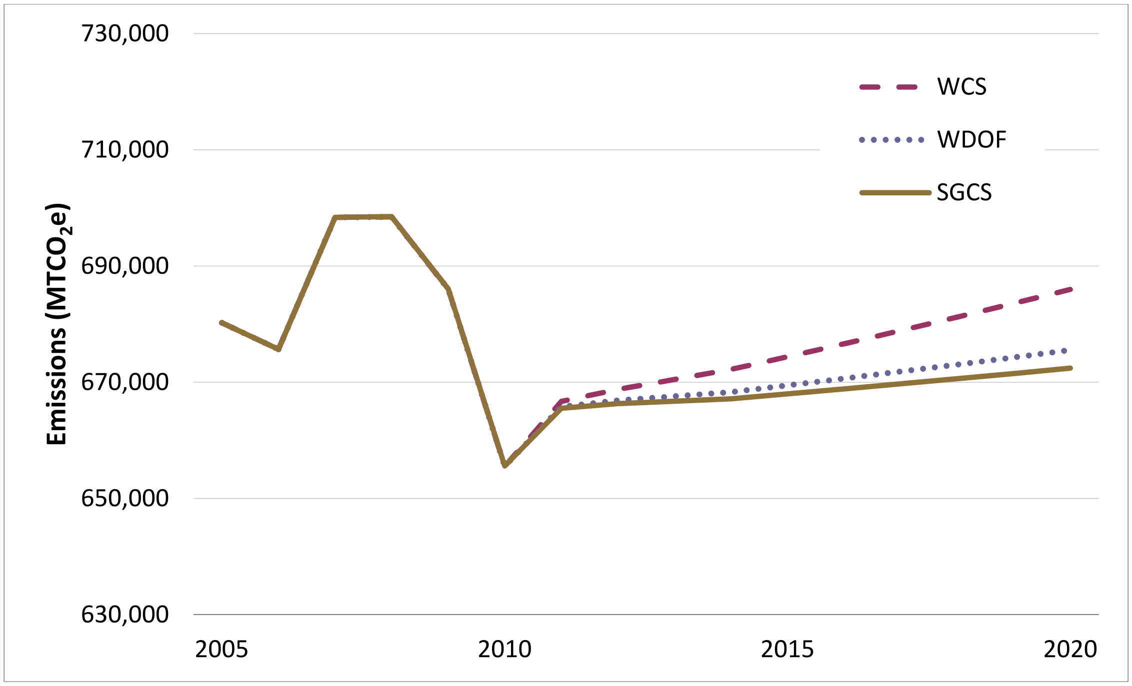

Figure 16: Total Emissions Projections Per Year (without RPS)

Not applying RPS factors yields total 2020 emissions estimates that are 6.5% higher than RPS estimates using WDOF, 6.7% higher than RPS estimates using WCS, and 6.4% higher than RPS estimates using SGCS in the year 2020.

In Tables 27 and 28 we show the total emissions estimates for each emissions source by the emissions scope for the estimates that use the SCGS population projection.

Table 27: Summary of projections for 2020 with RPS using the SCGS projection method

Emissions Source	Emissions ($MTCO_2e$) Scope 1	Scope 2	Scope 1&2	Scope 3
Community				
Electricity-Residential	0	20,908	20,908	0
Electricity-Commercial	0	23,932	23,932	0
Natural Gas-Residential	46,363	0	46,363	0
Natural Gas-Commercial	62,580	0	62,580	0
Transportation	359,648	0	359,648	109,444
Municipal				
Electricity	0	785	785	0
Natural Gas	511	0	511	0
Vehicle Use	1,378	0	1,378	0
PWS	0	762	762	0
WWT	474	789	1,263	0
Wastewater Reuse	4,559	0	4,559	0
Total	**475,513**	**47,176**	**522,689**	**109,444**

Table 28: Summary of projections for 2020 without RPS using the SCGS projection method

Emissions Source	Emissions ($MTCO_2e$) Scope 1	Scope 2	Scope 1&2	Scope 3
Community				
Electricity-Residential	0	38,768	38,768	0
Electricity-Commercial	0	44,375	44,375	0
Natural Gas-Residential	46,363	0	46,363	0
Natural Gas-Commercial	62,580	0	62,580	0
Transportation	359,648	0	359,648	109,444
Municipal				
Electricity	0	1,456	1,456	0
Natural Gas	511	0	511	0
Vehicle Use	1,378	0	1,378	0
PWS	0	1,412	1,412	0
WWT	474	1,464	1,937	0
Wastewater Reuse	4,559	0	4,559	0
Total	**479,827**	**87,475**	**562,987**	**109,444**

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Technical Appendix II: Reduction Strategies Summaries

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/y	Potential for Successful Implementation[5,6] 1 - 5; 5 =
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**

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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**
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**

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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**
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**

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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**
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**

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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**
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**

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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**
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**

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4-2	Tree Planting to Shade Buildings	Encourage tree 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**
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)								**2.9**
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**

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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**
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**
9-14	Install New Light Rail Systems	Create a light rail systems in high density areas; Light rails have shown to increase property values which could help fund LR projects; City of Woodland has considered light rail between Woodland, Davis, Sacramento	# of additional daily transit passengers	U	U	U	2.647	**1.3**

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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**
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**

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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 natura 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.

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/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 tc 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**
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**

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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**
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**

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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**
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**

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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**
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**

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 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**
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	Convert Woodland's existing oxidation ditches to a modified Ludzack-Ettinger (MLE) process, which will reduce effluent total nitrogen (both nitrate and ammonia) concentrations	NA	8100000	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

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

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.

Technical Appendix IIIA: Bundle Summaries

A Guide to Reading Bundle Summaries

Bundle Summary:
Bundle name, emissions source, and GHG 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 refers to how many units could be affected

Recommended Tracking Method: Describes the tracking method highlighted in green in the "Tracking

Alternative Tracking Method: Describes tracking methods that could be used in lieu of, or in addition to recommended methods. Also describes why the alternative method is "second best".

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

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 Low-Emission Vehicles (#)	Self-Reporting Survey Low-Emission Vehicles (#)	Applicable Incentives
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

IIIA-40

Ease of Implementation:
● = Easy
● = Moderate
● = Challenging

Objective: Overview of the bundle objective and the means with which it can be implemented

Tracking Options: This table shows:

1. The reduction strategies included in the bundle. Details on strategies are included in Appendix II.
2. The means of tracking each reduction strategy. The recommended metric is highlighted in green.
3. Applicable incentives identifies any rebates/incentives that apply to the reduction strategy, and corresponds to the rebates listed in the appendix. This column is only included in bundles that have at least one reduction strategy with an applicable rebate.

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

Additional Notes: Describes any additional information about the 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 (green)
- Incentive/Rebate (yellow)
- Municipal Action/Service (green)

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 (green)
- Incentive/Rebate (yellow)
- Regulatory/Policy (red)
- Municipal Action/Service (yellow)

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:
- (green) Education/Outreach
- (yellow) Incentive/Rebate
- (green) 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 (green)
- Incentive/Rebates (yellow)
- Regulatory/Policy (yellow)
- Municipal Action/Service (red)

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** (green)
- **Incentive/Rebate** (yellow)
- **Regulatory/Policy** (yellow)
- **Municipal Action/Service** (red)

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,

4: Urban Forestry

Emissions Source: Residential & Commercial Energy Use (Community)

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

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

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	Applicable Incentives
	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	UF1
4-3. Develop Policies to Encourage Community-Based Farms	Benefits Unknown		
4-4. Tree Planting for Carbon Storage & Heat Island	X	X	UF1

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/expanding existing 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

	City Operations Tracking					Other Organization Tracking	Self-Reporting Survey		
Reduction Strategy	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 (#)	**Applicable Incentives**
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				X			X		

Infrastructure									
9-14. Install New Light Rail Systems		X				X	X		T7,T8

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 strategies 9-12 and 9-14 can also be quantified using CAPPA emission factors for the number of passengers using mass/public transit. These strategies consist of the creation of new public transportation services by the city or regional transit organizations. If the programs are city-run, the city could use the total number of passengers as recorded directly by the city service organization. If they are 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.

Strategies 9-12 and 9-14 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 strategies 9-12 and 9-14 involve the creation of new public transportation services, large initial and operations and maintenance costs would be required. However, these strategies have the largest potential GHG emissions reduction potential in the bundle and are 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

Strategy 9-2 would only result in city-specific GHG emission reductions when implemented in conjunction with strategy 9-14. There were no emissions associated with rail travel included in the baseline inventory. If a rail program were not created as part of strategy 9-14, 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** (green)
- **Incentive/Rebate** (yellow)
- **Regulatory/Policy** (yellow)
- **Municipal Action/Service** (red)

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

	Incentive/ Rebate Tracking	City Operations Tracking			Self-Reporting Survey	
Reduction Strategy	**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** (green)
- **Incentive/Rebate** (yellow)
- **Regulatory/Policy** (yellow)
- **Municipal Action/Service** (red)

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

	PG&E Data and Reports		City Operations Tracking			
Reduction Strategy	**Aggregate Energy Used (kWh)**	**Energy Savings (kWh)**	**Units installed or Replaced (#)**	**Area Upgraded or Affected (Sq. Ft.)**	**Usage Reduction (hrs/day/ lamp)**	**Applicable Incentives**
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)**

Ease of Implementation: **Incentive/Rebate**; **Municipal Action/Service**

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

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

	PG&E Data and Reports		City Operations Tracking					
Reduction Strategy	**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)**	**Applicable Incentives**
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** (green)
- **Incentive/Rebate** (green)
- **Municipal Action/Service** (red)

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 (green)
- Incentives (yellow)
- Regulations (yellow)
- Municipal Action/Service (yellow)

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-WC5
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-WC4
23-6. Use Low-Maintenance Landscaping			X		X		X	X			WC1-WC4
23-7. Funding for Municipal Water Conservation Projects	Benefits Unknown										
23-8. Low Impact Development	Benefits Unknown										WC1-WC5
23-9. Water Efficient Model Homes	Benefits Unknown										WC1, WC2, WC4, WC5
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 (yellow); Municipal Action/Service (red)

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

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 in the community. This action would require coordination with local food providers and processing facilities to

[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.

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.

Action 24-5 involves upgrading the WWTP’s secondary treatment process to reduce energy requirements and to reduce current effluent nitrogen concentrations. Although data is unavailable for this action, it appears 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
9-14	Install New Light Rail Systems			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		
Bundle 20: Transit and Bike/Ped (Transportation)				
20-1	Implement a Police on Bicycle Program	X		
20-2	Bicycle Lending Program	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 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		

[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	
UF1	Residential Street Tree Rebate Program	City Govt (Woodland)	Residential	The City of Woodland will reimburse, up to $75, a home owner upon the purchase of a residential street tree.	Unknown	http://www.cityofwoodland.org/residents/rebates.asp	
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	
WC4	Weather-based Irrigation Controller/Rain Sensor Rebate	City Govt (Woodland)	Residential & Commercial	The City of Woodland offers a rebate of up to $150 for weather-based irrigation controllers and up to a $25 rebate for rain sensors.	Unknown	http://www.cityofwoodland.org/residents/rebates.asp	
WC5	Rain Barrel Rebate	City Govt (Woodland)	Residential & Commercial	The City of Woodland offers a rebate of up to $75 for the purchase of a rain barrel. Two rebates are allowed per property.	Unknown	http://www.cityofwoodland.org/residents/rebates.asp	

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, UF = Urban Forestry, 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)

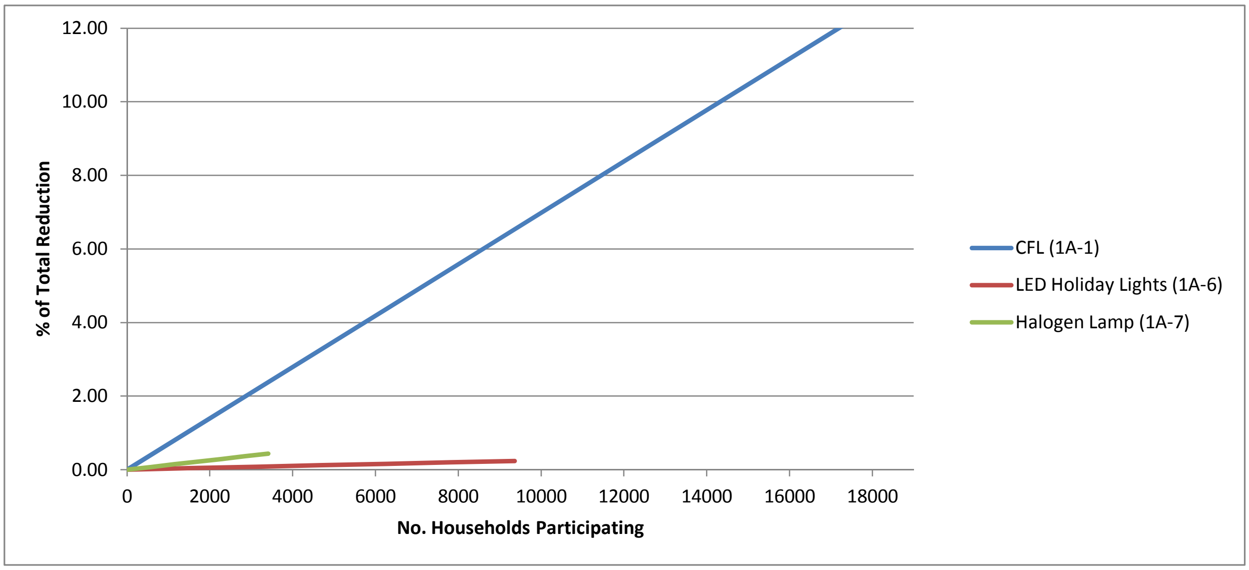
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.18	3120	1310
4.36	6240	2621
6.53	9361	3931
8.71	12481	5242
10.89	15601	6552
13.07	18721	7863

LED Holiday Lights (1A-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.04	1560	24
0.08	3120	48
0.12	4680	72
0.16	6240	96
0.20	7800	120
0.24	9361	144

Halogen Lamp (1A-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.07	568	44
0.15	1136	88
0.22	1704	132
0.29	2271	176
0.36	2839	219
0.44	3407	263



Eff Computer (1B-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.22	2484	133
0.44	4967	266
0.66	7451	398
0.88	9935	531
1.10	12418	664
1.32	14902	797

Eff Monitor (1B-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.03	1778	16
0.05	3557	33
0.08	5335	49
0.11	7114	66
0.14	8892	82
0.16	10671	99

Eff Printer (1B-3)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.29	2059	173
0.57	4119	345
0.86	6178	518
1.15	8237	690
1.43	10297	863
1.72	12356	1036

Eff Fridge (1B-5)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.54	3120	323
1.08	6240	647
1.61	9361	970
2.15	12481	1294
2.69	15601	1617
3.23	18721	1940

Eff Dishwasher (1B-6)

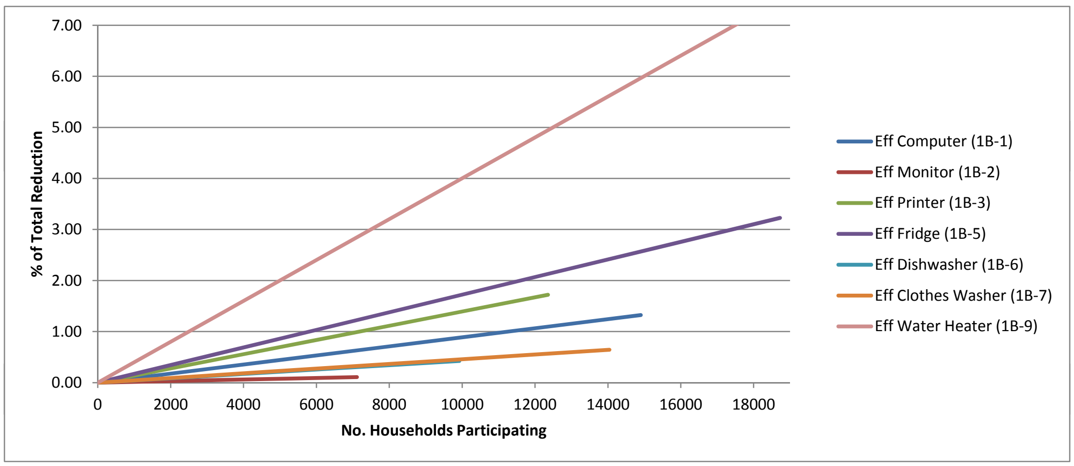
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.07	1654	43
0.14	3307	85
0.21	4961	128
0.28	6615	170
0.35	8268	213
0.42	9922	255

Eff Clothes Washer (1B-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.11	2340	64
0.21	4680	129
0.32	7020	193
0.43	9361	258
0.54	11701	322
0.64	14041	387

Eff Water Heater (1B-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.25	3120	751
2.50	6240	1503
3.75	9361	2254
5.00	12481	3006
6.25	15601	3757
7.49	18721	4509



Retro Commissioning (1C-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
10.02	3120	6030
20.05	6240	12060
30.07	9361	18091
40.09	12481	24121
50.11	15601	30151
60.14	18721	36181

Energy Conservation EDU (1C-3)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
3.52	3120	2115
7.03	6240	4231
10.55	9361	6346
14.06	12481	8462
17.58	15601	10577
21.10	18721	12693

Energy Efficiency Retrofits (1C-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
6.77	3120	4076
13.55	6240	8152
20.32	9361	12228
27.10	12481	16304
33.87	15601	20380
40.65	18721	24456

TOS Energy Upgrades[1] (1C-7)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.05	36	30
0.10	73	60
0.15	109	90
0.20	145	120
0.25	182	150
0.30	218	180

New Construction Energy Code (1C-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.43	60	258
0.86	120	515
1.28	180	773
1.71	240	1031
2.14	300	1288
2.57	360	1546

Res. Energy Code[1] (1C-11)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.06	60	38
0.13	120	76
0.19	180	114
0.25	240	152
0.32	300	191
0.38	360	229

Efficient Affordable Housing (1C-13)

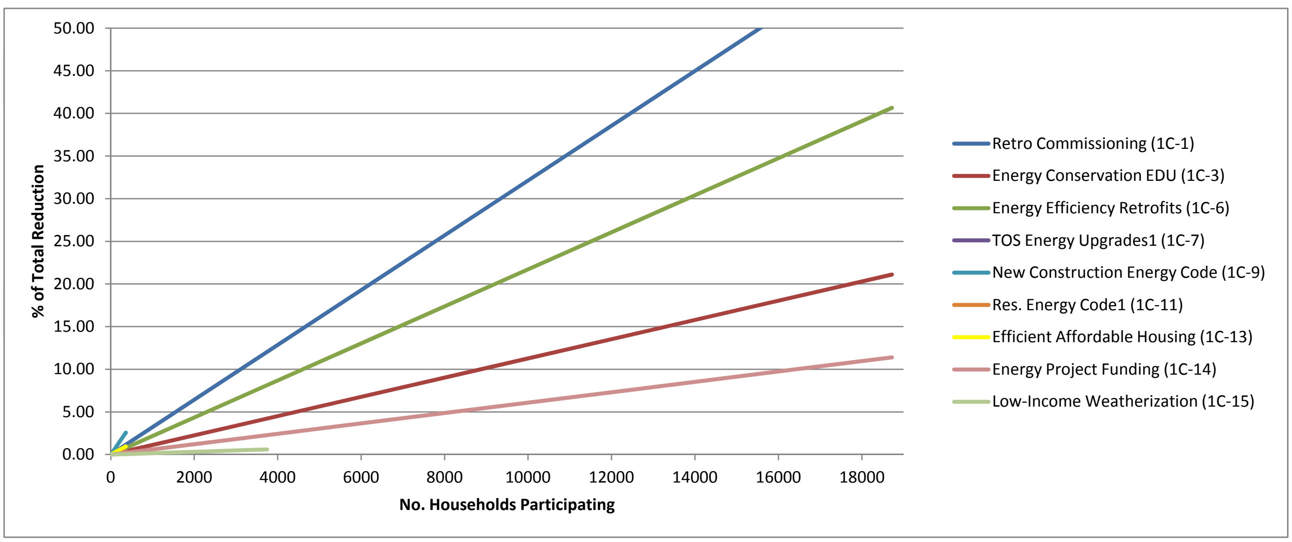
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.16	60	95
0.32	120	191
0.48	180	286
0.63	240	381
0.79	300	477
0.95	360	572

Energy Project Funding (1C-14)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.90	3120	1143
3.80	6240	2286
5.70	9361	3430
7.60	12481	4573
9.50	15601	5716
11.40	18721	6859

Low-Income Weatherization (1C-15)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.10	624	60
0.20	1248	119
0.30	1872	179
0.40	2496	239
0.50	3120	299
0.60	3744	358



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
0.02	499	13
0.04	998	25
0.06	1498	38
0.08	1997	51
0.11	2496	63
0.13	2995	76

HVAC Fan Upgrade (1D-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.66	3120	998
3.32	6240	1995
4.97	9361	2993
6.63	12481	3990
8.29	15601	4988
9.95	18721	5986

Natural Gas Heating (1D-7)

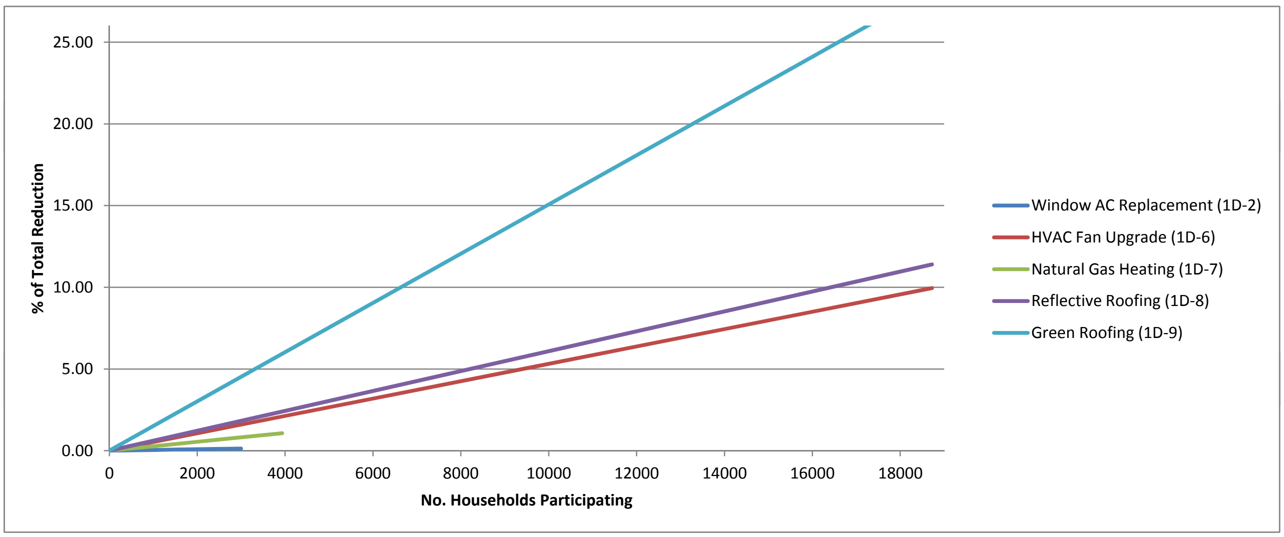
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.18	655	107
0.36	1310	215
0.54	1966	322
0.71	2621	430
0.89	3276	537
1.07	3931	645

Reflective Roofing (1D-8)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.90	3120	1143
3.80	6240	2286
5.70	9361	3428
7.60	12481	4571
9.50	15601	5714
11.40	18721	6857

Green Roofing (1D-9)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
4.70	3120	2829
9.40	6240	5658
14.11	9361	8487
18.81	12481	11316
23.51	15601	14145
28.21	18721	16974



Geothermal Heat Pumps (2-1)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.82	3120	1697
5.64	6240	3395
8.46	9361	5092
11.28	12481	6789
14.11	15601	8487
16.93	18721	10184

PV Panels (2-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
6.55	1560	3939
13.09	3120	7878
19.64	4680	11817
26.19	6240	15756
32.74	7800	19695
39.28	9361	23634

Solar Water Heaters (2-3)

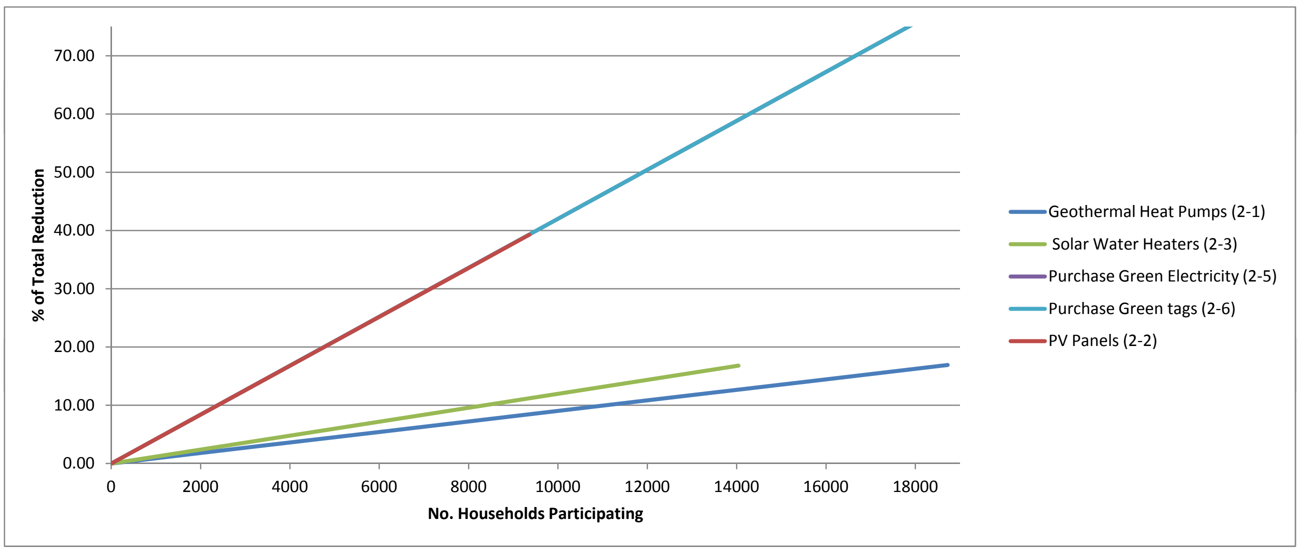
% of total reduction	no. hh particip	total GHG saved
0.00	0	0
2.80	2340	1685
5.60	4680	3370
8.40	7020	5055
11.20	9361	6740
14.00	11701	8424
16.80	14041	10109

Purchase Green Electricity (2-5)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
13.11	3120	7890
26.23	6240	15781
39.34	9361	23671
52.46	12481	31562
65.57	15601	39452
78.69	18721	47342

Purchase Green tags (2-6)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
13.11	3120	7890
26.23	6240	15781
39.34	9361	23671
52.46	12481	31562
65.57	15601	39452
78.69	18721	47342

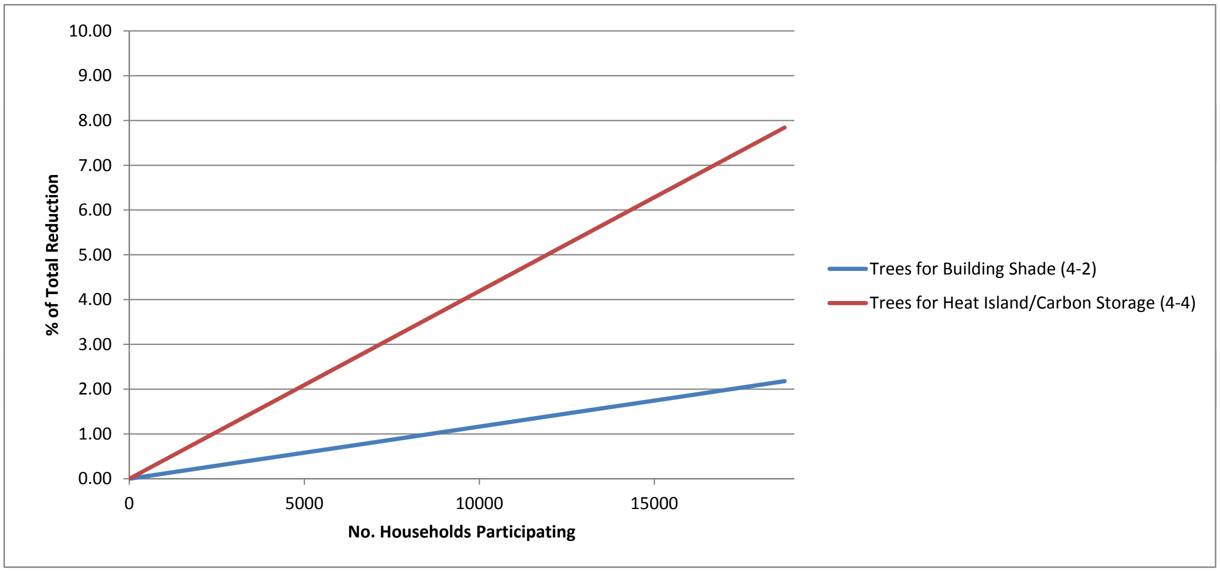


Trees for Building Shade (4-2)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
0.36	3120	218
0.73	6240	437
1.09	9361	655
1.45	12481	874
1.82	15601	1092
2.18	18721	1310

Trees for Heat Island/Carbon Storage (4-4)

% of total reduction	no. hh particip	total GHG saved
0.00	0	0
1.31	3120	786
2.61	6240	1573
3.92	9361	2359
5.23	12481	3145
6.53	15601	3931
7.84	18721	4718



Commercial Curves

LED Exit Signs (1A-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.14	3237167	86
0.29	6474333	173
0.43	9711500	259
0.57	12948667	345
0.72	16185833	432
0.86	19423000	518

Occupancy Sensors (1A-3)

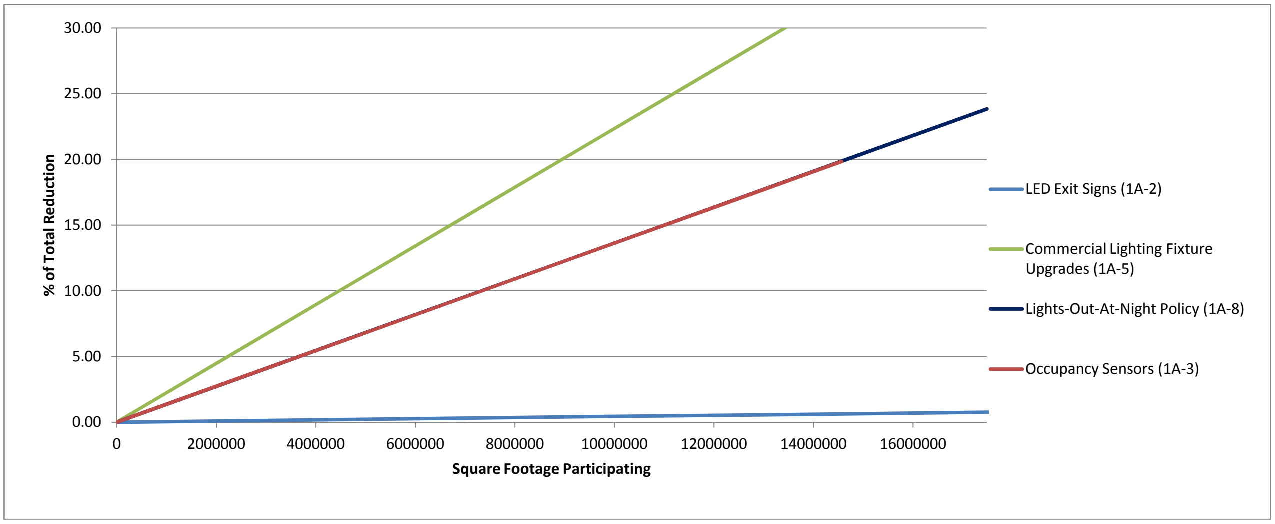
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
3.31	2427875	1991
6.62	4855750	3982
9.93	7283625	5973
13.24	9711500	7963
16.54	12139375	9954
19.85	14567250	11945

Commercial Lighting Fixture Upgrades (1A-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
5.23	2342665	3149
10.47	4685329	6298
15.70	7027994	9446
20.93	9370659	12595
26.17	11713324	15744
31.40	14055988	18893

Lights-Out-At-Night Policy (1A-8)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
3.97	2913450	2389
7.94	5826900	4778
11.91	8740350	7167
15.88	11653800	9556
19.85	14567250	11945
23.82	17480700	14334



Eff Computer (1B-1)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.03	533630	19
0.06	1067260	39
0.10	1600890	58
0.13	2134520	77
0.16	2668150	97
0.19	3201780	116

Eff Monitor (1B-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.01	527425	5
0.02	1054850	10
0.03	1582275	16
0.03	2109700	21
0.04	2637125	26
0.05	3164550	31

Eff Printer (1B-3)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.01	452965	4
0.01	905930	8
0.02	1358895	12
0.03	1811860	16
0.03	2264825	20
0.04	2717790	24

Eff Photocopier (1B-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.00857	440555	5
0.02	881110	10
0.03	1321665	15
0.03	1762220	21
0.04	2202775	26
0.05	2643330	31

Eff Refrigerators (1B-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	508810	9
0.03	1017620	19
0.05	1526430	28
0.06	2035240	37
0.08	2544050	46
0.09	3052860	56

Eff Water Cooler (1B-8)

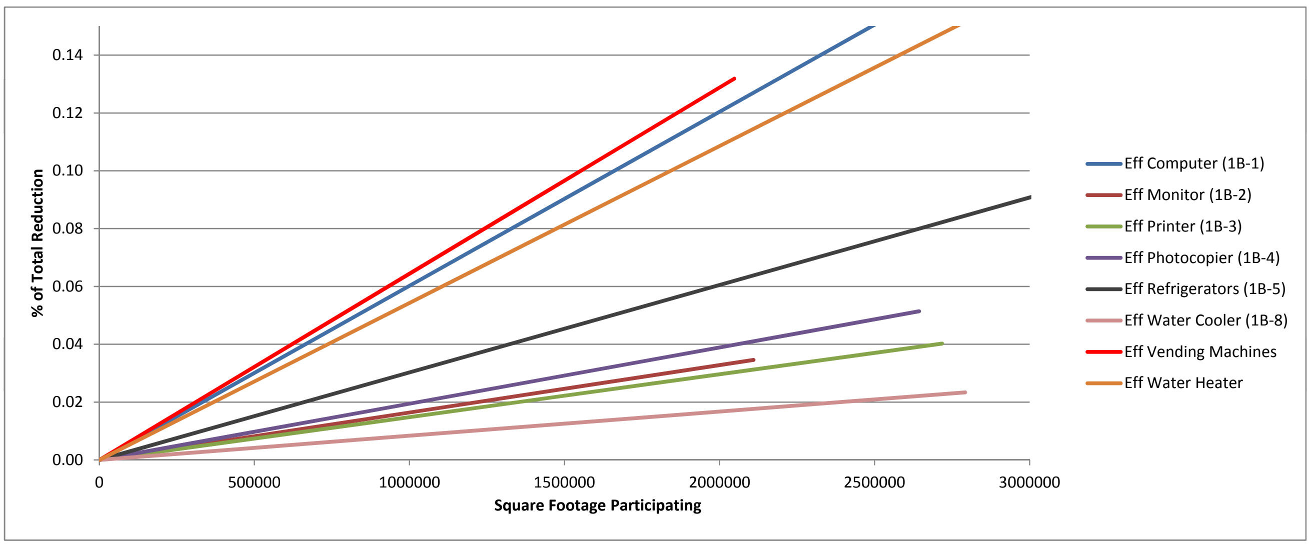
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.00	465375	2
0.01	930750	5
0.01	1396125	7
0.02	1861500	9
0.02	2326875	12
0.02	2792250	14

Eff Water Heater (1B-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.03	620500	20
0.07	1241000	41
0.10	1861500	61
0.13	2482000	81
0.17	3102500	101
0.20	3723000	122

Eff Vending Machine (1B-10)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	341275	13
0.04	682550	26
0.07	1023825	40
0.09	1365100	53
0.11	1706375	66
0.13	2047650	79



Retro Commissioning (1C-1)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
4.36	3237167	2622
8.72	6474333	5244
13.07	9711500	7866
17.43	12948667	10488
21.79	16185833	13111
26.15	19423000	15733

Energy Conservation Campaigns (1C-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
2.23	3237167	1342
4.46	6474333	2684
6.69	9711500	4026
8.92	12948667	5368
11.15	16185833	6710
13.38	19423000	8052

Green Building Practices[1] (1C-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.09	30429	56
0.18	60859	111
0.28	91288	167
0.37	121717	222
0.46	152147	278
0.55	182576	334

Energy Efficient Retrofits (1C-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.20	988708	722
2.40	1977417	1444
3.60	2966125	2165
4.80	3954833	2887
6.00	4943542	3609
7.20	5932250	4331

New Construction Energy Code[1] (1C-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.09	30429	55
0.18	60859	110
0.27	91288	164
0.36	121717	219
0.46	152147	274
0.55	182576	329

Commercial Energy Code[1] (1C-10)

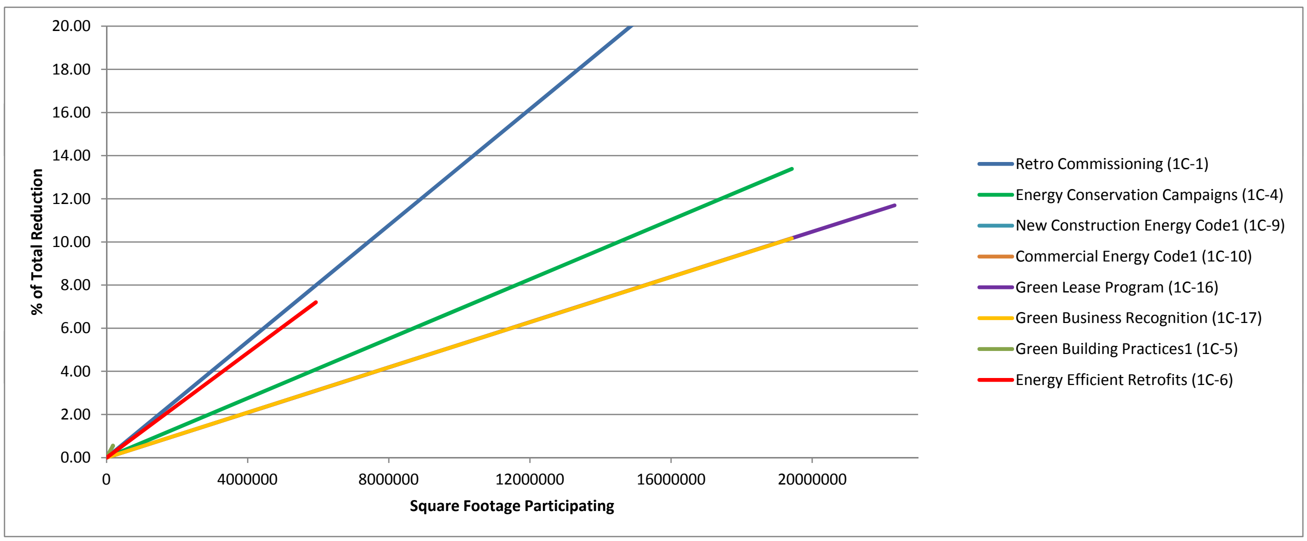
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.04	30429	22
0.07	60859	44
0.11	91288	67
0.15	121717	89
0.18	152147	111
0.22	182576	133

Green Lease Program (1C-16)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.95	3722359	1173
3.90	7444718	2345
5.85	11167077	3518
7.80	14889435	4690
9.74	18611794	5863
11.69	22334153	7035

Green Business Recognition (1C-17)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.69	3237167	1020
3.39	6474333	2039
5.08	9711500	3059
6.78	12948667	4079
8.47	16185833	5099
10.17	19423000	6118



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.

Window AC Replacement (1D-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.0000	0	0
0.0004	105485	0
0.0008	210970	0
0.0012	316455	1
0.0017	421940	1
0.0021	527425	1
0.0025	632910	1

Efficient Boiler Replacements (1D-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.02	198560	14
0.05	397120	29
0.07	595680	43
0.10	794240	57
0.12	992800	72
0.14	1191360	86

Efficient Chiller Replacements (1D-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.26	353685	154
0.51	707370	308
0.77	1061055	462
1.02	1414740	615
1.28	1768425	769
1.53	2122110	923

HVAC Fan Upgrades (1D-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.36	335536	214
0.71	671073	428
1.07	1006609	642
1.42	1342145	855
1.78	1677681	1069
2.13	2013218	1283

Natural Gas Heating Conversion[1] (1D-7)

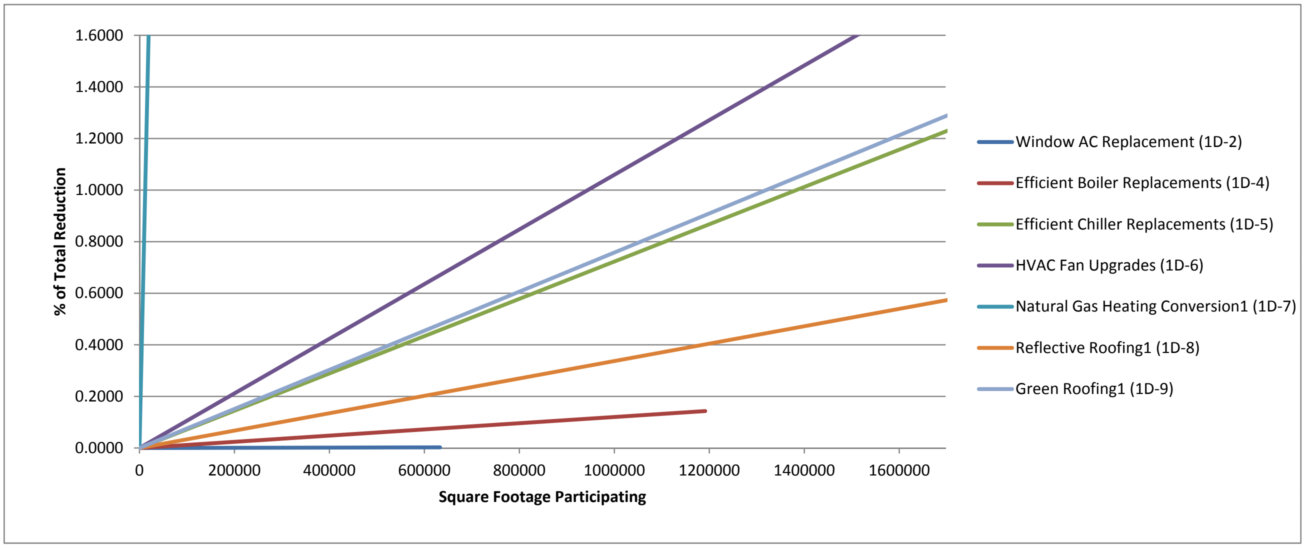
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
217.88	799310	131087
435.76	1598621	262174
653.64	2397931	393261
871.52	3197241	524348
1089.39	3996551	655434
1307.27	4795862	786521

Reflective Roofing[1] (1D-8)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
1.09	3237167	657
2.18	6474333	1314
3.28	9711500	1971
4.37	12948667	2627
5.46	16185833	3284
6.55	19423000	3941

Green Roofing[1] (1D-9)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
2.45	3237167	1476
4.91	6474333	2952
7.36	9711500	4428
9.81	12948667	5905
12.27	16185833	7381
14.72	19423000	8857



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)

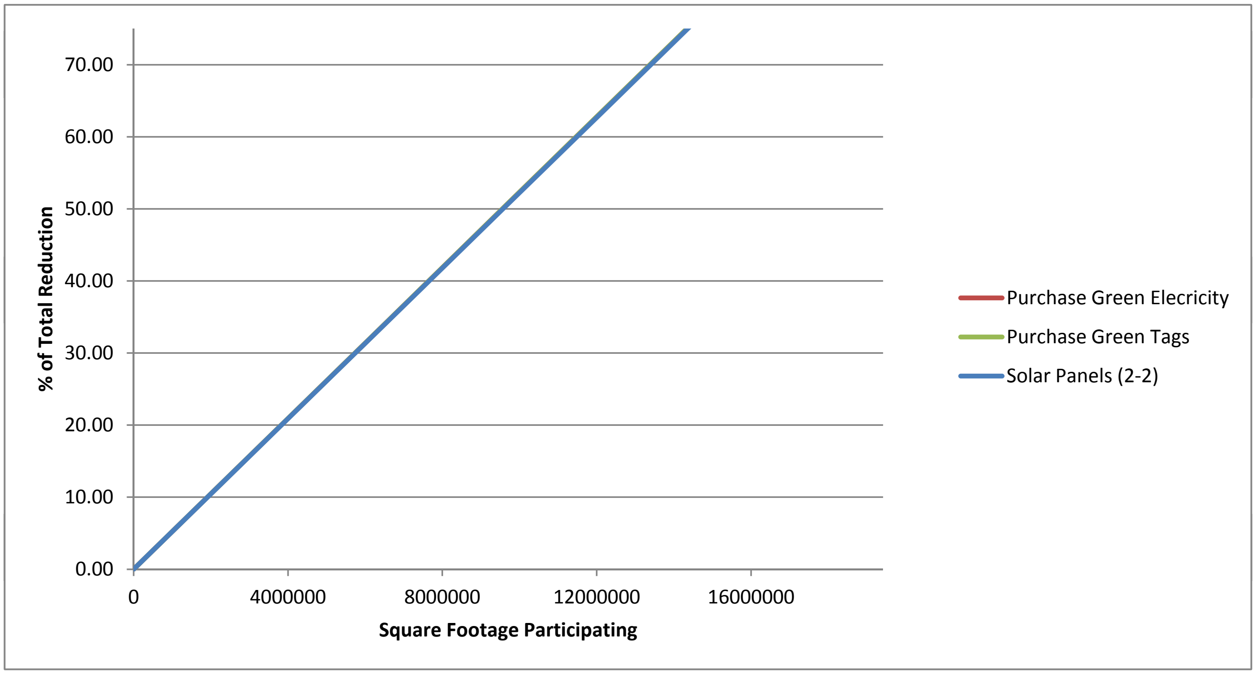
% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
12.68	2427875	7630
25.36	4855750	15261
38.05	7283625	22891
50.73	9711500	30521
63.41	12139375	38151
76.09	14567250	45782

Purchase Green Electricity[1] (2-5)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
16.94	3237167	10190
33.87	6474333	20379
50.81	9711500	30569
67.74	12948667	40758
84.68	16185833	50948
101.62	19423000	61137

Purchase Green Tags[1] (2-6)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
16.94	3237167	10190
33.87	6474333	20379
50.81	9711500	30569
67.74	12948667	40758
84.68	16185833	50948
101.62	19423000	61137



Notes:

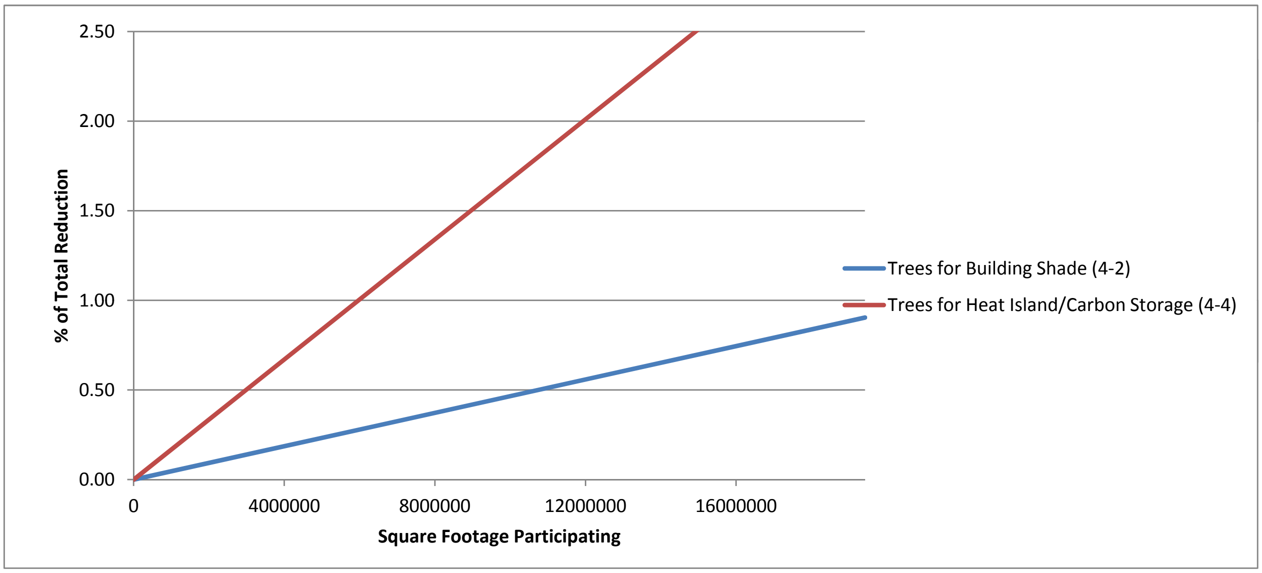
1. The graph does not show the line for Purchase Green Electricty because the % reduction and square footage is the same as for Purchase Green Tags.

Trees for Building Shade (4-2)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.15	3237167	91
0.30	6474333	181
0.45	9711500	272
0.60	12948667	363
0.75	16185833	453
0.90	19423000	544

Trees for Heat Island/Carbon Storage (4-4)

% of total reduction	Sq. Feet particip	total GHG saved
0.00	0	0
0.54	3237167	326
1.08	6474333	653
1.63	9711500	979
2.17	12948667	1305
2.71	16185833	1632
3.25	19423000	1958



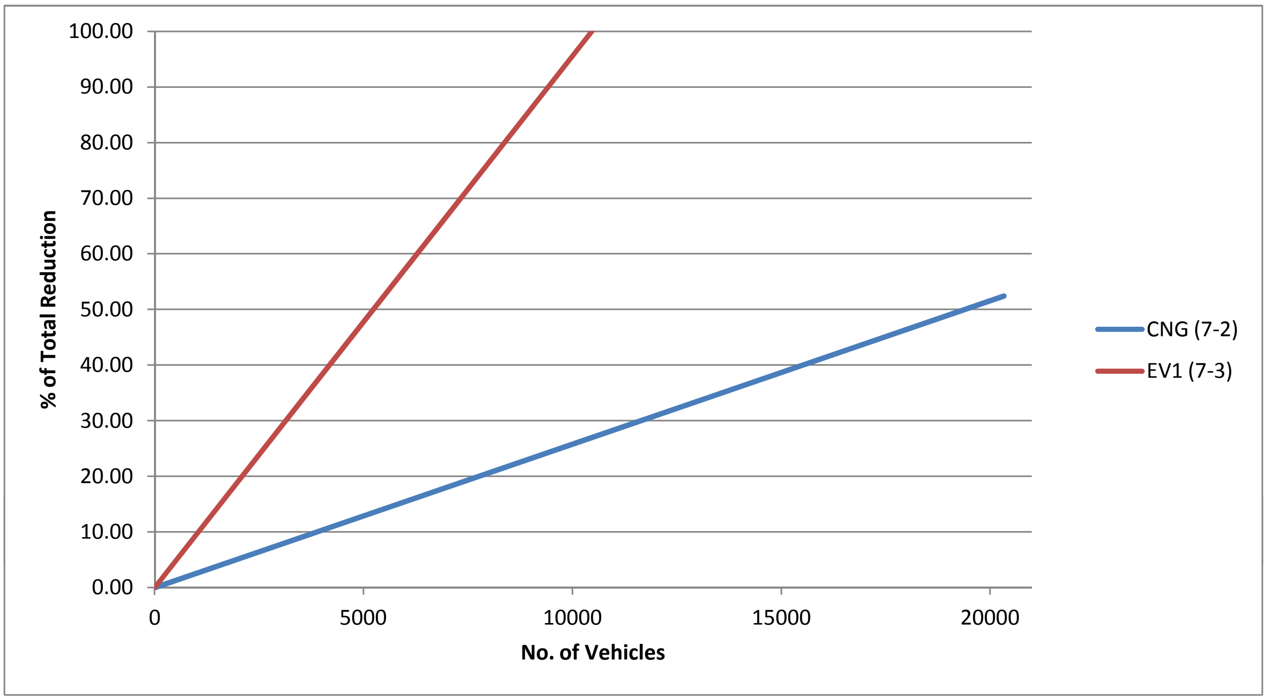
Community Transportation Curves

CNG (7-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
8.74	3389	5257
17.47	6778	10513
26.21	10167	15770
34.95	13557	21026
43.68	16946	26283
52.42	20335	31539

EV[1] (7-3)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
32.41	3391	19497
64.81	6781	38993
97.22	10172	58490
129.62	13563	77987
162.03	16954	97483
194.43	20344	116980



Notes:

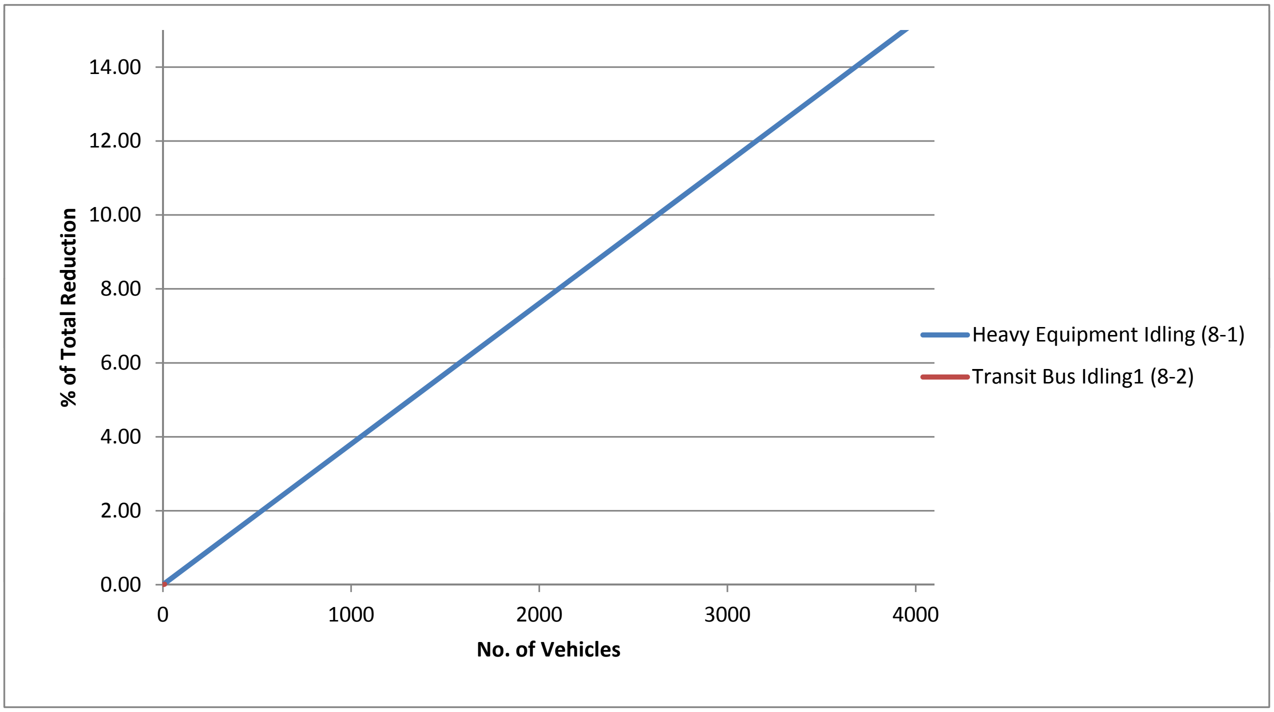
1. The maximum % reduction that can be attained for EV is higher than what is shown on the graph; See table above graph for the maximum % reduction.

Heavy Equipment Idling (8-1)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
2.58	677	1551
5.16	1354	3102
7.73	2032	4652
10.31	2709	6203
12.89	3386	7754
15.47	4063	9305

Transit Bus Idling[1] (8-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.00	2	1
0.00	3	3
0.01	5	4
0.01	6	5
0.01	8	6
0.01	9	8



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
3.26	7154	1959
6.51	14307	3918
9.77	21461	5878
13.03	28614	7837
16.28	35768	9796
19.54	42921	11755

Mass Transit Ridership (9-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
15.92	7154	9579
31.84	14307	19157
47.76	21461	28736
63.68	28614	38314
79.60	35768	47893
95.52	42921	57471

Bus Ridership (9-3)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
6.58	7124	3961
13.17	14248	7922
19.75	21372	11883
26.33	28496	15844
32.92	35620	19805
39.50	42744	23766

Transit Bike Policy (9-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
11.01	1431	6624
22.02	2861	13248
33.03	4292	19872
44.04	5723	26497
55.05	7154	33121
66.06	8584	39745

Free Student Bus Passes (9-6)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.83	712	499
1.66	1424	997
2.49	2137	1496
3.31	2849	1994
4.14	3561	2493
4.97	4273	2991

Provide Bicycles (9-7)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.45	7840	273
0.91	15680	546
1.36	23521	819
1.81	31361	1091
2.27	39201	1364
2.72	47041	1637

Safe Routes to School[1] (9-8)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.16	1399	95
0.32	2798	190
0.47	4197	285
0.63	5595	380
0.79	6994	476
0.95	8393	571

Expand Bus Service (9-9)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
4.14	7124	2493
8.29	14248	4987
12.43	21372	7480
16.58	28496	9974
20.72	35620	12467
24.87	42744	14960

Pedestrian Infrastructure (9-10)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.65	7840	392
1.30	15680	784
1.95	23521	1176
2.61	31361	1568
3.26	39201	1960
3.91	47041	2352

Bus Rapid Transit/Shuttle[2] (9-12)

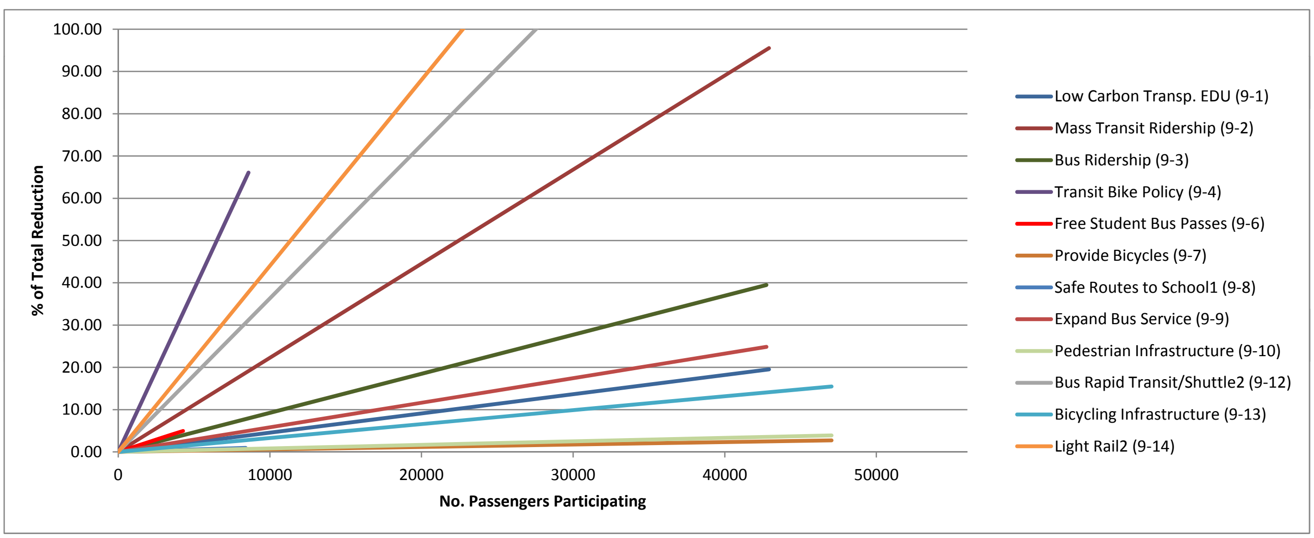
% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
25.97	7154	15623
51.93	14307	31246
77.90	21461	46870
103.87	28614	62493
129.84	35768	78116
155.80	42921	93739

Bicycling Infrastructure (9-13)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
2.58	7840	1552
5.16	15680	3105
7.74	23521	4657
10.32	31361	6209
12.90	39201	7762
15.48	47041	9314

Light Rail[2] (9-14)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
31.47	7154	18935
62.94	14307	37871
94.42	21461	56806
125.89	28614	75741
157.36	35768	94677
188.83	42921	113612

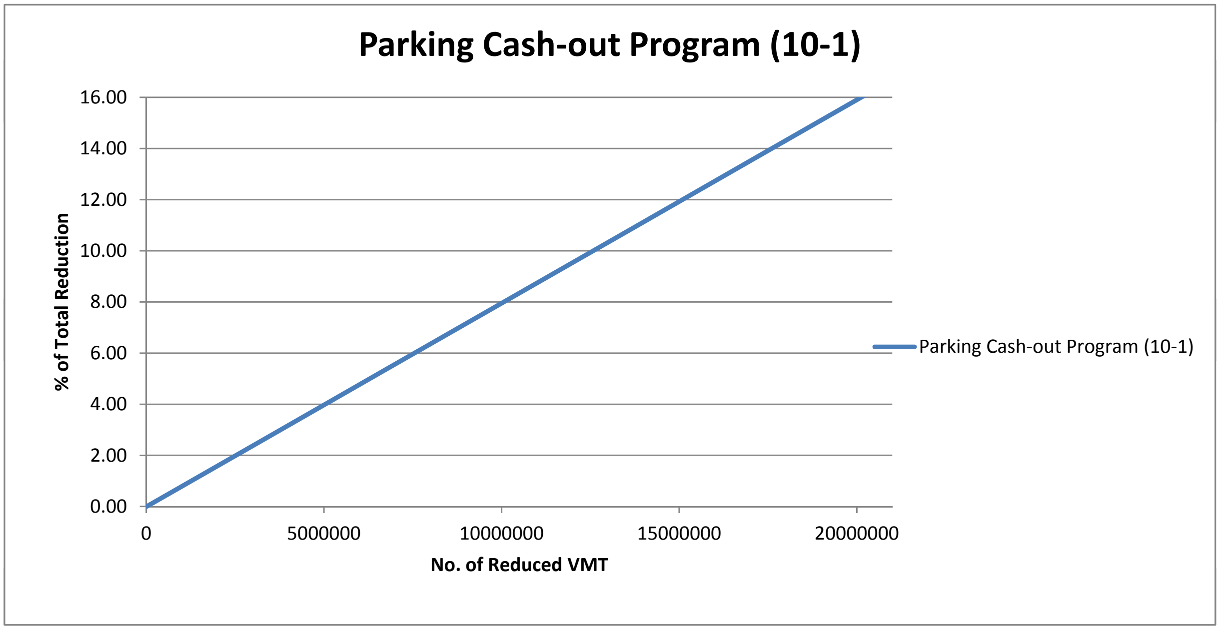


Notes:

1. The graph does not show the lines for Safe Routes to School due to the strategy's relatively small % reduction.
2. The maximum % reduction that can be attained for Bus Rapid Transit/Shuttle and Light Rail 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
2.72	3422003	1637
5.44	6844006	3274
8.16	10266010	4910
10.88	13688013	6547
13.60	17110016	8184
16.32	20532019	9821

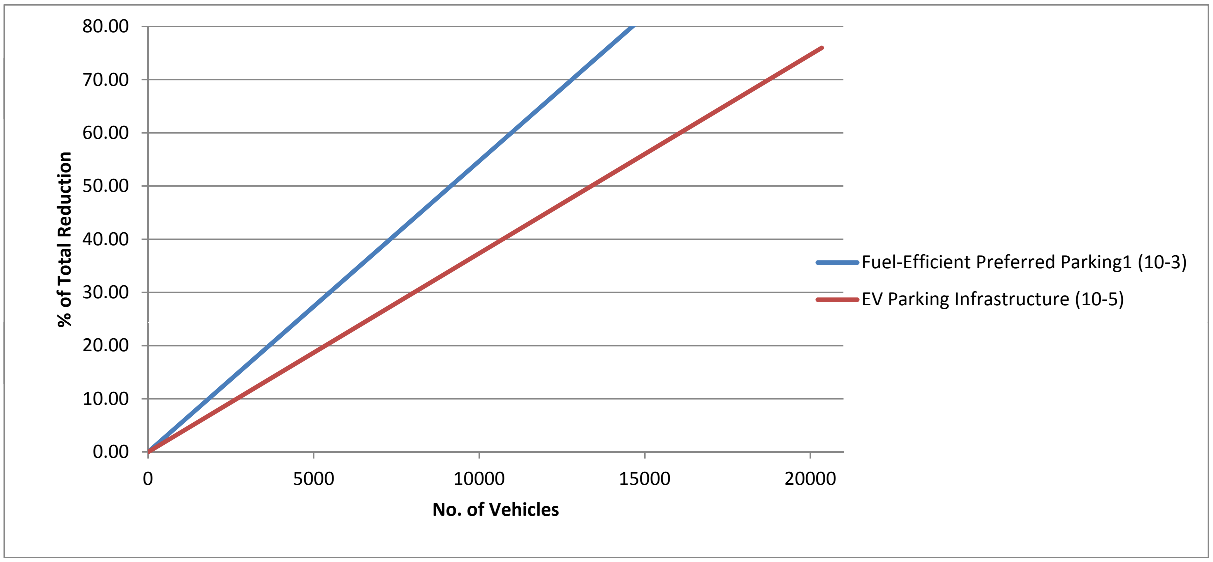


Fuel-Efficient Preferred Parking[1] (10-3)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
18.54	3391	11155
37.08	6781	22311
55.62	10172	33466
74.17	13563	44622
92.71	16954	55777
111.25	20344	66933

EV Parking Infrastructure (10-5)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
12.66	3391	7619
25.33	6781	15238
37.99	10172	22857
50.65	13563	30476
63.32	16954	38095
75.98	20344	45714



Notes:

1. The maximum % reduction that can be attained for Fuel-Efficient Preffered Parking 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
0.31	33	188
0.62	65	376
0.94	98	564
1.25	131	751
1.56	163	939
1.87	196	1127

Ethanol (E85) Conversion (18-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.27	33	160
0.53	65	319
0.80	98	479
1.06	131	639
1.33	163	799
1.59	196	958

CNG Conversion (18-3)

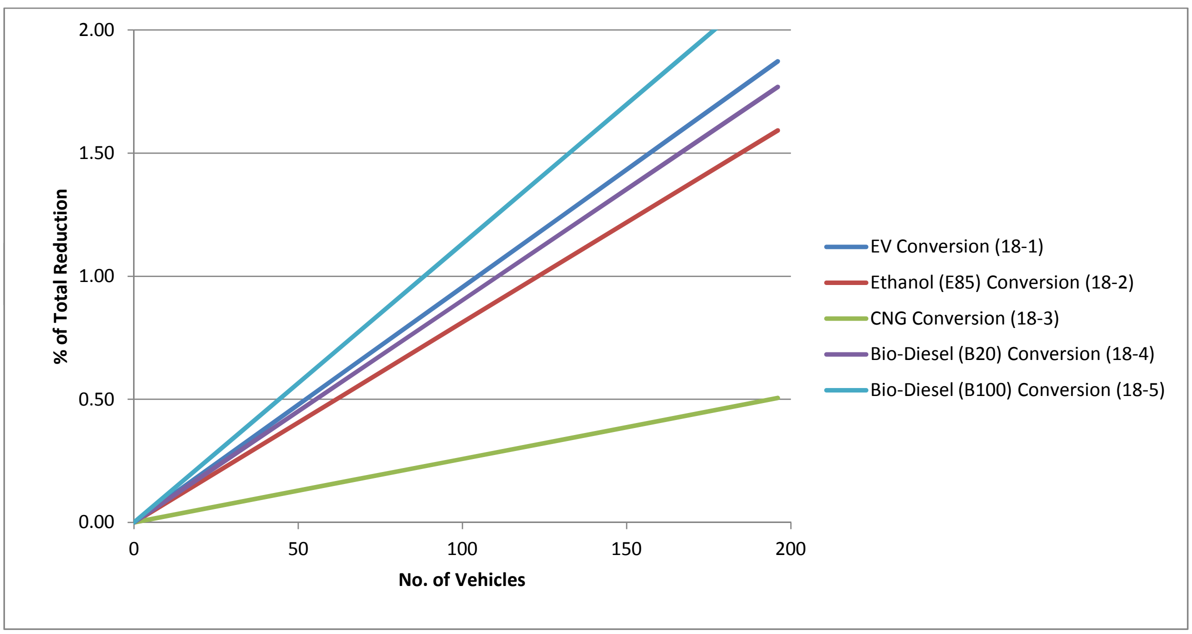
% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.08	33	51
0.17	65	101
0.25	98	152
0.34	131	203
0.42	163	253
0.51	196	304

Bio-Diesel (B20) Conversion (18-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.29	33	177
0.59	65	355
0.88	98	532
1.18	131	710
1.47	163	887
1.77	196	1064

Bio-Diesel (B100) Conversion (18-5)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.37	33	222
0.74	65	445
1.11	98	667
1.48	131	890
1.85	163	1112
2.22	196	1335

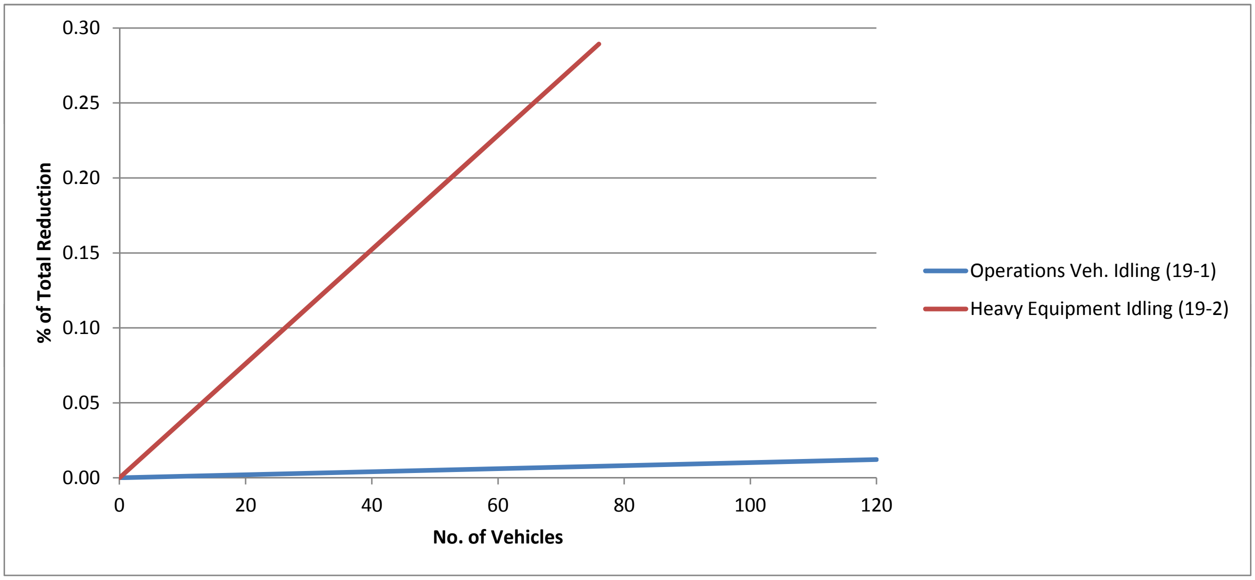


Operations Veh. Idling (19-1)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.00	20	1
0.00	40	2
0.01	60	4
0.01	80	5
0.01	100	6
0.01	120	7

Heavy Equipment Idling (19-2)

% of total reduction	no. veh particip	total GHG saved
0.00	0	0
0.05	13	29
0.10	25	58
0.14	38	87
0.19	51	116
0.24	63	145
0.29	76	174

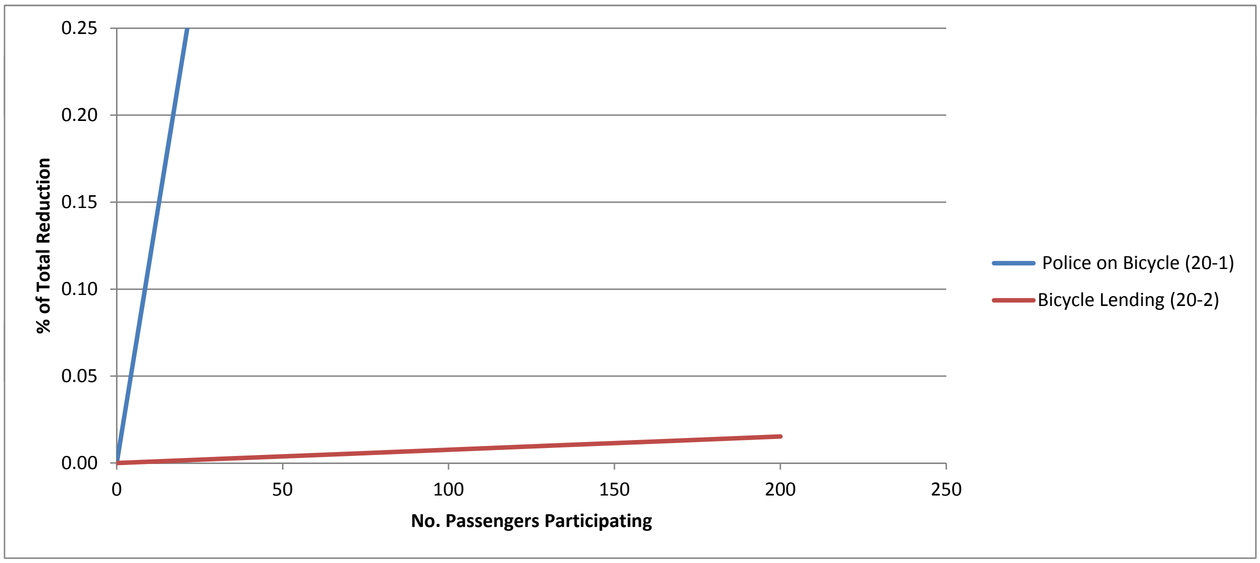


Police on Bicycle (20-1)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.05	4	27
0.09	8	54
0.14	12	81
0.18	15	109
0.23	19	136
0.27	23	163

Bicycle Lending (20-2)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.00	33	2
0.01	67	3
0.01	100	5
0.01	133	6
0.01	167	8
0.02	200	9



Eff. Parking Vehicles (21-2)

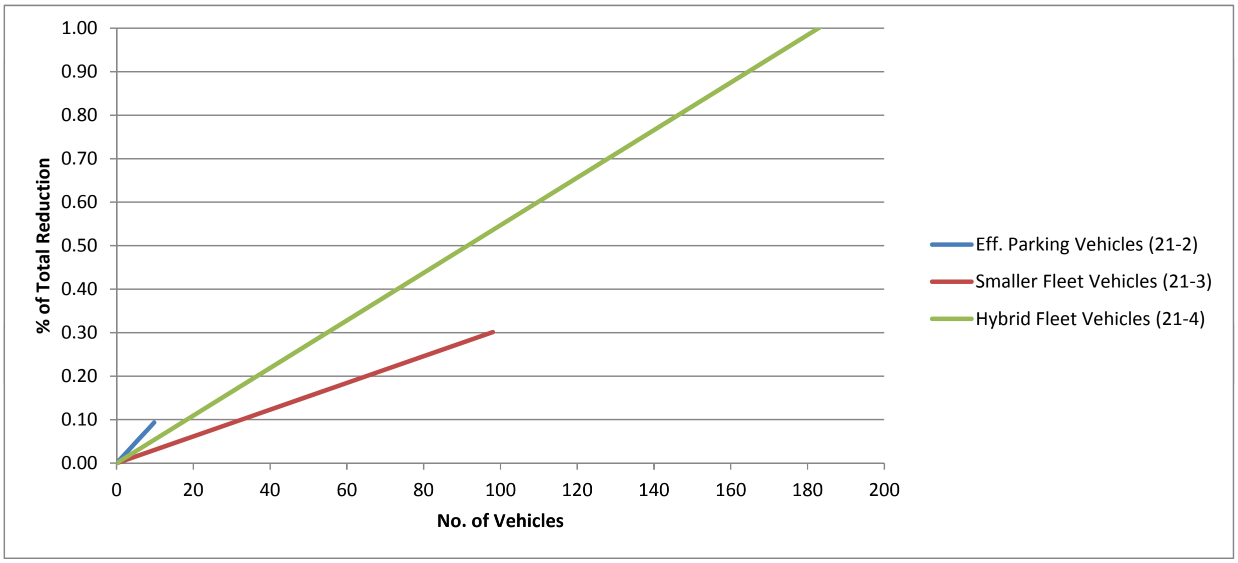
% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.02	2	9
0.03	3	19
0.05	5	28
0.06	7	38
0.08	8	47
0.09	10	56

Smaller Fleet Vehicles (21-3)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.05	16	30
0.10	33	60
0.15	49	91
0.20	65	121
0.25	82	151
0.30	98	181

Hybrid Fleet Vehicles (21-4)

% of total reduction	no. ppl particip	total GHG saved
0.00	0	0
0.18	33	107
0.36	65	215
0.54	98	322
0.71	131	430
0.89	163	537
1.07	196	645



Appendix C
2035 Forecasts and Target Methodology

Adopted May **2017**

APPENDIX C

2035 Forecasts and Target Methodology

The baseline emissions inventory was forecast to future planning horizon years (i.e., 2020 and 2035) to provide an estimate against which to measure emissions reduction target progress. As described in the Climate Action Plan (CAP), the City partnered with the University of California, Davis Sustainable Design Academy to develop the 2020 emissions forecasts and Preliminary 2020 CAP document. AECOM later prepared the 2035 community-wide emissions forecasts and long-term emissions reduction analysis as part of the General Plan Update process. This appendix describes methodologies and assumptions pertaining to the 2035 analysis. Appendix B, 2020 Climate Action Plan Technical Report, describes the previous work undertaken to develop the 2020 analysis.

This appendix first describes the indicators and assumptions used to forecast the business-as-usual (BAU) community-wide emissions in 2035. BAU forecasts represent the emissions growth that can be reasonably expected to occur without local, statewide, or federal intervention (beyond those policies or programs already in place as of the baseline year). It then describes the methodology used to estimate the impact of statewide actions considered in the two adjusted business-as-usual (ABAU) forecast scenarios that correspond to the two land use scenarios considered in the draft General Plan Update. Finally, it presents the rationale for selecting the City's 2035 GHG target based on efforts and projections at the statewide level.

2035 Business-as-Usual Emissions Forecasts

AECOM referenced the 2020 emissions forecast methodologies described in the 2020 Climate Action Plan Technical Report, where possible, when choosing growth indicators and/or forecasting methodologies for the 2035 GHG analysis to provide consistency between the two forecasting years. This section describes the methodological approach taken to develop BAU emissions forecasts for the 2035 horizon year.

Emissions Growth Indicators

Estimating future GHG emissions resulting from community-wide land use activities is an imprecise science. A single formula cannot perfectly capture the number of factors affecting how residents, businesses, and industries will consume resources in the future. Rather, numerous indicators can illustrate the growth of GHG emissions and resource consumption within a community. The indicators most directly linked to residential, commercial, and industrial resource consumption are community-wide population and local jobs. Increases in residents or jobs are typically associated with growth in household sizes, number of dwelling units, and non-residential square footage, all of which lead to increased energy consumption, transportation, water use, solid waste and wastewater generation, and other GHG-generating activities. Service population (SP) is another commonly used indicator for emissions forecasting purposes, which represents the sum of resident population and local jobs within a community.

Emissions projection indicators should (1) represent the factors that influence GHG emissions growth within a community, (2) be based on the local context for greater applicability (as opposed to use of statewide or national trends), and (3) represent a readily-available metric to facilitate future revisions. In addition, the 2035 emissions forecasts for this project were also developed to maintain consistency with the previously prepared 2020 forecasts, where feasible. Use of the three previously identified growth indicators (i.e., population, jobs, service population) in Woodland achieves these goals, and further strengthens the relationship between the 2035 General Plan and the CAP.

AECOM used population and jobs data from the 2005 baseline year and 2035 General Plan horizon year to estimate community emissions growth, assuming a linear growth trend. Table C.1 shows the growth indicators used in the 2035 forecasts, including separate metrics for the General Plan: Lower and General Plan: Higher land use scenarios. The table includes population, jobs, and service population metrics, as well as the annual average growth rates for 2005-2035.

Table C.1

City of Woodland Service Population Growth

		General Plan: Lower Scenario		**General Plan: Higher Scenario**	
Indicator	**2005**	**2035**	**Average Annual Growth** (2005-2035)	**2035**	**Average Annual Growth** (2005-2035)
Population	52,584 [1]	74,990 [2]	1.4%	74,990 [2]	1.4%
Jobs	24,634 [1]	44,210 [2]	2.6%	45,340 [2]	2.8%
Service Population	77,218	119,200	1.8%	120,330	1.9%

Source: AECOM 2016

Note: Service Population = Population + Jobs

[1] County of Yolo Comprehensive Economic Development Strategy (CEDS), 2009-2014 (As Amended – August 2009)

[2] Dyett and Bhatia 2016

Emissions Forecast Methodology

As previously described, AECOM reviewed the methodology used to develop the 2020 emissions forecast and followed a similar approach, where feasible, to calculate the 2035 emissions forecasts. Table C.2 lists the growth indicators that were applied to each emissions sector and/or subsector to estimate the 2035 forecasts.

Table C.2
Growth Indicators by Sector

Sector / *Subsector*	**Growth Indicator**
Transportation	Vehicle Miles Traveled (VMT) from traffic model
Energy	
Electricity - Commercial	Service Population average annual growth
Electricity - Residential	Residential average annual growth
Natural Gas - Commercial	Service Population average annual growth
Natural Gas - Residential	Residential average annual growth
Solid Waste	Tons disposed per service population
Wastewater Reuse	Calculated using equation in 2020 Climate Action Plan Technical Report
Municipal Energy Use	Residential average annual growth
Municipal Transportation	Residential average annual growth
Water and Wastewater	Residential average annual growth

The following formula demonstrates how the majority of GHG emissions sectors[1] were forecast using average annual growth rates (i.e., population or service population):

$$Emissions_{2035} = Emissions_{BASE} + (Emissions_{BASE} \times AAGR \times Years)$$

Where:

$Emissions_{2035}$ = GHG emissions during the 2035 planning horizon year

$Emissions_{BASE}$ = GHG emissions during the 2005 baseline year

AAGR = average annual growth rate from Table C.1

Years = years of growth between the baseline and planning horizon year

Emissions were forecast from the 2005 baseline year to the 2035 planning horizon year, which represents 30 years of growth (i.e., *Years* factor above), respectively.

[1] *This equation was not applied to the Transportation sector, Solid Waste sector, or Wastewater Reuse sectors*

Transportation, Solid Waste, and Wastewater Reuse emissions were quantified using a different methodology than that expressed in the equation above. The following sections provide additional detail on these sectors, and a calculation nuance applied to the electricity subsectors.

Electricity Subsectors

As described in the CAP, the 2020 forecasts were prepared under an ABAU scenario that considered the future impact of the Renewables Portfolio Standard (RPS), Pavley I, and the Low Carbon Fuel Standard (LCFS).[2] In order to estimate the future impact of statewide reductions described in the next section of this appendix, AECOM completed an additional step in the 2035 BAU forecast process related to electricity subsectors. AECOM collected activity data for the electricity-related subsectors (i.e., kilowatt hours [kWh] consumed) from the 2020 Climate Action Plan Technical Report, and then applied the annual average growth forecast indicators listed in Table C.2 to estimate future activity levels in the electricity subsectors in the Energy, Municipal Energy Use, and Water and Wastewater sectors. Table C.3 lists the 2005 electricity activity data and the 2035 forecast activity data used to estimate the BAU emissions.

Table C.3
Electricity Subsector Activity Data

Sector/Subsector	2005 Electricity Consumption (kWh/yr) [1]	General Plan: Lower Scenario	General Plan: Higher Scenario
		2035 Electricity Consumption (kWh/yr)	**2035 Electricity Consumption (kWh/yr)**
Energy - Electricity			
Commercial	*188,727,474*	*291,335,115*	*294,096,933*
Residential	*133,260,950*	*190,043,333*	*190,043,333*
Municipal Energy Use			
Electricity	*4,652,583*	*6,635,045*	*6,635,045*
Water and Wastewater			
Potable Water Supply	*6,013,878*	*8,576,387*	*8,576,387*
Wastewater Treatment	*4,138,112*	*5,901,358*	*5,901,358*

[1] Climate Action Plan Technical Report, City of Woodland, Final Report. December 2012.

The estimated future electricity consumption was then multiplied by the 2005 baseline year electricity emissions factor (i.e., MT CO_2e/kWh) to calculate future year emissions. This approach assumes that the RPS is not implemented, and therefore, future electricity emissions are generated at the same rate as in the baseline year (i.e., each unit of electricity consumption will generate the same amount of GHG emissions).

[2] *The Preliminary 2020 CAP described the 2020 calculations as BAU forecasts, though they more accurately align with what is traditionally referred to as ABAU forecasts in CAPs and emissions inventories from other jurisdictions.*

Table C.4 shows the 2005 and 2020/2035 electricity emissions factors used to calculate BAU and ABAU electricity emissions.

Table C.4

Electricity Emissions Factors

	2005 ($MT\ CO_2e/kWh$)	2020 / 2035 ($MT\ CO_2e/kWh$)
Electricity Emissions Factor [1]	0.000224	0.000132

Note: MT CO_2e = metric tons of carbon dioxide equivalent; kWh = kilowatt hours

[1] Climate Action Plan Technical Report, City of Woodland, Final Report. December 2012.

Transportation Sector

The transportation emissions sector includes exhaust-related GHG emissions associated with on-road vehicles coming to and leaving from the City of Woodland. The 2035 transportation emissions were calculated based on the projected levels of vehicle travel within the community under the two General Plan land use scenarios evaluated in the CAP (i.e., General Plan: Lower and General Plan: Higher scenarios). This approach directly links the future emissions forecasts with the land use and circulation strategies described in the City's General Plan, and is different from the transportation emissions analysis prepared for the 2020 CAP. Please see Appendix B, 2020 Climate Action Plan Technical Report for a description of how the 2020 transportation emissions were calculated.

The City's transportation consultant, Fehr and Peers, provided AECOM with 2035 vehicle miles traveled (VMT) estimates for the two General Plan land use scenarios using their own in-house Travel Demand Forecasting Model. This forecast method allows more specific estimates for future transportation sector emissions than would be possible using the previously described average annual growth rate approach, as the VMT estimates were based on the mix and geographic distribution of land uses described in the City's General Plan. Table C.5 presents estimated daily VMT for each land use scenario in 2035, along with the annualization factor used to convert daily VMT to annual values.

Table C.5

2035 Transportation Growth Estimates

Transportation Category	General Plan: Lower Scenario	General Plan: Higher Scenario
Daily Vehicle Miles Traveled (DVMT)	2,092,768	2,107,542
Annualization Factor	347	347

Source: Fehr and Peers 2016

Vehicle trips were distinguished by their origin and destination as being internal (i.e., within city limits) or external (i.e., outside of city limits). For the purposes of this GHG forecast and pursuant to the Regional Targets Advisory Committee (RTAC) prescribed methods, only the internal-internal and external-internal vehicle trips were included in the City's emissions forecasts.[3] That is, if a vehicle trip originated and terminated within city limits, it would be considered an internal-internal trip. If a trip originated within city limits and terminated outside of city limits, or vice versa, it would be considered an internal-external trip

[3] Regional Targets Advisory Committee (RTAC). 2009. Recommendations of the Regional Targets Advisory Committee (RTAC) Pursuant to Senate Bill 375: Report to the California Air Resources Board. Available: <http://www.arb.ca.gov/cc/sb375/rtac/report/092909/finalreport.pdf>. Accessed March 2014.

(or an external-internal trip). If a trip neither originated nor terminated within city limits, but passed through city limits, this external-external trip VMT would be omitted from the inventory because the jurisdiction has no control over the trip, and therefore is not responsible for its associated emissions.

One hundred percent of VMT associated with internal-internal trips were included in the forecasts. RTAC recommends that a jurisdiction take responsibility for half of the VMT if a trip would originate or terminate in its jurisdiction. Therefore, 50% of the internal-external and external-internal VMT were included in the forecasts. All external-external trips and VMT were omitted from Woodland's forecasts. The daily VMT shown in Table C.5 represent the total VMT included in the GHG analysis (i.e., 100% of internal-internal, 50% of internal-external and external-internal, and 0% of external-external). Speed bin data for baseline and future condition VMT was also obtained from Fehr and Peers.[4]

Relationship of BAU and ABAU Transportation Sector Emissions

In the past, community-wide VMT estimates were combined with on-road emissions factors provided in the California Air Resources Board (ARB) EMFAC model. EMFAC is a mobile source emission model for California that provides vehicle emission factors by vehicle class and county or region. Previous versions of the model would provide BAU on-road emissions estimates, as well as ABAU emissions estimates that reflected the estimated impact of Pavley I and LCFS. However, in its most recent revision to the model, ARB incorporated all known statewide transportation regulations into the model outputs, such that EMFAC2014 (the current version of the model recommended for use by ARB) provides only ABAU emissions estimates (i.e., BAU emissions can no longer be calculated in the model). Therefore, in order to estimate BAU transportation emissions at the community-wide level, AECOM evaluated the relationship of BAU and ABAU estimates in previous versions of the model based on a review of the City's previous 2020 transportation emissions calculations. Table C.6 shows the results of this analysis.

Table C.6

Relationship of BAU and ABAU Transportation Estimates in 2020 Forecasts

Total County On-Road Emissions – 2020 Forecast	MT CO_2e/yr
Business-as-Usual (BAU)	1,533,541
Adjusted Business-as-Usual (ABAU)	1,194,846
Ratio of ABAU to BAU Emissions	0.779

Source: Woodland 2020 CAP, AppendixIB3_2020BAU_Transportation_WD.xlsx; provided to AECOM by City of Woodland 2016

As shown in Table C.6, the ratio of ABAU to BAU emissions estimated for 2020 is equal to 0.779; or stated differently, statewide actions were estimated to result in emissions reductions of approximately 22.1% in the transportation sector in 2020. Using this relationship between ABAU and BAU emissions estimates, AECOM estimated Woodland's BAU transportation emissions in 2035 under the two land use scenarios. The ABAU transportation emissions presented later in Table C.10 were divided by 0.779 to estimate BAU transportation emissions. This approach assumes that the ratio of BAU to ABAU transportation emissions will remain the same in 2035 as was estimated for 2020.

[4] Speed bin data disaggregates total VMT into vehicle speed ranges (e.g., 0-5 miles per hour [mph], 5-10 mph) to support finer-grained transportation emissions analysis that considers the variability of GHG emissions rates as a function of vehicle speed.

Solid Waste Sector

AECOM calculated community-wide solid waste emissions for the 2005 base year inventory and the 2020 and 2035 target years. See the following section *Solid Waste Emissions Estimates* for the methodologies applied to that sector.

Wastewater Reuse Sector

The baseline and 2020 GHG emissions include an emissions sector associated with the application to agricultural land of wastewater from Pacific Coast Producers tomato processing and canning. AECOM applied the same equation described in the 2020 Climate Action Plan Technical Report to forecast emissions in 2035 from this sector. As in the 2020 forecasts, the 2035 forecasts assume that the average amount of nitrogen added to the soil for the harvest season remains unchanged in future years. Similarly, the 2035 forecasts also assume that the biochemical oxygen demand (BOD) loading rate will increase by 0.5% each year after 2011. Table C.7 depicts the estimated BOD emissions from 2020 through 2035.

Table C.7

Wastewater Reuse Emissions Forecast 2020-2035

Year	Soil Mineralization (MT CO_2e/yr) [1]	BOD Degradation (MT CO_2e/yr) [2]	Total (MT CO_2e/yr)
2020	423	4,136	4,559
2021	423	4,157	4,580
2022	423	4,177	4,600
2023	423	4,198	4,621
2024	423	4,219	4,642
2025	423	4,240	4,663
2026	423	4,262	4,685
2027	423	4,283	4,706
2028	423	4,304	4,727
2029	423	4,326	4,749
2030	423	4,348	4,771
2031	423	4,369	4,792
2032	423	4,391	4,814
2033	423	4,413	4,836
2034	423	4,435	4,858
2035	423	4,457	4,880

Source: AECOM 2016

[1] Soil mineralization emissions held constant per City’s 2020 GHG forecast methodology; Climate Action Plan Technical Report, City of Woodland, Final Report. December 2012.

[2] BOD degradation emissions estimated to grow by 0.05% annually per City’s 2020 GHG forecast methodology; Climate Action Plan Technical Report, City of Woodland, Final Report. December 2012.

Table C.8 on the following page shows the 2035 BAU emissions forecasts.

Table C.8
2035 BAU Emissions Forecasts

Sectors	General Plan: Lower Scenario MT CO_2e/yr	General Plan: Higher Scenario MT CO_2e/yr
Transportation	**314,852**	**317,574**
Energy	**249,500**	**250,936**
Electricity	*107,657*	*108,275*
Commercial	65,155	65,773
Residential	42,502	42,502
Natural Gas	*141,843*	*142,661*
Commercial	86,366	87,185
Residential	55,477	55,477
Solid Waste	**25,616**	**25,858**
Wastewater Reuse	**4,880**	**4,880**
Municipal Energy Use	**2,173**	**2,173**
Electricity	*1,484*	*1,484*
Natural Gas	*689*	*689*
Municipal Transportation	**1,643**	**1,643**
Water and Wastewater	**3,803**	**3,803**
Electricity Use	*3,238*	*3,238*
Potable Water Supply	1,918	1,918
Wastewater Treatment	1,320	1,320
Process Emissions	*565*	*565*
Treatment	93	93
Effluent	472	472
TOTAL	**602,467**	**606,867**

Note: MT CO_2e/yr = metric tons of carbon dioxide equivalent per year; Columns may not appear to sum exactly due to rounding
Source: AECOM 2016

Solid Waste Emissions Estimates

The Preliminary 2020 CAP did not include estimates of community solid waste emissions because the City does not control local landfill operations. The majority of Woodland's solid waste is disposed of at the Yolo County Central Landfill operated by Yolo County, and the Yolo County CAP accounted for these emissions and reduction opportunities. Since the Preliminary 2020 CAP was developed, consensus within the GHG inventory industry has evolved such that it is common practice for a community to estimate and report solid waste emissions even if its waste is treated outside of the city boundaries. AECOM prepared solid waste emissions estimates for the 2005 base year, and the 2020 and 2035 forecast years using the methane commitment model outlined in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The equations and inputs associated with that model are presented below, followed by additional data items used to estimate Woodland's solid waste emissions.

AECOM applied equations 8.1, 8.3, and 8.4 from the GPC for each of the land use scenarios considered (i.e., General Plan: Lower and General Plan: Higher scenarios). The calculations assumed a baseline methane capture factor at the Yolo County Landfill of 75%, which corresponds to the f_{rec} value in equation 8.3. The Yolo County CAP identified a 75% methane capture rate in the landfill as part of the inventory baseline conditions, as well as a goal of 90% capture for 2030. AECOM prepared the same analysis using the estimated waste disposals values for the 2020 target year to estimate strategy reductions in that target year, as well. The 2035 solid waste emissions estimates are based on the same per service population disposal rate for the General Plan: Lower and General Plan Higher: scenarios, as described later in this section. Therefore, the estimates are not based on assumptions of different land uses that could occur under each scenario, which might result in a different solid waste disposal rate. Future GHG inventory updates are the best method for monitoring actual solid waste emissions in the community.

Equation 8.1: Degradable organic carbon (DOC)

DOC = (0.15 x A) + (0.2 x B) + (0.4 x C) + (0.43 x D) + (0.24 x E) + (0.15 x F) + (0.39 x G) + (0.0 x H) + (0.0 x I) + (0.0 x J) + (0.0 x K)	
A	= Fraction of solid waste that is food
B	= Fraction of solid waste that is garden waste and other plant debris
C	= Fraction of solid waste that is paper
D	= Fraction of solid waste that is wood
E	= Fraction of solid waste that is textiles
F	= Fraction of solid waste that is industrial waste
G	= Fraction of solid waste that is rubber and leather
H	= Fraction of solid waste that is plastics
I	= Fraction of solid waste that is metal
J	= Fraction of solid waste that is glass
K	= Fraction of solid waste that is other, inert waste

Source: Default carbon content values sourced from IPCC Waste Model spreadsheet, available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf
Note: GPC Equation 8.1 includes factors A-F; AECOM added factors G-K using the default DOC content in % of wet waste from the same IPCC Waste Model spreadsheet referenced in the source above

Equation 8.3: Methane commitment estimate for solid waste sent to landfill

CH_4 emissions = MSW_x x L_0 x (1-f_{rec}) x (1-OX)		
Description		**Value**
CH_4 emissions	= Total CH4 emissions in metric tons	Computed
MSW_x	= Mass of solid waste sent to landfill in inventory year, measured in metric tons	User input
L_0	= Methane generation potential	Equation 8.4 Methane generation potential
f_{rec}	= Fraction of methane recovered at the landfill (flared or energy recovery)	User input
OX	= Oxidation factor	0.1 for well-managed landfills; 0 for unmanaged landfills

Source: Adapted from *Revised 1996 IPCC Guidelines for National Greenhous Gas Inventories*

AECOM used the following values in Equation 8.3 for Woodland's calculations:

- MSW_x = see Table C.12
- f_{rec} = 75%
- OX = 0.1

Equation 8.4: Methane generation potential, L_0

L_0 = MCF x DOC x DOC_F x F x 16/12		
Description		**Value**
L_0	= Methane generation potential	Computed
MCF	= Methane correction factor based on type of landfill site for the year of deposition (managed, unmanaged, etc., fraction)	Managed = 1.0 Unmanaged (≥ 5 m deep) = 0.8 Unmanaged (<5 m deep) = 0.4 Uncategorized = 0.6
DOC	= Degradable organic carbon in year of deposition, fraction (tons C/tons waste)	Equation 8.1
DOC_F	= Fraction of DOC that is ultimately degraded (reflects the fact that some organic carbon does not degrade)	Assumed equal to 0.6
F	= Fraction of methane in landfill gas	Default range 0.4-0.6 (usually taken to be 0.5)
16/12	= Stoichiometric ratio between methane and carbon	

Source: *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)*

AECOM used the following values in Equation 8.4 for Woodland's calculations:

- MCF = 1.0
- DOC_f = 0.5; GPC equation 8.4 notes that the DOC_f value is assumed to be 0.6, as shown in the preceding table. However, the IPCC guidance upon which GPC developed its solid waste reporting protocol suggests a default DOC_f value of 0.5, which AECOM applied in its calculations for Woodland.[5]
- F = 0.5

Woodland Waste Characterization

AECOM collected waste disposal data for the City of Woodland and statewide waste characterization data from CalRecycle to estimate value MSW_x in Equation 8.3.

Waste Disposal Data

The City of Woodland provided solid waste disposal data for the calendar years 2005-2015, as shown in Table C.9. City data was provided in short tons, which AECOM converted into metric tons (1 short ton = 0.9072 metric tons) for use in Equation 8.3.

Table C.9
Annual Solid Waste Disposal

Year	Waste Disposed (short tons)	Waste Disposed (metric tons)
2005	62,751	56,927
2006	60,029	54,457
2007	64,001	58,061
2008	59,995	54,427
2009	50,857	46,137
2010	47,244	42,859
2011	44,314	40,201
2012	41,870	37,984
2013	49,522	44,925
2014	52,588	47,707
2015	56,191	50,976

AECOM forecast future disposal values for the 2020 and 2035 target years using a metric tons/service population (MT/SP) ratio based on actual City data. AECOM used 2013 service population data collected during the 2035 General Plan update, to calculate a MT/SP ratio to be used in the 2020 and 2035 forecast years. The 2013 service population data represented the most recent data available at the time of analysis, and reflects an improvement in waste generation per demographic unit over 2005 conditions. See Table C.10 on the following page for the waste disposal forecasts and inputs.

[5] *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste. Available online at: <http://www.ipcc-nggip.iges.or.jp/public/2006gl/>*

Table C.10 Waste Disposal Forecasts				
Land Use Scenario	Year	Metric Tons (MT)	Service Population (SP) [3]	MT/SP [4]
	2005	56,927 [1]	77,218	0.74
	2013	44,925 [1]	81,690	0.55
	2020	48,541 [2]	88,264	0.55
General Plan: Lower	2035	65,554 [2]	119,200	0.55
General Plan: Higher	2035	66,176 [2]	120,330	0.55

Source: AECOM 2016

Notes: Service population (SP) = population from jobs

[1] See Table C.9

[2] Calculated as SP * (MT/SP)

[3] See Table C.1 for demographic data sources; 2013 data is from Dyett and Bhatia 2016

[4] 2005 and 2013 values calculated from MT and SP data shown above; 2020 and 2035 target years assume 2013 MT/SP rate remains constant

Waste Characterization

AECOM estimated landfill waste composition based on CalRecycle's *2014 Disposal-Facility-Based Characterization of Solid Waste in California* report. Per the report, CalReycle's side-by-side analysis of the 2008 Statewide Waste Characterization Study and the 2014 study results identified an unexpected anomaly in the distribution of waste per sector (i.e., residential, commercial, and self-hauled). CalRecycle is obtaining additional data to verify the 2014 report results. In the interim, the 2014 report presents two sets of data: one reflecting the 2014 calculated sector percentages, and the other based on the 2008 report sector percentages. AECOM selected to use the set of data based on the 2008 report.

The CalRecycle report estimates the percentage of different materials in California's waste stream. AECOM referred to *Table 7: Composition of California's Overall Disposed Waste Stream* to determine the distribution of waste by the material types included in Equation 8.1. Table C.11 shows the results of this data sorting.

Table C.11 Waste Characterization – Selected Material Categories		
Material	Estimated % of Total Disposed Waste Stream	Material Categories/Sub-types from CalRecycle 2014 Report [1]
Paper	18.1%	Paper category plus Gypsum Board sub-type from Inerts and Other category
Textiles	3.6%	Textiles sub-type from Other Organic category
Food	30.8%	Other Organic category minus Textiles sub-type
Wood	13.7%	Lumber sub-type from Inerts and Other category
Rubber and Leather	0.1%	Tires sub-type from Special Waste category
Plastics	10.4%	Plastic category
Metal	3.1%	Metal category

Table C.11 Waste Characterization – Selected Material Categories		
Material	**Estimated % of Total Disposed Waste Stream**	**Material Categories/Sub-types from CalRecycle 2014 Report [1]**
Glass	2.5%	Glass category
Other	17.7%	Electronics category, Household Hazardous Waste (HHW) category, Mixed Residue category, Inerts and Other category (minus Lumber and Gypsum Board sub-types), and Special Waste category (minus Tires sub-type)
Total	100.0%	

Source: AECOM 2016

[1] *2014 Disposal-Facility-Based Characterization of Solid Waste in California,* CalRecycle 2015. Available online at: <http://www.calrecycle.ca.gov/Publications/Documents/1546/20151546.pdf>

Woodland Waste Disposal by Characterization Type

AECOM multiplied the solid waste disposal values (in metric tons) from Table C.10 by the waste characterization values presented in Table C.11 to estimate disposal values by waste type for the 2005, 2020, and 2035 inventory years. Table C.12 below presents the results, which were applied to Equations 8.1 and 8.3 to calculate Woodland's solid waste emissions.

Table C.12 Waste Disposed by Waste Type				
Waste Type	**2005 (MT)**	**2020 (MT)**	**General Plan: Lower Scenario**	**General Plan: Higher Scenario**
			2035 (MT)	**2035 (MT)**
Paper	10,304	8,786	11,865	11,978
Textiles	2,049	1,747	2,360	2,382
Food	17,533	14,951	20,191	20,382
Wood	7,799	6,650	8,981	9,066
Rubber and Leather	57	49	66	66
Plastics	5,920	5,048	6,818	6,882
Metal	1,765	1,505	2,032	2,051
Glass	1,423	1,214	1,639	1,654
Other	10,076	8,592	11,603	11,713
Total	**56,927**	**48,541**	**65,554**	**66,176**

Source: AECOM 2016
Notes: MT = metric tons

Table C.13 presents the emissions results by waste type and year.

Table C.13 Solid Waste Emissions by Waste Type				
Waste Type	2005 (MT CO_2e)	2020 (MT CO_2e)	General Plan: Lower Scenario	General Plan: Higher Scenario
			2035 (MT CO_2e)	2035 (MT CO_2e)
Paper	8,634	7,362	9,942	10,036
Textiles	1,030	879	1,186	1,198
Food	5,509	4,698	6,344	6,404
Wood	7,025	5,990	8,089	8,166
Rubber and Leather	47	40	54	54
Plastics	0	0	0	0
Metal	0	0	0	0
Glass	0	0	0	0
Other	0	0	0	0
Total	**22,244**	**18,968**	**25,616**	**25,858**

Source: AECOM 2016

Notes: MT CO_2e = metric tons of carbon dioxide equivalent

Strategy Reduction Calculation

State law requires each local jurisdiction to divert at least 50% of its waste from landfills through reuse, recycling, and composting. The State assigned Woodland a threshold of 5.7 pounds of waste per capita per day to meet its 50% diversion requirement, which the City has achieved since 2009. Legislation passed in 2013 directed the State to achieve a 75% diversion rate for trash by 2020, with a focus on removing organics, such as food waste, from landfilled waste. While there is not yet a State law requiring local jurisdictions to achieve a new 75% diversion target, Woodland is implementing waste reduction programs that will contribute to higher diversion rates. Further, based on waste diversion statistics provided to AECOM by City staff, the City achieved diversion rates as high as 64% in 2012. GHG reduction estimates presented in Strategy W/W-2 are based on the assumption that the City will achieve 75% waste diversion by 2020, aligning with the State's goal. The reduction estimates further assumed that waste diversion practices would focus on those waste types contributing to GHG emissions, as shown in Table C.13.

Table C.14 shows the 50% and 75% diversion targets expressed as pounds per person per day, which helped to frame the analysis of Strategy W/W-2. The City currently implements waste diversion strategies that achieve the 50% diversion target required by State law. Increasing efforts to achieve a 75% diversion target would correspond to waste disposal rates of 2.85 pounds per resident per day.

Table C.14 Solid Waste Diversion Targets	
Pounds per Resident per Day	% Diverted Relative to Baseline
11.40	-
5.70	50%
2.85	75%

Source: City of Woodland, adapted by AECOM 2016

Table C.15 shows the results from converting the per capita disposal target into total disposal metric tons based on the following equation:

$$\boldsymbol{MSW_d} = DT * P * Y_{days} * MT$$

Where:
MSW_d = metric tons of disposed waste
DT = diversion target in pounds per capita per day
P = population
Y_{days} = 365 days per year
MT = 0.000454, conversion of pounds to metric tons

Table C.15
Solid Waste Diversion Targets

2035	Population	Diversion Target (pounds/capita/day)	Metric Tons of Disposed Waste	% below BAU [1]
General Plan: Lower	74,990	2.85	35,384	46%
General Plan: Higher	74,990	2.85	35,384	47%

Source: AECOM 2016
Note: BAU = business-as-usual
[1] Represents percent reduction below BAU solid waste disposal amount shown in Table C.12

Based on this method for calculating disposal targets, the City would need to reduce its solid waste disposal to approximately 35,400 metric tons by 2035 to achieve the 75% diversion metric. This represents diversion of approximately 46% of the City's 2035 BAU solid waste estimate (or 30,170 and 30,792 metric tons for the General Plan: Lower and General Plan: Higher scenarios, respectively), as shown in Table C.12. However, various sub-sectors of waste types comprise the City's total solid waste stream, and achievement of a 75% diversion target could be applied to the waste stream in numerous ways. Further, an emphasis on the organic components of the solid waste stream will be necessary to achieve the dual goals of waste diversion and emissions reductions. Removing plastics, glass, and metal from the landfill stream will contribute to the diversion goal, but will have no impact on emissions reductions (see Table C.13 or Equation 8.1 for emissions-generating waste types). The emissions reduction estimates shown in Strategy W/W-2 are based on one possible waste diversion scenario in which diversion of organic waste types is prioritized. Table C.16 shows the waste characterization adjustments assumed in this scenario.

Table C.16
Solid Waste Diversion Targets

Waste Type	Reduction from Baseline Characterization
Paper	60%
Textiles	25%
Food	60%
Wood	70%
Rubber and Leather	25%
Plastics	0%
Metal	0%
Glass	0%
Other	0%

In this calculation, the composition of Woodland's solid waste was adjusted from the BAU scenario presented in Table C.12 (which is based on the 2008 Statewide Waste Characterization Study results) to a mitigated scenario in which diversion efforts focus on the organic waste types as shown in Table C.16. The results for 2020, 2035 – General Plan: Lower Scenario, and 2035 – General Plan: Higher Scenario are shown in Tables C.17-C.19, respectively (on the following pages). Each table shows the BAU and mitigated estimates for metric tons disposed and the resulting emissions in MT CO_2e/yr. The tables also show the corresponding emissions reductions calculated as the difference between the BAU and mitigated scenario emissions. The total reductions correspond to the values shown in Strategy W/W-2, which were rounded to the nearest hundred.

As shown in Tables C.18 and C.19, the 2035 mitigated disposal values are higher than the disposal targets from Table C.15 (i.e., 35,385 metric tons), and represent diversion achievement of approximately 72% in each land use scenario. However, this analysis did not focus on diversion of the non-emissions-generating waste types, which can be targeted through advanced recycling programs to achieve the overall 75% diversion target.

Table C.17
Organic Waste Diversion – 2020

Waste Type	Disposal BAU (MT)	Disposal Mitigated (MT)	BAU Emissions (MT CO_2e)	Mitigated Emissions (MT CO_2e)	Solid Waste Reductions (MT CO_2e)
Paper	8,786	3,514	7,362	2,945	4,417
Textiles	1,747	1,311	879	659	220
Food	14,951	5,831	4,698	1,832	2,866
Wood	6,650	1,995	5,990	1,797	4,193
Rubber and Leather	49	36	40	30	10
Plastics	5,048	5,048	-	-	-
Metal	1,505	1,505	-	-	-
Glass	1,214	1,214	-	-	-
Other	8,592	8,592	-	-	-
Total	**48,541**	**29,045**	**18,968**	**7,262**	**11,706**

Source: AECOM 2016
Note: MT = metric tons; BAU = business-as-usual

Table C.18 Organic Waste Diversion – 2035 General Plan: Lower Scenario					
Waste Type	**Disposal BAU (MT)**	**Disposal Mitigated (MT)**	**BAU Emissions (MT CO_2e)**	**Mitigated Emissions (MT CO_2e)**	**Solid Waste Reductions (MT CO_2e)**
Paper	11,865	4,746	9,942	3,977	5,965
Textiles	2,360	1,770	1,186	890	296
Food	20,191	8,076	6,344	2,538	3,806
Wood	8,981	2,964	8,089	2,670	5,419
Rubber and Leather	66	49	54	40	14
Plastics	6,818	6,818	-	-	-
Metal	2,032	2,032	-	-	-
Glass	1,639	1,639	-	-	-
Other	11,603	11,603	-	-	-
Total	**65,554**	**39,697**	**25,616**	**10,114**	**15,502**

Source: AECOM 2016
Note: MT = metric tons; BAU = business-as-usual

Table C.19 Organic Waste Diversion – 2035 General Plan: Higher Scenario					
Waste Type	**Disposal BAU (MT)**	**Disposal Mitigated (MT)**	**BAU Emissions (MT CO_2e)**	**Mitigated Emissions (MT CO_2e)**	**Solid Waste Reductions (MT CO_2e)**
Paper	11,978	4,791	10,036	4,014	6,022
Textiles	2,382	1,787	1,198	898	300
Food	20,382	7,745	6,404	2,434	3,970
Wood	9,066	2,720	8,166	2,450	5,716
Rubber and Leather	66	50	54	41	13
Plastics	6,882	6,882	0	0	0
Metal	2,051	2,051	0	0	0
Glass	1,654	1,654	0	0	0
Other	11,713	11,713	0	0	0
Total	**66,176**	**39,394**	**25,858**	**9,837**	**16,021**

Source: AECOM 2016
Note: MT = metric tons; BAU = business-as-usual

Enhanced Landfill Methane Capture

Strategy W/W-2 also describes Yolo County's intent to increase methane capture at the Yolo County Central Landfill to 90% from 75%. The County included reductions associated with this improvement in its CAP for the 2020 and 2030 target years. The majority of solid waste generated in Woodland is disposed at the County's landfill, so any changes to methane capture there will impact the City's solid waste-related emissions. However, the City has no authority over landfill operations, which is why the Draft 2035 CAP focuses on solid waste diversion strategies to reduce emissions from this sector; the City *can* implement these strategies locally to minimize the amount of solid waste sent to the landfill. Should the County pursue an advanced methane capture system at the landfill (or implement some other operational or technological strategy that results in fugitive emissions reductions), additional emissions reductions could occur relative to Woodland's solid waste sector. It is worth noting that improvements to methane capture at the County's landfill would reduce the GHG reduction potential of waste diversion strategies for organic waste types. The net difference between the City's diversion efforts and the County's landfill operations improvements will need to be analyzed during future CAP updates to ensure that all solid waste emissions reduction sources are considered.

AECOM estimated the emissions reduction potential associated with an advanced methane capture system at the landfill for the 2020 and 2035 target years. The calculations represent a scenario in which (a) the County increases landfill methane capture to 90%, and (b) the City *does not* implement waste diversion strategies that reduce the amount of organic waste types sent to the landfill. AECOM changed the value for F_{rec} in Equation 8.3 from 75% to 90%, with the resulting difference in solid waste emissions from these two scenarios representing the reduction potential of an advanced methane capture system. Table C.20 presents the results of this calculation for illustrative purposes only; calculations in the CAP do not assume reductions resulting from advanced methane capture at the County landfill. However, if future CAP updates indicate that the City is not on track toward its reduction targets, the information in this table may be useful when considering the potential efficacy of additional solid waste strategies. Future solid waste emissions reductions may ultimately result from a combination of City waste diversion efforts and County action to minimize landfill methane emissions.

Table C.20
Solid Waste Diversion Targets

Land Use Scenario	Target Year	75% Methane Capture (MT CO_2e)	90% Methane Capture (MT CO_2e)	Reduction (MT CO_2e)
	2020	18,968	7,587	11,381
General Plan: Lower	2035	25,616	10,246	15,370
General Plan: Higher	2035	25,858	10,343	15,515

Source: AECOM 2016

2035 Adjusted Business-as-Usual Emissions Forecast Scenarios

As described in the CAP, the precise future impact of statewide actions on local GHG emissions is unknown. Instead, the impact of currently known State programs, policies, and regulations can be estimated for future years assuming their continued implementation. The 2035 ABAU emissions analysis was prepared under two scenarios: (1) Conservative Scenario - continuation of existing statewide actions at the known implementation target levels, (2) CAP Planning Scenario - enhanced implementation of statewide actions to achieve deeper emissions reductions consistent with future State GHG targets. This section describes the methodology used to calculate 2035 ABAU emissions forecasts under both scenarios.

Conservative Scenario

The Preliminary 2020 CAP analysis considered the local GHG reduction impact associated with implementation of three statewide actions: RPS, Pavley I, and LCFS (described further in the CAP). To maintain consistency with the 2020 estimates, the 2035 ABAU forecasts were developed to consider the same three statewide actions. Under this scenario, the implementation goals associated with each action were assumed to remain constant through 2035. Therefore, implementation of these actions will result in emissions reductions from the transportation sector and the previously identified electricity sub-sectors.

Renewables Portfolio Standard Reductions

Table C.3 shows the estimated electricity consumption amounts (i.e., total kWh) in 2035 for the two land use scenarios considered. The BAU emissions estimates were calculated by multiplying the electricity consumption forecasts by the 2005 electricity emissions factor. Similarly, the ABAU emissions estimates were calculated by multiplying the electricity consumption forecasts by the 2035 electricity emissions factor. Table C.21 shows the BAU and ABAU emissions for each land use scenario.

Table C.21
2035 Electricity BAU and ABAU Emissions Forecasts

Sector/Subsector	General Plan: Lower Scenario		General Plan: Higher Scenario	
	BAU Emissions (MT CO_2e/yr)	ABAU Emissions (MT CO_2e/yr)	BAU Emissions (MT CO_2e/yr)	ABAU Emissions (MT CO_2e/yr)
Energy - Electricity				
Commercial	65,155	38,327	65,773	38,690
Residential	42,502	25,001	42,502	25,001
Municipal Energy Use				
Electricity	1,484	873	1,484	873
Water and Wastewater				
Potable Water Supply	1,918	1,128	1,918	1,128
Wastewater Treatment	1,320	776	1,320	776
Total	**112,379**	**66,106**	**112,997**	**66,469**
RPS Reductions	**46,273**		**46,528**	

Source: AECOM 2016

As described in the CAP, the 2020/2035 electricity emissions factor shown in Table C.4 reflects the Pacific Gas and Electric Company (PG&E) estimate for the 2020 RPS compliance year. Therefore, this factor represents an electricity portfolio that includes at least 33% of its electricity supplies from RPS-compliant renewable energy sources. PG&E has not yet released its estimates for compliance with the recently revised RPS requirement per Senate Bill 350 (SB 350) to provide 50% of electricity from RPS-compliant sources by 2030. Therefore, AECOM conservatively estimated future emissions reductions related to this statewide action by holding the 2020 electricity emissions factor constant through 2035. In order to comply with the regulations of SB 350, PG&E will need to increase the share of its RPS-compliant electricity purchases. To date, the company's pathway for compliance has not been defined, and it is too speculative to estimate what mix of electricity sources might be selected to achieve this requirement (and therefore, what the resulting electricity emissions factor would be).

On-Road Vehicle Reductions

The City's 2035 transportation-related emissions were modeled using ARB's EMFAC2014, which was the most current version at the time of this analysis. EMFAC2014 provides emission factors by speed bin and vehicle class for specific operational years and geographical locations. For the City's forecasts, emission factors associated with the Sacramento Valley region default vehicle distributions in 2035 were used to estimate GHG emissions.

Weighted emission factors in units of grams of CO_2 per mile for each speed bin were calculated using the region-wide amount of VMT in each speed bin by each vehicle type. For example, if vehicle class "A" accounts for 10% of region-wide VMT within a particular speed, its emission factor would account for 10% of the total weighted emission factor. The daily VMT values provided by Fehr and Peers (shown in Table C.5) were then multiplied by the speed bin distributions to calculate the daily VMT occurring in each speed bin. These daily VMT values by speed bin were then multiplied by the weighted emission factor to calculate GHG emissions. Daily VMT emissions were multiplied by an annualization factor of 347 days/year to calculate annual GHG emissions.

The outputs from EMFAC2014 already include on-road vehicle related emissions reductions associated with implementation of various statewide actions.[6] Therefore, the results from the EMFAC2014 model run, combined with the Woodland-specific VMT and speed bin data provided by Fehr and Peers, reflect the 2035 ABAU forecasts for existing statewide actions. Table C.22 shows the 2035 BAU and ABAU transportation sector emissions for the two land use scenarios analyzed in the CAP, and the resulting total reductions related to implementation of statewide actions.

Table C.22
2035 Transportation Sector BAU and ABAU Emissions Forecasts

Sector	General Plan: Lower Scenario		General Plan: Higher Scenario	
	BAU Emissions (MT CO_2e/yr)	ABAU Emissions (MT CO_2e/yr)	BAU Emissions (MT CO_2e/yr)	ABAU Emissions (MT CO_2e/yr)
Transportation	314,852	245,270	317,574	247,390
Transportation Reductions	**69,582**		**70,184**	

Source: AECOM 2016

Table C.23 on the following page shows the 2035 ABAU emissions forecasts, assuming the continuation of existing statewide actions at their known implementation target levels.

[6] *Per EMFAC2014 model, emissions reduction estimates integrated into model outputs include Advanced Clean Cars, Truck and Bus Regulation (2014 Amendments), and federal Heavy-Duty GHG Phase 1 (aerodynamic improvements, low rolling resistant tires, fuel-efficient engine design).*

Table C.23
2035 ABAU Emissions Forecasts

Sectors	General Plan: Lower Scenario MT CO_2e/yr	General Plan: Higher Scenario MT CO_2e/yr
Transportation	**245,270**	**247,390**
Energy	**205,171**	**206,353**
Electricity	*63,328*	*63,692*
Commercial	38,327	38,690
Residential	25,001	25,001
Natural Gas	*141,843*	*142,661*
Commercial	86,366	87,185
Residential	55,477	55,477
Solid Waste	**25,616**	**25,858**
Wastewater Reuse	**4,880**	**4,880**
Municipal Energy Use	**1,562**	**1,562**
Electricity	873	873
Natural Gas	689	689
Municipal Transportation	**1,643**	**1,643**
Water and Wastewater	**2,469**	**2,469**
Electricity Use	1,905	1,905
Potable Water Supply	1,128	1,128
Wastewater Treatment	776	776
Process Emissions	565	565
Treatment	93	93
Effluent	472	472
TOTAL	**486,611**	**490,155**

Note: MT CO_2e/yr = metric tons of carbon dioxide equivalent per year; Columns may not appear to sum exactly due to rounding
Source: AECOM 2016

CAP Planning Scenario

The previously presented Conservative Scenario forecasts represent a future in which the State takes no further action to reduce GHG emissions statewide. The CAP also considered an ABAU forecast scenario in which additional statewide action is taken in support of the State's more aggressive longer-term GHG targets (i.e., 2030 and 2050 targets). Recent legislation, including SB 32 and AB 197, further strengthens the rationale for use of ABAU forecasts that assume additional statewide action toward GHG reductions.

This ABAU scenario assumes that statewide actions would contribute the same share of local reductions in 2035 as they did in 2020, relative to the horizon year target. This analysis required the development of a 2020 BAU emissions forecast, so that the estimated impact of statewide actions in 2020 could be compared to the total reductions needed to achieve the City's 2020 GHG target. The analysis in the Preliminary 2020 CAP provided only ABAU emissions forecasts for 2020, so AECOM analyzed the technical appendices from that previous work to calculate the 2020 BAU forecasts.[7] This work included revisions to the electricity subsectors to remove RPS-related reductions, as well as transportation sector revisions to remove reductions from Pavley I and the LCFS, as shown in the following sections.

RPS Reductions

As with the 2035 RPS reduction calculations, AECOM multiplied electricity consumption forecasts and the electricity emissions factors (shown in Table C.4) to calculate the total reductions related to this statewide action. AECOM divided the 2020 emissions forecast values from each of the electricity subsectors by the 2020/2035 electricity emissions factor to calculate the assumed electricity consumption values used in the 2020 forecast analysis. These 2020 consumption values were then multiplied by the 2005 electricity emissions factor to calculate the BAU electricity emissions (i.e., electricity emissions if the RPS regulation is not implemented in 2020). As shown in Table C.24, statewide reductions resulting from implementation of the RPS total 33,022 MT CO_2e/yr in 2020.

Table C.24

2020 Electricity BAU and ABAU Emissions Forecasts

Sector/Subsector	2020 Electricity Consumption (kWh/yr) [1]	BAU Emissions (MT CO_2e/yr)	ABAU Emissions (MT CO_2e/yr)
Energy - Electricity			
Commercial	181,914,307	40,684	23,932
Residential	158,927,977	35,543	20,908
Municipal Energy Use			
Electricity	5,967,020	1,334	785
Water and Wastewater			
Potable Water Supply	5,792,190	1,295	762
Wastewater Treatment	5,997,426	1,341	789
Total	**358,598,920**	**80,198**	**47,176**
RPS Reductions	-	**33,022**	

Source: AECOM 2016

Note: MT CO_2e = metric tons of carbon dioxide equivalent; kWh = kilowatt hours

[1] Derived from Climate Action Plan Technical Report, City of Woodland, Final Report. December 2012.

Transportation Reductions

AECOM reviewed the 2020 transportation technical appendix Excel workbook developed during the GHG analysis of the Preliminary 2020 CAP to identify the BAU transportation emissions for 2020. While the Preliminary 2020 CAP reported only the ABAU transportation emissions (i.e., the EMFAC results that included emissions reductions from implementation of Pavley I and the LCFS), the technical appendix workbook included all of the necessary data to calculate 2020 BAU emissions that are directly related to the CAP's stated ABAU transportation values. Table C.25 on the following page shows the 2020 BAU and ABAU transportation emissions calculated to support the original CAP GHG analysis.

[7] *As previously mentioned, the Preliminary 2020 CAP described the 2020 emissions forecasts as a BAU scenario; however, the calculations included estimated emissions reductions related to implementation of the RPS, Pavley I, and LCFS, which is more closely associated with an ABAU emissions analysis.*

Table C.25 2035 Transportation Growth Estimates	
Transportation Category	**MT CO_2e/yr**
BAU	446,608
ABAU	359,648
Transportation Reductions	**86,960**

Source: Woodland 2020 CAP, AppendixIB3_2020BAU_Transportation_WD.xlsx; provided to AECOM by City of Woodland 2016

Statewide Reductions Compared to 2020 Target

The reductions assumed to accrue locally from implementation of the statewide actions in 2020 total approximately 120,000 MT CO_2e/yr. The City's 2020 GHG target was to achieve emissions levels 15% below the 2005 baseline value. The 2005 emissions were 566,389 MT CO_2e/yr, resulting in a 2020 target of 481,431 MT CO_2e/yr. The 2020 BAU emissions were calculated by adding the 2020 ABAU emissions (i.e., 541,657 MT CO_2e/yr) to the total statewide reductions shown in Table C.26 for a total of 661,639 MT CO_2e/yr. The difference between the 2020 BAU total and the 2020 GHG target results in a need for reductions totaling 180,208 MT CO_2e/yr. Of this total, statewide actions are estimated to provide approximately 66.6% of the needed reductions in 2020. The ABAU forecast scenario presented in the CAP is based on the assumption that the State will enhance existing or develop new statewide actions such that statewide actions continue to provide the same share of reductions in 2035 as in 2020 relative to the total reductions needed.

Table C.26 Relationship of Statewide Actions to Total Reductions Needed		
	Value	**Unit**
RPS Reductions	33,022	MT CO_2e/yr
Transportation Reductions	86,960	MT CO_2e/yr
Total Statewide Action Reductions	119,982	MT CO_2e/yr
Total Reductions Needed in 2020	180,208	MT CO_2e/yr
Statewide Actions share of Total Reductions Needed	**66.6%**	**%**

Source: AECOM 2016

Calculation of 2035 Reduction Target

This section provides further detail on the calculation of the 2035 efficiency target analyzed in the CAP. As described in the CAP Chapter 3 (Emissions Inventories and Targets), the 2035 target (i.e., 2.25 MT CO_2e/SP/yr) was selected to demonstrate consistency with the State's long-term emissions goals.

Target Selection

The purpose of establishing a GHG emissions reduction target and strategies to meet that target is to enable the City to achieve future GHG emissions reductions in a manner that supports statewide efforts, and complies with recent revisions to the CEQA guidelines that allow environmental review streamlining benefits. The following discussion presents the rationale for the City's target development approach, and provides the underlying calculations used to develop the target.

Mass Emissions and Efficiency Thresholds

Targets can be expressed as either *mass emissions* reductions or *efficiency thresholds*. Mass emissions targets establish an absolute emissions level to be achieved by a target year, such as 100,000 MT CO_2e/yr by 2020. Typically, mass emissions targets are expressed as a percent below the emissions level of some base year, such as 15% below 2005 emissions by 2020. Alternatively, efficiency thresholds set a target level of emissions per population or per service population (i.e., population plus local jobs), such as 5.14 MT CO_2e/SP/yr. Efficiency thresholds demonstrate a community's ability to grow population and employment, while emissions shrink on a per-unit basis; in effect, a community could be growing more efficiently from an emissions standpoint. In this case, total emissions within a community may increase while still achieving an efficiency target, as long as service population is growing faster than emissions. Both types of targets are useful to consider when selecting an appropriate emissions reduction target.

It is anticipated that the Governor's Office of Planning and Research will provide future guidance regarding preparation of plans for the reduction of GHG emissions. However, at the time the 2035 GHG emissions analysis was completed for the City's CAP, there was no state-level guidance requiring local governments to adopt specific reduction targets.

During development of the 2035 GHG analysis, the City considered both mass emissions and emissions efficiency targets. The City selected an emissions efficiency target that represents the rate of GHG emissions that is required throughout California to achieve the State's own GHG emission reduction goals for 2030 and 2050. This target was based on statewide GHG policy guidance as described in the remainder of this section.

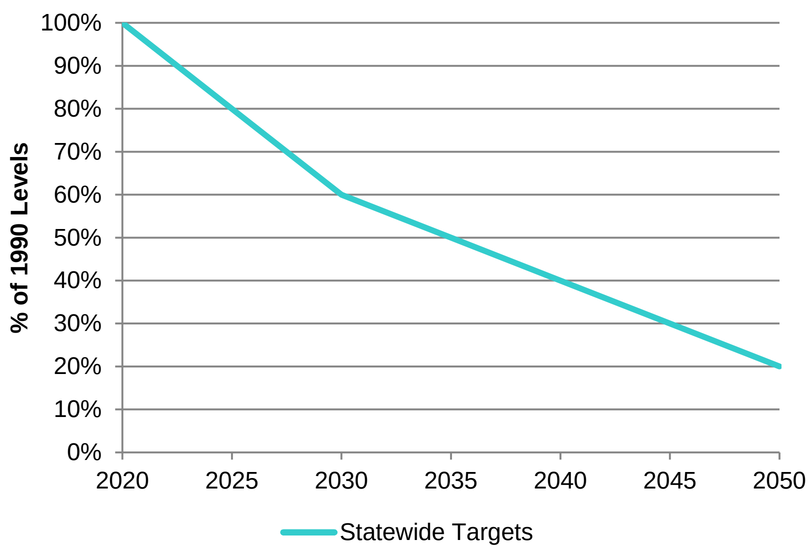
Analyzing an efficiency target for Woodland allows the City to demonstrate how it can grow population and employment, while becoming more efficient in its GHG generation. The use of an efficiency target represents the rate of emissions needed to achieve a fair share of the State's emissions goals. The use of "fair share" in this instance indicates the GHG efficiency level that, if applied statewide, would meet the State's emission goals. The intent of AB 32 is to accommodate population and economic growth in California, but to do so in a way that achieves a lower *rate* of GHG emissions. With a reduced rate of emissions per service population, California can accommodate expected population growth and achieve economic development objectives, while also abiding by the State's emissions targets. For land development projects, the use of an efficiency approach that considers emissions per service population correlates with the activities that are accommodated by development: population growth and additional employment opportunities. Development projects and plans do not *create* new population or employment (except temporary construction related employment), but rather *accommodate* population and employment growth. One of the benefits of an efficiency target is that, because it does not focus on mass emissions, it is not necessary to isolate new emissions sources from existing emissions sources that are moved to each subject project site. The efficiency approach allows the City to assess whether development in Woodland would accommodate population and employment growth in a way that is consistent with the emissions limit established under AB 32 and the State's other emissions targets.[8]

The remainder of this section describes how the City's GHG emissions efficiency target was calculated based on the statewide emissions inventory and reduction targets.

Statewide Targets

In 2006, California took steps to develop a long-term response to the challenges of climate change through adoption of Assembly Bill 32 (AB 32). As the first-of-its-kind legislation in the country, AB 32 established a statewide GHG emissions reduction target to return to 1990 emissions levels by the year 2020. In addition to the near-term 2020 target codified in AB 32, two executive orders (EO) have established longer-term statewide reduction targets, though neither has been formally adopted by the state legislature. EO-S-3-05 was signed by then-Governor Schwarzenegger in 2005 to establish a long-term emissions target of 80% below 1990 levels by 2050. In early 2015, Governor Brown signed EO-B-30-15 to establish an interim target between the State's 2020 and 2050 targets, calling for reductions of 40% below 1990 levels by 2030. Figure C.1 illustrates the trajectory of the State's targets from 2020 through 2050.

Figure C.1 Statewide Emissions Target Trajectory



[8] *The AB 32 emissions limit applies to statewide emissions levels. Through implementation of ARB's Scoping Plan, various emissions sources will be reduced to achieve the statewide target. Economic feasibility is an important aspect of AB 32. From the language of the legislation (Health and Safety Code Section 38501 (h): "It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established pursuant to this division in a manner that minimizes costs and maximizes benefits for California's economy…" Overall, implementation of the Scoping Plan has been shown to include benefits related to overall economic production, gross state product, personal income, per-capita income, household cost savings, and business cost savings. However, these economic benefits and cost savings will not necessarily be evenly distributed. The legislation directs the State to implement AB 32 in a way that minimizes costs and maximizes benefits, but not in a way that necessarily distributes costs and benefits equally across the regions of the state. An efficiency target provides a straightforward approach for projects to demonstrate consistency with the AB 32 mandate and other state goals.*

Statewide Emissions Inventory

Assembly Bill 32 requires that the Air Resources Board (ARB) determine the statewide greenhouse gas emissions level in 1990, from which progress toward achievement of the emissions targets shown in Figure C.1 can be measured. The act also requires ARB to approve a statewide greenhouse gas emissions limit, equal to the 1990 level, as a limit to be achieved by 2020. In 2014, ARB adopted a revised 2020 emissions limit of 431 million metric tons (MMT) of carbon dioxide equivalent (CO_2e). This new emissions limit replaced the original 1990 limit approved in 2007. The approved 1990 limit (i.e., 431 MMT CO_2e) represents emissions from all sectors within the state. Table C.27 shows the State's 2020, 2030, and 2050 emissions targets based on the approved 1990 limit.

Table C.27
Statewide Emissions Inventory and Reduction Targets

	1990	2020	2030	2050
Statewide Emissions Targets (MMT CO_2e)	431.0 [1]	431.0 [1]	258.6 [2]	86.2 [3]
Amount below 1990 Levels	0%	0%	40%	80%

Source: AECOM 2016
Note: MMT CO_2e = million metric tons of carbon dioxide equivalent
[1] California 1990 Greenhouse Gas Emissions Level and 2020 Limit, ARB: <http://www.arb.ca.gov/cc/inventory/1990level/1990level.htm>
[2] 40% below 1990 levels (i.e., 2020 target levels) per EO-B-30-15
[3] 80% below 1990 levels (i.e., 2020 target levels) per EO-S-3-05

Local Application of Statewide Emissions Targets

Local governments in California often select the same emissions targets as the State when preparing greenhouse gas analyses. However, not all of the state's emissions occur as a result of activities over which local governments have control. Further, it would be infeasible for a local agency to develop emissions reduction strategies that address the full scope of statewide emissions. For example, local jurisdictions cannot control the amount of air travel or rail transport that occur within the state and could not implement local strategies that effectively reduce emissions from these sources. Therefore, a scaled version of the full statewide emissions inventory was developed as part of the City's CAP analysis, which is based on the land uses over which local governments have jurisdiction. This version represents the emissions from sectors over which local governments *do* have control through land use planning, zoning, development approval, and permitting authority. The revised inventory is more appropriate for use in community CAP target-setting because it focuses attention on the emissions sources that can actually be influenced locally. Table C.28 on the following page presents a revised version of the 1990 statewide emissions shown in Table C.27 that includes only the sectors and sub sectors over which local governments have jurisdiction.

Table C.28
Adjusted Statewide Emissions Inventory – Land Use-Related Sectors

Main Sector / Sub Sector Level 1	Total Emissions (MMT CO_2e/yr) [1]	Adjusted Land Use-Related Emissions (MMT CO_2e/yr)	Notes/Adjustments
Agriculture & Forestry	18.9	0.0	Not included in land use sector
Commercial	14.4	13.9	Excludes National Security emissions from Sub Sector Level 1
Electricity Generation (Imports)	61.5	61.5	Land use sector includes all emissions
Electricity Generation (In State)	49.0	34.4	Excludes CHP: Industrial from Sub Sector Level 1
Industrial	105.3	11.7	Industrial emissions excluded from land use sector, except as described in sub sectors below
CHP: Industrial	*9.7*	*0.0*	
Flaring	*0.1*	*0.0*	
Landfills	*7.4*	*7.4*	
Manufacturing	*32.1*	*0.7*	*Construction emissions from Sub Sector Level 2 included in land use sector*
Mining	*0.03*	*0.0*	
Not Specified	*2.7*	*0.0*	
Oil & Gas Extraction	*14.8*	*0.0*	
Petroleum Marketing	*0.02*	*0.0*	
Petroleum Refining	*32.8*	*0.0*	
Pipelines	*1.92*	*0.0*	
Waste Water Treatment	*3.6*	*3.6*	*Waste water treatment emissions are included in community-wide GHG inventory*
Not Specified	1.3	1.3	Land use sector includes all emissions
Residential	29.7	29.7	Land use sector includes all emissions
Transportation	150.6	140.9	Excludes Aviation, Rail, and Water-borne emissions from Sub Sector Level 1
Total	**431.0**	**293.4**	

Notes: Sectors/sub-sectors may not sum exactly due to rounding
[1] California 1990 Greenhouse Gas Emissions Level and 2020 Limit, ARB: <http://www.arb.ca.gov/cc/inventory/1990level/1990level.htm>

Table C.29 presents the statewide land use-related emissions with the corresponding statewide emissions targets for the 2020, 2030, and 2050 target years.

Table C.29
Revised Statewide Emissions Inventory, Forecasts, and Reduction Targets – Land Use-Related Sectors

	1990	2020	2030	2050
Statewide Emissions Targets ($MMT\ CO_2e$)	293.4 [1]	293.4 [1]	176.04 [2]	58.68 [3]
Amount below 1990 Levels	0%	0%	40%	80%

Source: AECOM 2016
Note: $MMT\ CO_2e$ = million metric tons of carbon dioxide equivalent
[1] See Table C.27 for statewide inventory source; see Table C.22 for land use-related emissions assumptions.
[2] 40% below 1990 levels (i.e., 2020 target levels) per EO-B-30-15
[3] 80% below 1990 levels (i.e., 2020 target levels) per EO-S-3-05

Statewide Efficiency Targets

Efficiency targets can be developed to mirror statewide emissions reduction policy (e.g., AB 32). For example, to create an efficiency target that would mirror AB 32, one would simply divide the statewide emissions target for 2020 (shown in Table C.28) by the statewide population and employment forecasts for 2020. This would yield an emissions “budget” for each California resident and employee, and demonstrate that emissions levels in a community are the same as what would be required statewide to achieve the AB 32 GHG reduction target. Table C.30 presents statewide population and employment forecasts through 2050.

Table C.30
Statewide Demographic Projections

	2020	2022	2030	2050
Population	40,619,346 [1]	41,320,928 [2]	44,085,600 [1]	49,779,362 [1]
Employment	18,223,080 [3]	18,708,600 [4]	19,960,342 [5]	22,538,269 [5]
Service Population (population + employment)	58,842,426	60,029,528	64,045,942	72,317,631

Source: AECOM 2016
Note: $MMT\ CO_2e$ = million metric tons of carbon dioxide equivalent
[1] DOF Table P-1 State and County Population Projections, July 1, 2010-2060 (5-year increments). Available online at: <http://www.dof.ca.gov/research/demographic/projections/>
[2] Interpolated from DOF estimates for 2020 (40,619,346) and 2025 (42,373,301). See note 1 for population estimation source.
[3] Interpolated from Employee Development Department (EDD) Employment Projections for 2012 (16,281,000) and 2022 (18,708,600). See Note 4 for employment estimation source.
[4] Employee Development Department (EDD) Employment Projections. Available online at: <http://www.labormarketinfo.edd.ca.gov/data/employment-projections.html>
[5] EDD does not provide employment estimates to 2050, so the ratio of employment to population estimated in 2022 (i.e., 45.3%) was applied to the DOF population estimates for 2030 and 2050.

Using the demographic forecasts from Table C.30, statewide emissions efficiency targets can be developed for the 2020, 2030, and 2050 State GHG target years, which are presented in Table C.31.

Table C.31
Statewide Efficiency Targets

	2020	2030	2050
Emissions Targets (MT CO_2e/yr) [1]	431,000,000	258,600,000	86,200,000
Service Population (SP) [2]	58,842,426	64,045,942	72,317,631
Emissions Efficiency Targets (MT CO_2e/SP/yr)	**7.32**	**4.04**	**1.19**

Source: AECOM 2016

Note: MMT CO_2e = million metric tons of carbon dioxide equivalent; Service Population (SP) = population + employment

[1] See Table C.27 for sources.

[2] See Table C.30 for sources.

Statewide Efficiency Targets – Land-Use Related

As previously stated, local emissions targets should be based upon the revised statewide emissions inventory to reflect emissions sources over which local governments have more direct control. The calculation of local efficiency targets needs to incorporate the employment projections associated with the land uses for which emissions are being considered. Table C.32 presents the revised statewide demographic projections reflecting only those employment sectors included in the land use-related statewide emissions from Table C.28. It also includes demographic estimates for 2035 to align with Woodland's longer-term CAP horizon year.

Table C.32
Statewide Demographic Projections – Land Use-Related Employment

	2020	2022	2030	2035	2050
Population	40,619,346 [1]	41,320,928 [2]	44,085,600 [1]	45,747,645 [1]	49,779,362 [1]
Employment	17,012,480 [3]	17,488,400 [4]	18,658,502 [5]	19,361,935 [5]	21,068,292 [5]
Service Population (population + employment)	57,631,826	58,809,328	62,744,102	65,109,580	70,847,654

Source: AECOM 2016

Note: MMT CO_2e = million metric tons of carbon dioxide equivalent

[1] DOF Table P-1 State and County Population Projections, July 1, 2010-2060 (5-year increments). Available online at: <http://www.dof.ca.gov/research/demographic/projections/>

[2] Interpolated from DOF estimates for 2020 (40,619,346) and 2025 (42,373,301). See note 1 for population estimation source.

[3] Interpolated from revised (i.e., land-use related) Employee Development Department (EDD) Employment Projections for 2012 (15,108,800) and 2022 (17,488,400). See Note 4 for employment estimation source.

[4] Employee Development Department (EDD) Employment Projections. Available online at: <http://www.labormarketinfo.edd.ca.gov/data/employment-projections.html>. Sorted to remove jobs from Farming, Fishing, and Forestry Occupations sector, Production Occupations sector, and Extraction Workers subsector of Construction and Extraction Occupations sector.

[5] EDD provides 2- and 10-year employment estimates that currently extend to 2022, so the ratio of employment to population estimated in 2022 (i.e., 42.3%) was applied to the DOF population estimates for 2030 and 2050 to estimate employment in those years.

City of Woodland 2035 Efficiency Target

Based on the revised statewide demographic projections shown above, Table C.33 shows the land-use related efficiency targets most applicable for use in local climate planning documents. The City has evaluated its long-term GHG emissions reductions against the 2035 efficiency level of 2.25 MT CO_2e/SP/yr.

Table C.33
Local Efficiency Targets

	2020	2030	2035	2050
Emissions Targets (MT CO_2e/yr) [1]	293,400,000	176,040,000	146,700,000	58,680,000
Service Population (SP) [2]	57,631,826	62,744,102	65,109,580	70,847,654
Emissions Efficiency Targets (MT CO_2e/SP/yr)	**5.09**	**2.81**	**2.25**	**0.83**

Source: AECOM 2016

Note: MMT CO_2e = million metric tons of carbon dioxide equivalent; Service Population (SP) = population + employment

[1] See Table C.29 for sources; 2035 emissions target was interpolated between 2030 and 2050 values.

[2] See Table C.32 for sources.

Appendix D
2035 CAP Strategy Metrics

Adopted May **2017**

APPENDIX D

2035 CAP Strategy Metrics

This appendix presents a summary of the implementation goals developed for the 2035 GHG reduction estimates. The table presents only the quantified strategies from the 2020 CAP as these were the only strategies included in the 2035 GHG reduction analysis. Information is presented in the table to identify: (1) estimated GHG reductions, (2) the implementation level corresponding to the GHG reduction estimate, including units of measurement, (3) GHG reductions per implementation unit, where applicable, and (4) notes and other assumptions developed during the 2035 quantification process.

In most cases, the 2020 emissions estimates were used as a starting point for evaluating a strategy's long-term emissions reduction potential. Implementation of the 2020 CAP strategies covers a period of 15 years (i.e., 2005–2020). However, since the CAP was not under development until 2013, the actual implementation timeframe is less than 10 years. Long-term implementation of the reduction strategies through the 2035 horizon year will provide an additional 15-year period (i.e., 2020–2035) to increase community participation and technological adoption and allow for further market transitions or maturity (e.g., increasing prevalence of high-efficiency passenger vehicles). The 2035 estimates are also based on an assumption that the 2020 goals and corresponding implementation levels are achievable within or shortly after the 2020 timeframe, and that there is additional capacity for deeper implementation community-wide. In some instances, further implementation was deemed infeasible or achievement of the 2020 goal was estimated to occur on a longer timeframe than originally envisioned; these instances are identified through comments in the Notes/Assumptions column.

Where applicable, different 2035 reduction estimates related to the General Plan: Lower and General Plan: Higher land use scenarios are shown. This occurs in Strategies E-1, T/LU-5, and W/W-2. Note that the summary rows at the strategy level (highlighted in light gray) and at the sector level (highlighted in blue) only depict emissions reductions from the General Plan: Lower land use scenario.

As described throughout the CAP, the City will monitor strategy implementation and progress to ensure the estimated reductions levels are achieved for each target year. If the CAP is found to be behind schedule in its progress, a number of additional reduction strategies are identified in the plan, which the City can implement to generation additional reductions.

Finally, in some instances, the Notes/Assumptions column refers to demographic and development indicators in different horizon years, such as the percentage of residents in 2013 or the share of service population in 2035. Table D.1 on the following page provides the indicators and horizon years that were referenced during calculation of the 2035 emissions reductions. Where the CAP strategy table refers to existing conditions, this is a reference to 2013 conditions when development of the CAP began.

Table D.1
Demographic and Development Indicators

Indicators	2005	2013	2020	General Plan: Lower Scenario 2035	General Plan: Higher Scenario 2035
Population	52,584 [1]	55,690 [3]	60,540 [3]	**74,990 [3]**	**74,990 [3]**
Employment	24,634 [1]	26,000 [3]	27,724 [3]	**44,210 [3]**	**45,340 [3]**
Service Population	77,218	81,690	88,264	**119,200**	**120,330**
Housing Units	18,550 [2]	19,980 [3]	22,207 [3]	**26,980 [3]**	**26,980 [3]**
Non-Residential sq. ft.	-	19,824,000	20,000,000 [4]	**36,509,000 [3]**	**37,210,000 [3]**

Source: AECOM 2016

Note: Service Population = Population + Jobs

[1] County of Yolo Comprehensive Economic Development Strategy (CEDS), 2009–2014 (As Amended – August 2009)

[2] California Department of Finance, Table E-8 Historical Population and Housing Estimates, 2000–2010

[3] Dyett and Bhatia 2016

[4] Estimate based on Strategy E-4 in the CAP, which states that 1.0 million sq. ft. represents 5% participation among commercial properties

Strategy	Strategies and Goal Metrics	2020			Reductions per Implementation Unit (MT CO_2e)	2035			Notes/Assumptions
		Reductions MT CO_2e/yr	Implementation Level	Implementation Units		Implementation Level	Implementation Units	Reductions MT CO_2e/yr	
ENERGY		**26,000**						**54,750**	
E-1	**Lighting Upgrades**	**6,400**						**10,900**	
General Plan: Lower Scenario	6,000 new/existing homes switch to LED/CFL lighting	1,200	6,000	housing units	0.2	13,500	housing units	2,700	27% of units covered in 2020 assumption; 50% of total units covered in 2035 assumption
	15,000 new/existing homes use improved incandescent lighting	1,000	15,000	housing units	0.07	26,980	housing units	1,800	67% of units covered in 2020 assumption; 100% of total units covered in 2035; implementation of Assembly Bill 1109 – Lighting Efficiency statewide will contribute to deep implementation
	2/3 of commercial sector improves lighting by 75%	4,200	30.2	million kWh	n/a	48.6	million kWh	6,400	Per 2020 CAP, 1/3 of commercial electricity use is for electricity; 2035 estimate assumes 2/3 of commercial users reduce lighting electricity demand by 75%
General Plan: Higher Scenario	6,000 new/existing homes switch to LED/CFL lighting	1,200	6,000	housing units	0.2	13,500	housing units	2,700	27% of units covered in 2020 assumption; 50% of total units covered in 2035 assumption
	15,000 new/existing homes use improved incandescent lighting	1,000	15,000	housing units	0.07	26,980	housing units	1,800	67% of units covered in 2020 assumption; 100% of total units covered in 2035; implementation of Assembly Bill 1109 – Lighting Efficiency statewide will contribute to deep implementation
	2/3 of commercial sector improves lighting by 75%	4,200	30.2	million kWh	n/a	49.0	million kWh	6,500	Per 2020 CAP, 1/3 of commercial electricity use is for electricity; 2035 estimate assumes 2/3 of commercial users reduce lighting electricity demand by 75%
E-2	**Appliance/Equipment Upgrades**	**900**						**1,950**	
	1/4 of households replace major appliance or computer equipment with energy efficient models	600	5,550	housing units	0.11	13,500	housing units	1,500	25% of households participate in 2020; 50% of households participate by 2035
	1/2 of businesses upgrade appliance or office equipment with energy efficient models	300	n/a	n/a	n/a	n/a	n/a	450	2035 estimate assumes that local businesses continue to participate in utility-sponsored energy efficiency programs and that reductions in this category increase 50% from 2020 levels by 2035 through increased participation (i.e., more participating businesses) and deeper implementation (i.e., greater energy savings achieved on a per-business basis)
E-3	**Comprehensive Building Efficiency**	**6,500**						**13,000**	
	Weatherization for low-income units	2,000	2,000	low-income housing units	1.00	4,000	housing units	4,000	2035 estimate assumes that participation in weatherization program doubles from 2020 to 2035 and is expanded to target older housing stock, in addition to low-income units
	Energy-efficiency retrofits for homes	1,200	1,000	housing units	1.20	2,000	housing units	2,400	2035 estimate assumes that participation in home energy efficiency programs doubles from 2020 to 2035
	New energy-efficient, affordable units	400	250	housing units	1.60	500	housing units	800	2035 estimate assumes that construction of new energy-efficient, affordable housing units doubles from 2020 to 2035
	Energy-efficiency retrofits and retro-commissioning for commercial buildings	2,900	4.0	million sq. ft. commercial space	725.00	8.0	million sq. ft. commercial space	5,800	20% of existing (2013) commercial sq. ft. covered in 2020 assumption; 40% of existing (2013) commercial sq. ft. covered in 2035 assumption

Strategy	Strategies and Goal Metrics	2020			Reductions per Implementation Unit ($MT\ CO_2e$)	2035			Notes/Assumptions
		Reductions $MT\ CO_2e$/yr	Implementation Level	Implementation Units		Implementation Level	Implementation Units	Reductions $MT\ CO_2e$/yr	
E-4	**Improved Building Temperature Controls**	**1,450**						**9,800**	
	Install cool / reflective roofing on residential units	250	500	residential roofs	0.50	9,990	residential roofs	5,000	2035 calculation assumes residential roof replacement every 30 years, and that in any year 3.33% of residential roofs will need to be replaced (i.e., 1 / 30 = 3.33%); during 15 year implementation period from 2020 to 2035, 50% of residential roofs will need to be replaced; existing CalGreen Code specifies reflective roofing materials for residential re-roofing projects
	Upgrade residential HVAC systems	500	n/a	n/a	n/a	n/a	n/a	1,000	2035 estimate assumes participation in HVAC retrofit and replacement programs doubles from 2020 to 2035
	Install cool / reflective roofing on 1.0 million sq. ft. of commercial properties	300	1.0	million sq. ft. commercial roof	300.00	10.0	million sq. ft. commercial roof	3,000	2020 calculation estimated that 1.0 million sq. ft. of commercial roofing represented 5% of participation, which would equal 20.0 million total sq. ft. of commercial roofing in 2020; 2035 calculation assumes commercial roof replacement every 30 years, and that in any year 3.33% of roofs will need to be replaced (i.e., 1 / 30 = 3.33%); during 15 year implementation period from 2020 to 2035, 50% of commercial roofs will need to be replaced, or 10.0 million sq. ft.
	Upgrade commercial property HVAC systems	400	n/a	n/a	n/a	n/a	n/a	800	2035 estimate assumes that participation in HVAC retrofit and replacement programs doubles from 2020 to 2035
E-5	**Energy Conservation Education**	**1,200**						**4,800**	
	Home energy conservation campaigns	300	500	housing units	0.60	2,000	housing units	1,200	2.5% of existing (2013) housing units covered in 2020 assumption; 10% of existing (2013) units covered in 2035 assumption
	Business energy conservation campaigns	900	150	businesses	n/a	n/a	n/a	3,600	2035 calculation assumes that an increased number of businesses will participate in energy conservation programs and that participants in 2020 will implement deeper energy-savings programs; reductions could come from conservation of electricity, natural gas, or both, and represent approximately 2% of total commercial energy emissions in 2035 ABAU scenario
E-6	**Renewable Energy and Generation Procurement**	**9,550**						**14,300**	
	Residential solar PV or green electricity purchase	3,400	25.9	million kWh generated from solar PV capacity (or green electricity purchase)	n/a	38.8	million kWh generated from solar PV capacity (or green electricity purchase)	5,100	City solar PV permit data shows 8.5 MW of residential capacity installed since 2005 (i.e., 8,500 kW capacity); National Renewable Energy Laboratory (NREL) estimates Woodland's solar hours per day at 4.17; 8,500 kW * 365 days * 4.17 solar hours = 12,937,425 kWh/yr generated from existing residential systems; 12,937,425 * 0.000132 (2020 electricity emissions factor) = 1,707 MT CO_2e/yr reductions from existing residential PV systems; 2035 estimate assumes that existing residential solar PV installs will triple to provide 38.8 million kWh/yr

Strategy	Strategies and Goal Metrics	2020			Reductions per Implementation Unit ($MT CO_2e$)	2035			Notes/Assumptions
		Reductions $MT CO_2e/yr$	Implementation Level	Implementation Units		Implementation Level	Implementation Units	Reductions $MT CO_2e/yr$	
									(green electricity purchases may offset some of this generation amount in lieu of on-site PV installations)
	Residential solar hot water heaters	1,400	2,000	housing units	0.70	3,500	housing units	2,450	2035 estimate assumes that installation of residential solar hot water heaters increases 75% from 2020 to 2035; City does not currently track installation of SHW systems to evaluate progress towards 2020 levels; achievement of 2035 implementation levels will require greater financial incentives from utility companies or State government, higher natural gas prices, or both
	Non-residential solar PV or green electricity purchase	4,400	33.5	million kWh generated from solar PV capacity (or green electricity purchase)	n/a	48.7	million kWh generated from solar PV capacity (or green electricity purchase)	6,400	City solar PV permit data shows nearly 8.5 MW of non-residential (i.e., commercial, schools, municipal) capacity installed since 2005; 8.5 MW = 8,500 kW capacity; National Renewable Energy Laboratory (NREL) estimates Woodland's solar hours per day at 4.17; 8,500 kW * 365 days * 4.17 solar hours = 12,937,425 kWh/yr generated from existing non-residential systems; 12,937,425 * 0.000132 (2020 electricity emissions factor) = 1,707 MT CO_2e/yr reductions from existing non-residential PV systems 2035 estimate assumes that existing non-residential solar PV installs will more than triple to provide 48.7 million kWh/yr (green electricity purchases may offset some of this generation amount in lieu of on-site PV installations)
	Wind turbines	300	500	kW turbine	0.60	500	kW turbine	300	2035 calculation assumes that 2020 goal will be achieved, but not further expanded
	Geothermal heat pumps	50	100	geothermal heat pumps	0.50	100	geothermal heat pumps	50	2035 calculation assumes that 2020 goal will be achieved, but not further expanded
TRANSPORTATION AND LAND USE		**18,000**						**34,850**	
T/LU-4	**Reduced Motor Vehicles Trips**	**900**						**1,350**	
	Residents carpooling, car sharing, and telecommuting	900	5,000	residents regularly carpooling or telecommuting	0.18	7,500	residents regularly carpooling or telecommuting	1,350	8.25% of 2020 residents covered in 2020 assumption; 10% of 2035 residents covered in 2035 assumption
T/LU -5	**Increased Mass Transit Use/Walking/Bicycling**	**1,500**						**2,300**	
General Plan: Lower Scenario	School children walk or bike (net increase)	200	3,000	school children arriving via bike or walk	0.067	4,500	school children arriving via bike or walk	300	2035 estimate assumes that 1,500 additional school children participate in walk-and-ride programs from 2020 to 2035
	Employee weekly trips to work via bike or walk (net increase)	700	7,000	employees trips per week via bike or walk	0.1	11,200	employees trips per week via bike or walk	1,100	25% of 2020 employees covered in 2020 assumption; 25% of 2035 residents covered in 2035 assumption
	Bus ridership increase (net increase)	600	1,000	new regular bus riders	0.6	1,500	new regular bus riders	900	2035 estimate assumes 500 additional new, regular bus riders from 2020 to 2035

Strategy	Strategies and Goal Metrics	2020			Reductions per Implementation Unit ($MT\ CO_2e$)	2035			Notes/Assumptions
		Reductions $MT\ CO_2e/yr$	Implementation Level	Implementation Units		Implementation Level	Implementation Units	Reductions $MT\ CO_2e/yr$	
General Plan: Higher Scenario	School children walk or bike (net increase)	200	3,000	school children arriving via bike or walk	0.067	4,500	school children arriving via bike or walk	300	2035 estimate assumes that 1,500 additional school children participate in walk-and-ride programs from 2020 to 2035
	Employee weekly trips to work via bike or walk (net increase)	700	7,000	employees trips per week via bike or walk	0.1	11,500	employees trips per week via bike or walk	1,150	25% of 2020 employees covered in 2020 assumption; 25% of 2035 residents covered in 2035 assumption
	Bus ridership increase (net increase)	600	1,000	new regular bus riders	0.6	1,500	new regular bus riders	900	2035 estimate assumes 500 additional new, regular bus riders from 2020 to 2035
T/LU -6	**Reduced Vehicle Idling/Other Equipment Emissions**	**600**						**1,200**	
	Heavy vehicle / equipment idling	600	250	heavy-duty vehicles	2.40	500	heavy-duty vehicles	1,200	2035 estimate assumes 250 additional heavy-duty vehicles participate in vehicle idling reduction programs from 2020 to 2035
T/LU -7	**Increased Use of Alternative-Fuel Vehicles**	**15,000**						**30,000**	
	Electric vehicles replace gas or diesel vehicles	1,400	250	vehicles	5.60	500	vehicles	2,800	2020 scenario estimates 4,500 gas or diesel vehicles are replaced with alternative fuel vehicles; this participation assumptions represents approximately 5% of service population in 2020;
	Hybrid vehicles replace gas or diesel vehicles	13,200	4,000	vehicles	3.30	8,000	vehicles	26,400	
	CNG vehicles replace gas or diesel vehicles	400	250	vehicles	1.60	500	vehicles	800	2035 estimate assumes doubling of alternative fuel vehicles deployed in community, representing approximately 7.5% of service population in 2035
URBAN FOREST AND OPEN SPACE		**2,300**						**3,700**	
UF-2	**Increased Tree Planting**	**1,700**						**3,100**	
	Plant net new street trees	1,500	6,000	net new street trees	0.25	10,500	net new street trees	2,625	Per CAP Strategy UF-2 description, City plants approximately 300 trees per year (since 2005); 2035 estimate assumes 300 net new trees planted each year for 2020-2035 period (i.e., 4,500 net new trees after 2020)
	Plant net new building shade trees	200	2,500	net new shade trees	0.08	6,000	net new shade trees	475	2035 estimate assumes that 75% of new residential construction after 2020 will include 1 building shade tree
UF-3	**Maintenance of Existing Trees**	**600**						**600**	
	Existing urban forest is maintained	600	n/a	n/a	n/a	n/a	n/a	600	2035 estimate assumes continued maintenance of existing urban forest with carbon capture and storage rate equal to that estimated for 2020; reductions associated with expansion of urban forest are represented in Strategy UF-2
WATER AND WASTE		**11,900**						**15,850**	
W/W-1	**Increased Water Conservation**	**200**						**350**	
	15% reduction in energy use in water and wastewater system	200	15%	Water-related energy reduction below 2020 forecast levels	n/a	20%	Water-related energy reduction below 2035 forecast levels	350	2035 calculation assumes 20% electricity savings below 2035 forecasted consumption levels in ABAU scenario

Strategy	Strategies and Goal Metrics	2020			Reductions per Implementation Unit ($MT\ CO_2e$)	2035			Notes/Assumptions
		Reductions $MT\ CO_2e/yr$	Implementation Level	Implementation Units		Implementation Level	Implementation Units	Reductions $MT\ CO_2e/yr$	
W/W-2	**Solid Waste Reduction and Waste Processing Improvements**	**11,700**						**15,500**	
General Plan: Lower Scenario	75% solid waste diversion	11,700	n/a	n/a	n/a	n/a	n/a	15,500	Based on achievement of state's 75% waste diversion goal for 2020 (which is not yet required at the local community level); assumes implementation will focus on organic waste characterization categories, including Paper, Textiles, Food, Wood, and Rubber/Leather; Difference in General Plan: Lower and General Plan: Higher scenarios is due to different 2035 solid waste disposal estimates based on service population differences in the two land use scenarios
General Plan: Higher Scenario	75% solid waste diversion	11,700	n/a	n/a	n/a	n/a	n/a	16,000	
MUNICIPAL OPERATIONS		**2,100**						**2,500**	
MO-3	**Increased Energy Efficiency and Renewable Energy**	**1,800**						**2,200**	
	80% reduction in electricity use from 2020 forecast	1,800	13.6	million kWh electricity/yr reduced from 2020 forecasted consumption	n/a	16.7	million kWh electricity/yr reduced from 2020 forecasted consumption	2,200	2035 calculation assumes 80% reduction in municipal electricity use from 2035 ABAU forecast level
MO-4	**Increased Use of Alternative-Fuel/Fuel-Efficient Vehicles**	**200**						**200**	
	30 gasoline vehicles replaced with 5 EVs and 25 hybrids; 10 diesel vehicles replaced with CNG, biodiesel, or E85 vehicles	200	n/a	n/a	n/a	n/a	n/a	200	2035 reductions assume no further implementation of this strategy beyond 2020 levels
MO-5	**Reduced Motor Vehicle Use**	**100**						**100**	
	70 employees participate in ride-sharing; 40 employees ride bicycles to work/meetings	100	n/a	n/a	n/a	n/a	n/a	100	2035 reductions assume no further implementation of this strategy beyond 2020 levels
TOTAL – General Plan: Lower Scenario		**60,300**						**111,650**	
TOTAL – General Plan: Higher Scenario		**60,300**						**112,300**	

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