Appendix B
GHG Reduction Measure Methods

B.1 Introduction

This Appendix provides a detailed overview of the calculations and assumptions used to quantify greenhouse gas (GHG) emissions reductions for each of the San Bernardino Regional Greenhouse Gas Reduction Plan (Plan) GHG reduction measures. A qualitative discussion of benefits is also presented. The following information is provided for each measure.

- **Measure Description**: Details the implementation requirement(s) and reduction goal for each measure.
- **Assumptions**: Includes all assumptions used in calculating emissions reductions.
- **Analysis Details**: Presents the methods for calculating 2020 business-as-usual (BAU) emissions[1], 2020 emissions with state measures and 2020 emissions with local measures. A qualitative summary of benefits is also provided. For additional information, please refer to the citations provided for each measure.

As an introduction to the measure details, this Appendix begins with an overview of the general GHG quantification methods by emissions sector.

B.2 Overview of GHG Methods

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

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

[1] BAU emissions are defined as those that would occur without the implementation of state (e.g., renewable energy portfolio, Title 24) or local action (e.g., Energy-1, Energy-2).

B.2.1 State Measures

The Reduction Plan includes emissions benefits from nine statewide initiatives. These State measures span multiple emission sectors, but are primarily targeted at the building energy and transportation sectors. Emissions reductions achieved by these measures were apportioned to the city-level using statewide estimates of measure effectiveness and sector-specific information. For example, the California Air Resources Board (CARB) estimates that implementation of Assembly Bill 1109 will reduce indoor residential lighting by at least 50% and reduce indoor commercial and outdoor lighting by at least 25% by 2018 (compared to 2007). GHG reductions achieved by Assembly Bill 1109 within the Partnership cities were therefore quantified by multiplying city-level 2020 BAU emissions from residential lighting and commercial lighting by 50% and 25%, respectively. It is important to note that while the Partnership cities will achieve emissions reductions as a result of State programs, implementation of State measures does not require local action.

B.2.2 San Bernardino County Measures

The County of San Bernardino plans to install methane capture systems at a number of county-owned and operated landfills. Since these landfills serve a number of the Partnership cities, the cities would see emission reductions from their solid waste management sector, as fewer fugitive methane emissions from the decomposition of city-generate waste would be released into the atmosphere.

B.2.3 Local Measures

The section summarizes local efforts that the Reduction Plan proposes to further reduce community-wide GHG emissions. Measures that are required by State law, such as compliance with Assembly Bill 1109, or city regulations, such as an Idling Ordinance, would be mandatory for either existing and/or new development (and are identified with a [M]). Each Partnership city would require implementation of these measures, pursuant to state and new or existing local laws and regulations. Measures that would be implemented through incentive-based approaches, such as building retrofits, would be voluntary and are marked with a [V]. GHG reductions associated with these voluntary measures were quantified based on anticipated participation rates. Measures that would be implemented by each Partnership city for municipal measures are marked with a [CITY] mark. An example of this is Land Use-1: Tree Planting Programs. Some measures are a combination of city measures and voluntary or mandatory measures.

B.2.4 GHG Performance Standard for New Development

The GHG Performance Standard for New Development (PS) provides a streamlined and flexible program for new projects to reduce their emissions. This approach uses a performance standard for new private developments as part of the discretionary approval process under CEQA. New projects would be required to quantify project-generated GHG emissions and adopt feasible reduction measures to reduce project emissions to a level which is a certain percentage below BAU project emissions, as specified by each Partnership city. This approach does not require project applicants implement a pre-determined set of measures. Rather, project applicants are encouraged to choose the most appropriate measures for achieving the reduction goal, while taking into consideration cost, environmental or economic benefits, schedule, and other project requirements.

In order to quantify the reductions achieved for the PS approach, the amount of new development emissions from 2012 to 2020 was estimated for each Partnership city along with the GHG reductions needed to achieve the overall PS reduction goal for each city. Then the value of the other state and local measures for new development was estimated for each Partnership city and subtracted from the PS reduction goal to derive the net additional reductions that would result from the PS implementation. This does not mean that the state and local other measures would apply on an equal basis for every single project, and thus individual new development projects may have higher or lower project-level burdens than the average. Analysis of this measure indicates that the bulk of reductions needed to meet the PS would be from other state and local measures and a smaller portion from project-level reductions.

B.2.5 Building Energy Use

Reduction measures to address GHG emissions from building energy use are separated into two categories: energy efficiency and renewable energy. Emissions reductions associated with these measures were quantified using estimates of electricity kilowatt hour (kWh) and natural gas (therms) consumed by residential, commercial, and industrial buildings. Activity data was provided for the existing inventory year (2008), which was scaled to 2020 under BAU conditions using the socioeconomic data summarized in the San Bernardino Regional Inventory Methods (GHG Inventory) (ICF International 2012).

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

B.2.6 Transportation

Measures within the transportation sector seek to both reduce the number of vehicle trips, as well as encourage mode shifts from single occupancy vehicles to alternative transportation. There are two local transportation measures included in the plan; SB 375 and Smart Bus. The effect of SB 375 on transportation emissions by 2035 in the county was quantified by SCAG using their regional transportation demand model. These reductions were scaled to 2020 and by city. Smart Bus reductions were estimated using data on average weekday and annual ridership, vehicle miles, and passenger miles from Omnitrans along with standard transportation emission factors.

B.2.7 Waste Generation

The waste reduction strategy aims to reduce the amount of waste produced by each community. Existing waste generation volumes and diversion rates were obtained from CalRecycle (2010a). GHG emissions that would have been generated by waste if they had not been diverted were quantified using the CARB First Order Decay (FOD) model and the methods described in the GHG Inventory (ICF International 2012).

B.2.8 Water Consumption

The Reduction Plan seeks to reduce energy and GHG emissions associated with water consumption through adoption of the voluntary CALGreen water efficiency measures for existing and new development and encourage water-efficient landscaping practices in the participating cities. Fixture flow rates from CALGreen (2010) and CAPCOA (2010) along with socioeconomic data were used to estimate the water savings from CALGreen standards. Information from CAPCOA was used to estimate the water savings from water-efficient landscaping practices. Indirect GHG emissions from electricity required to pump, treat, distribute and/or heat the consumed water were calculated using state-specific emission factors.

B.2.9 Wastewater Treatment

The Reduction Plan includes three wastewater measures; one to capture methane produced during the wastewater treatment process, one to improve the energy efficiency of wastewater treatment and pumping equipment, and one to reduce the need for freshwater through the use of recycled water.

GHG savings from methane capture were calculated assuming the majority of methane generated by wastewater treatment plants is captured and not released into the atmosphere. GHG savings associated with improvements in energy efficiency were calculated using the Inland Empire Utilities Agency's (IEUA) energy intensity factor for the treatment of waste and planned improvements (Pompa pers. comm.). Emission reductions from the increased use of recycled water are based on the reduced energy intensity associated with producing recycled water, compared to conveying water to southern California from the State Water Project.

B.2.10 Land Use

The Reduction Plan includes a measure to expand urban forestry programs to plant a certain number of new trees per year, depending on the city, and another measure to install green roofs on certain buildings. Emissions benefits from increased shade were quantified based on information provided by ICLEI and CAPCOA. Regional tree planting lists were consulted to determine the types of tree species appropriate for planting along city streets and in open spaces. It was assumed that tree planting would begin in 2012 and occur on an annual basis.

B.2.11 Off-Road Vehicle Activity

Measures within the off-road sector seek to increase the use of electricity and reduce the consumption of fossil fuels in heavy-duty off-road equipment. GHG emissions in 2020 for off-road activity within the participating cities were quantified using the CARB OFFROAD2007 emissions model. OFFROAD2007 provides detailed estimates of fuel consumption, hours of operation, and emissions by equipment type and horsepower. GHG emissions associated with electrifying portions of the off-road vehicle fleet were determined by multiplying the model outputs by the anticipated emission reductions estimated by CAPCOA (2010). GHG reductions from vehicle idling restrictions were also quantified using OFFROAD2007 and standard fuel consumption factors.

B.3 Overview of Measure Benefits

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

Benefits for the Reduction Plan's GHG Reduction Measures

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

State-1: Senate Bill 1078 (2002)/Senate Bill 107 (2006) and Senate Bill 2 (2011) Renewable Portfolio Standard

Measure Description

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

Assumptions

Quantification of this measure employs the following assumptions:

- The 2020 BAU renewable energy mix for each utility is as follows:
    - 13.8% for Southern California Edison (SCE) (California Energy Commission 2009)
    - 10.6% for Bear Valley Electric Service (BVES), which is the California average (California Energy Commission 2008a)
    - 4.6% for Colton Public Utilities (CPU) = (California Energy Commission 2011)
    - 5.7% for the City of Needles = (Energy Information Administration 2010a)

Analysis Details

GHG Analysis

Implementation of the Renewable Portfolio Standard (RPS) will increase the proportion of renewable energy within the energy supply mix of the utilities serving the participating cities. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to the each Partnership city by their utilities will be cleaner and less GHG intensive.

2020 BAU Emissions

The GHG Inventory (ICF International 2012) estimates that community-wide electricity consumption[2] in 2020 for the participating cities would be approximately 11,724 gigawatt hours (GWh). The 2020 BAU renewable energy mix for each utility was determined as follows:

a) SCE: the direct renewable percentage for 2008 from the CEC's Utility Energy Supply Plans was used.

b) BVES: the California average renewable percentage from the CEC's 2008 Net System Power Report was used.

c) CPU: the direct renewable percentage for 2008 from the CEC's Utility Energy Supply Plans was used.

d) City of Needles: The City of Needles purchases its power from out of state so its BAU electricity emission factor was assumed to be the eGRID Arizona-New Mexico (AZNM) factor. In order to calculate the renewable energy percentage for the AZMN region, the total renewable electricity generation for each state within the region (Arizona, New Mexico, Nevada, and Utah) was added (13,633 GWh) and divided by the total amount of electricity generated within each state (238,138 GWh) to yield the factor of 5.7%. These electricity generation figures were taken from the EIA's State Renewable Electricity Profiles 2008.

Emissions Reductions

Based on the renewable energy mix assumptions listed above, achievement of the RPS will reduce the carbon intensity of the 2020 CO_2 emission factor for each utility as follows:

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[2] Includes electricity consumed by buildings.

e) From 631 pounds per MWh to 490 pounds per MWh for SCE (The Climate Registry 2009; California Energy Commission 2009a).

f) From 681 pounds per MWh to 456 pounds per MWh for BVES (U.S. Environmental Protection Agency 2010; California Energy Commission 2008a).

g) From 2,073 pounds per MWh to 1,455 pounds per MWh for CPU (Lincus Incorporated 2012; California Energy Commission 2011).

h) From 1,253 pounds per MWh to 890 pounds per MWh for the City of Needles (Energy Information Administration 2010a).

Similar reductions will be achieved by the statewide CH_4 and N_2O emission factors as reported by the U.S. EPA (U.S. Environmental Protection Agency 2010). GHG emissions that would be generated by community-wide electricity consumption in 2020 will therefore be lower as a result of the RPS-adjusted emission factors.

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

Co-Benefit Analysis

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

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

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

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

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

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

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

State-2: Title 24 Standards for Non-Residential and Residential Buildings (Energy Efficiency Standards and CALGreen)

Measure Description

Requires that building shells and building components be designed to conserve energy and water. 2008 T24 standards are effective starting January 1, 2009, and 2013 T24 standards are effective starting January 1, 2014. The standards will be periodically updated between 2014 and 2020.

Assumptions

Quantification of this measure employs the following assumptions:

- The 2013 Title 24 standards are 25% and 14% more stringent than the 2008 T24 standards for single-family homes and multi-family homes, respectively (California Energy Commission 2012). This is equivalent to an increase in stringency of approximately 21% on average for all residential buildings the county as a whole.
- The 2013 Title 24 standards are 30% more stringent than the 2008 T24 standards for nonresidential buildings (California Energy Commission 2012).
- Stringency of the residential Title 24 standards will be increased by 17% every three years starting in 2017 (Maziar pers. comm.)
- Stringency of the nonresidential Title 24 standards will be increased by 7% every three years starting in 2017 (Maziar pers. comm.)

Analysis Details

GHG Analysis

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

<u>2020 BAU Energy Consumption</u>

The GHG Inventory (ICF International 2012) estimates that community-wide electricity consumption in 2020 for the participating cities is approximately 11,724 GWh and community-wide natural gas consumption in 2020 for the participating cities is approximately 480 million therms.

<u>Emissions Reductions</u>

The stringency of the Title 24 Standards will be increased three times relative to the GHG inventory base year (2008) by 2020.[3] The 2013 standards represent a 21% and 30% increase in energy efficiency (electricity and natural gas) compared to the 2008 T24 standards for residential and non-residential buildings, respectively. Assuming a 17% and 7% tri-annual increase in the stringency of the residential and non-residential Title 24 standards, respectively, after 2014, 2020 residential energy use would be reduced to 54.1% of the 2008 code.[4] Non-residential energy use would likewise be reduced to 60.5% of the 2008 code. However, because the Title 24 code is revised on a semi tri-annual basis, only a fraction of total energy use is subject to each code revision. To avoid-double counting, estimated energy reductions were multiplied by the annual fraction of electricity subject to each code revision. The average reduction in residential energy use in 2020 as a result of the Title 24 Standards was therefore estimated to be 17.9% (82.1% of the 2008 code), and the average non-residential reductions were estimated to be 19.5% (80.5% of the 2008 code).

[3] Increases assumed in 2014, 2017, and 2020.

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

Energy reductions achieved by Title 24 were calculated by multiplying 17.9% and 19.5% by each Partnership city's 2020 BAU electricity and natural gas consumption for residential and non-residential development, respectively. GHG emissions reductions were quantified by multiplying the total energy reductions by the appropriate utility emission factors.[5]

Co-Benefit Analysis

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

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

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

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

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

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

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

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

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

Measure Description

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

Assumptions

Quantification of this measure employs the following assumptions:

- Approximately 6.2% of electricity is used for commercial outdoor lighting (California Energy Commission 2006, Table 10-3).
- Approximately 29% of electricity is used for commercial indoor lighting (California Energy Commission 2006, Table 10-3).
- Approximately 39% of electricity is used for "other appliances and lighting" in residences in San Bernardino County based on climate zone (Energy Information Administration 2009, Table AP5).
- Of electricity is used for "other appliances and lighting," 50% is used for lighting (estimate); this means that approximately 20% of total residential electricity use is for lighting (39% * 50%).
- This measure results in a reduction of 50% for electricity used for indoor residential lighting and a reduction of 25% for electricity used for indoor commercial and outdoor lighting.

Analysis Details

GHG Analysis

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

<u>2020 BAU Lighting Electricity Consumption</u>

Electricity usage from outdoor lighting in commercial developments within each city was estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 6.2% (California Energy Commission 2006, Table 10-3). Electricity usage from indoor lighting in residential and commercial developments within the each city was estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 20% and 29%, respectively (California Energy Commission 2006, Table 10-3; Energy Information Administration 2009, Table AP5).

<u>Emissions Reductions</u>

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

Co-Benefit Analysis

The following benefits are expected from implementation of AB1109.

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

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

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

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

State-4: AB 1470 (Huffman) Solar Water Heaters

Measure Description

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

Assumptions

Quantification of this measure employs the following assumptions:

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

Analysis Details

GHG Analysis

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

<u>Emissions Reductions</u>

CARB estimates that implementation of AB 1470 would result in the installation of 200,000 solar water heaters by 2020. Assuming that an average of 0.013 heaters per home would be replaced as a result of AB 1470, and that the participating cities would have 520,241 single- and multifamily homes in 2020 (Southern California Association of Governments 2012b), a total of 6,503 water heaters would be replaced with solar water heaters. Each solar water heater will reduce natural gas use by 130 therms (California Air Resources Board 2008a). Natural gas reductions were therefore calculated by multiplying 130 therms by 6,503. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of AB 1470.

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

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

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

State-5: Industrial Boiler Efficiency

Measure Description

This measure evaluated by ARB would require one or more of the following: annual tuning of all boilers, the installation of an oxygen trim system, and/or a non-condensing economizer to maximize boiler efficiency. A source could also replace an existing boiler with a new one that is equipped with these systems.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- For cities without separate industrial natural gas emissions, the statewide ratio of commercial to industrial natural gas emissions was used to estimate industrial natural gas emissions. This value is 66% (California Air Resources Board 2008b).
- 80% of all industrial natural gas emissions in the State are affected by this measure (California Air Resources Board 2008a); the same percent effectiveness rate was used for the Partnership cities.
- The Industrial Boiler Efficiency measure will reduce emissions by 5% (California Air Resources Board 2008a); the same percent reduction was used for the Partnership cities.

Analysis Details

GHG Analysis

Newer, more efficient industrial boilers consume less natural gas, thereby reducing GHG emissions from natural gas combustion.

<u>2020 BAU Emissions</u>

The GHG Inventory quantified emissions associated with commercial and industrial natural gas use in 2020 under BAU conditions. Because the Industrial Boiler Efficiency measure only applies to industrial natural gas use, 2020 BAU emissions from commercial and industrial natural gas use were quantified by multiplying BAU emissions from this sector by 0.66.[6]

<u>Emissions Reductions</u>

CARB estimates that implementation of the Industrial Boiler Efficiency measure will reduce statewide emissions from industrial natural gas use by 4% (80% penetration multiplied by a 5% reduction) (California Air Resources Board 2008a). Since statewide emissions from industrial natural gas use account for 66% of total emissions from industrial and commercial natural gas use combined (California Air Resources Board 2008b), the net reduction in statewide industrial and commercial natural gas use emissions is 2.6% (4% multiplied by 66%).

GHG reductions achieved by the Industrial Boiler Efficiency measure within the Partnership cities were therefore quantified by multiplying 2020 BAU emissions from commercial plus industrial natural gas consumption by 0.026.

Co-Benefit Analysis

The following benefits are expected from implementation of the Industrial Boiler Efficiency Measure.

Reduced Energy Use: Newer, more efficient industrial boilers consume less natural gas. As such, the amount of energy (e.g., natural gas) consumed per unit of activity would be lowered.

[6] Value based on 38.41 $MMTCO_2e$ for statewide emissions in 2020 from natural gas use in the commercial and industrial sectors combined, with 25.4 $MMTCO_2e$ due to industrial natural gas use (California Air Resources Board 2008b)

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

Increased Property Values: Buildings with newer, more efficient boilers will likely have higher property values and resale prices than buildings with older, less efficient boilers.

Public Health Improvements: Reduced local air pollution would contribute to overall improvements in public health.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life.

State-6: AB 1493 (Pavley)/Advanced Clean Cars) and Executive Order S-1-07 (Low Carbon Fuel Standard)

Measure Description

AB 1493 (Pavley) will reduce GHG emissions from automobiles and light duty trucks by 30% from 2002 levels by the year 2016. The regulations affect 2009 models and newer. The "Advanced Clean Cars" regulations introduces new standards for model years 2017–2025, and will reduce GHG emissions from automobiles and light duty trucks by34 percent from 2017 levels by 2025.

The Low Carbon Fuel Standard (LCFS) reduces GHG emissions by requiring a low carbon intensity of transportation fuels sold in California by at least 10% by the year 2020.

Assumptions

Quantification of this measure employs the following assumptions:

- Assumptions are embodied in the EMFAC2011 model (California Air Resources Board 2011b).

Analysis Details

GHG Analysis

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

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

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

<u>2020 BAU Emissions</u>

The GHG Inventory quantified emissions associated with on-road transportation in 2020 under BAU conditions using emission factors generated by EMFAC 2011 and VMT data provided by SCAG (California Air Resources Board 2011b). These emission factors do not assume the implementation of Pavley/Advanced Clean Cars and the LCFS.

<u>Emissions Reductions</u>

The EMFAC2011 model was used to generate emission factors for vehicles traveling within San Bernardino County (in the Mojave Desert Air Basin and South Coast Air Basin) for the year 2020 with implementation of Pavley/Advanced Clean Cars and LCFS (California Air Resources Board 2011b). These emission factors were multiplied by the 2020 BAU VMT for the county and compared to the 2020 BAU emissions. The difference in emissions equal the reductions associated with Pavley/Advanced Clean Cars and the LCFS.

Co-Benefit Analysis

The following benefits are expected from implementation of Pavley/Advanced Clean Cars and the LCFS.

Reduced Energy Use: Pavley/Advanced Clean Cars would increase the fuel efficiency of passenger vehicles, which would reduce the amount of fossil fuels consumed per mile travelled. The LCFS would reduce the carbon content of transportation fuels by 10%. The combustion of hydrocarbons generates numbers air pollutants, including particulate matter, carbon monoxide, sulfur dioxide[7], and ozone precursors[8]. Reducing the carbon content of transportation fuels would therefore reduce local and regional air pollution.

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

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

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

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

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

[7] Sulfur dioxide contributes to acid rain.

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

State-7: AB 32 Transportation Reduction Strategies

Measure Description

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

Assumptions

Quantification of this measure employed the following assumptions:

- Tire Pressure Program will reduce statewide emissions from passenger vehicles by 0.6 million MT CO_2e (California Air Resources Board 2011a), corresponding to a 0.39% reduction in Statewide 2020 BAU emissions.
- Low Friction Oils Program will reduce statewide emissions from passenger vehicles by 2.8 million MT CO_2e (California Air Resources Board 2011a), corresponding to a 1.8% reduction in Statewide 2020 BAU emissions.
- Heavy-Duty Vehicle GHG Emission Reduction Program will reduce statewide emissions from heavy-duty vehicles by 0.9 million MT CO_2e (California Air Resources Board 2011a), corresponding to a 2.2% reduction in Statewide 2020 BAU emissions.
- The percent reduction in transportation emissions in the participating cities will be equal to the percent reduction in transportation emissions reductions on a state level.

Analysis Details

GHG Analysis

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

<u>2020 BAU Emissions</u>

The GHG Inventory quantified emissions associated with on-road transportation in 2020 under BAU conditions. The Tire Pressure and Low Friction Oils programs primarily affect light-duty vehicles, whereas the Heavy-Duty GHG Emissions Reduction Program affects heavy-duty vehicles. 2020 BAU emissions from light-duty autos and heavy-duty vehicles are approximately 5.8 and 1.1 million $MTCO_2e$, respectively.

<u>Emissions Reductions</u>

Tire Pressure

CARB estimates that implementation of the Tire Pressure Program will reduce statewide emissions from passenger vehicles by 0.6 million MT CO_2e, or by approximately 0.39% (California Air Resources Board 2011a). GHG reductions achieved by the Tire Pressure Program within the participating cities were therefore quantified by multiplying 2020 BAU emissions from passenger vehicles by 0.0039.

Low Friction Oils

CARB estimates that implementation of the Low Friction Oils Program will reduce statewide emissions from passenger vehicles by 2.8 million MT CO_2e, or by approximately 1.8% (California Air Resources Board 2011a). GHG reductions achieved by the Low Friction Oils Program within the participating cities were therefore quantified by multiplying 2020 BAU emissions from passenger vehicles by 0.018.

Heavy-Duty Vehicle GHG Emissions Reductions

CARB estimates that implementation of the Heavy-Duty Vehicle GHG Emission Reduction Program will reduce statewide emissions from heavy-duty vehicles by 0.9 million MT CO_2e, or by approximately 2.2% (California Air Resources Board 2011a). GHG reductions achieved by the Heavy-Duty Vehicle GHG Emission Reduction Program within the participating cities were therefore quantified by multiplying 2020 BAU emissions from heavy-duty vehicles by 0.022.

Co-Benefit Analysis

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

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

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

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

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

State-8: Executive Order S-1-07 (Low Carbon Fuel Standard) for Offroad Equipment

Measure Description

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

Assumptions

Quantification of this measure employs the following assumptions:

- Low Carbon Fuel Standard (LCFS) will reduce statewide emissions from transportation-based fuels[9] by 15 million $MTCO_2e$ (California Air Resources Board 2011a). This is equivalent to a 8.9% reduction in emissions from transportation fuels.

Analysis Details

GHG Analysis

See measure State-6 above for a detailed description of the LCFS. State-8 applies the LCFS to the Offroad Transportation and Equipment sector only (State-6 applies to on-road transportation only).

<u>2020 BAU Emissions</u>

The GHG Inventory quantified emissions associated with off-road transportation and equipment in 2020 under BAU conditions.

<u>Emissions Reductions</u>

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

Co-Benefit Analysis

The following benefits are expected from implementation of LCFS.

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

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

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

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

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

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

State-9: AB 32 Landfill Methane Program

Measure Description

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

Assumptions

The following assumptions were considered in the evaluation of this measure:

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

Analysis Details

GHG Analysis

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

<u>Emissions Reductions</u>

According to CalRecycle, the participating cities deposited waste to over 60 landfills between 1995 and 2010. A review of the waste-in-place at these landfills indicates that the following nine landfills would be subject to CARB's Landfill Methane Rule:

- Antelope Valley Public Landfill
- Barstow Sanitary Landfill
- Big Bear Refuse Disposal Site
- Boron Sanitary Landfill
- Calexico Solid Waste Site
- Hay Road Landfill
- Mojave-Rosamond Sanitary Landfill
- Shafter-Wasco Sanitary Landfill
- USMC - 29 Palms Disposal Facility

None of these landfills currently have methane capture systems. Pursuant to the Landfill Methane Rule, it was assumed that by 2020, all nine landfills would install a methane system with a capture efficiency of 75%.[10] GHG emissions generated by city-generated waste in 2020 were re-calculated using these assumptions and the methods outlined in the GHG Inventory.

Co-Benefit Analysis

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

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

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

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

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

County-1: San Bernardino County GHG Reduction Plan Landfill Controls

Measure Description

The County of San Bernardino, through their adopted GHG Emissions Reduction Plan, will install landfill gas controls on the following County-owned and operated landfills (County of San Bernardino 2011):

- 95% capture at Mid-Valley landfill
- 85% capture at Milliken and Colton landfills
- 75% capture at Barstow and Landers landfills

Since these landfills serve some of the cities of San Bernardino County, these cities will realize GHG reductions from the county's installation of landfill gas controls.

Assumptions

Quantification of this measure employs the following assumptions:

- The methane capture rate increases at the Mid-Valley landfill from 75% to 95%
- The methane capture rate increases at the Milliken landfill from 54% to 85% and at the Colton landfill from 37% to 85%
- The methane capture rate increases at the Barstow and Landers landfills from 0% to 75%

Analysis Details

GHG Analysis

Methane capture systems can reduce the amount of methane released from the decomposition of waste.

<u>Emissions Reductions</u>

The landfills listed above would install landfill gas controls as noted above. Some of these landfills currently have methane capture systems. Pursuant to this measure, it was assumed that by 2020, all 5 landfills would install a methane system with capture efficiencies as noted above. GHG emissions generated by city-generated waste in 2020 were re-calculated using these assumptions and the methods outlined in the GHG Inventory.

Co-Benefit Analysis

The following benefits are expected from implementation of the San Bernardino County GHG Plan Landfill Controls.

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

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

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

PS-1: GHG Performance Standard for New Development [M]

Measure Description

Individual cities could adopt a GHG Performance Standard for New Development (PS), which would provide a streamlined and flexible program for new projects to reduce their emissions. This measure would include a performance standard for new private developments as part of the discretionary approval process under CEQA. New projects would be required to quantify project-generated GHG emissions and adopt feasible reduction measures to reduce project emissions to a level which is a certain percent below BAU project emissions.

One potential PS reduction goal could be 29%, based on San Joaquin Air Pollution Control District's recommended CEQA significance threshold and based on the calculations of reductions necessary at the state level to meet AB 32 at the time of the Scoping Plan (29% below forecasted 2020 levels = 1990 levels based on data available at that time). Another potential PS reduction goal could be 20 to 22%, based on calculations of reductions necessary at the state level to meet AB 32 based on the most recent state inventory forecasts for 2020 available as of fall 2012.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Emissions were estimated for the year 2012 for each Partnership city using socioeconomic data. Socioeconomic data for the year 2012 was not available, so population, jobs, and housing were estimated using linear growth from 2010-2020.
- The PS percent reduction in new development emissions was determined by the cities on a city-by-city basis.
- Some state measures which will affect new development, and therefore might overlap with the PS measure, could not be broken down into reductions associated with new development only (e.g., RPS, Pavley). Consequently, these measures were not included in the calculation of the PS.

Analysis Details

GHG Analysis

Implementation of the performance standard would reduce GHG emissions attributable to new discretionary development projects by 2020 by the percentage goal selected by individual cities selecting this measure. Measurable reductions of GHG emissions would be achieved through each city's review and discretionary approval of residential, commercial, and industrial development projects. It is expected that project proponents would often include energy efficiency and alternative energy strategies to help reduce their project's GHG emissions because these are often the most cost-effective approach to reducing GHG emissions but are free to propose any valid measures that would achieve the overall reduction goal.

2020 BAU Emissions

The GHG Performance Standard for New Development would apply to all new buildings built in 2013 and later, so an estimate of emissions in 2012 was performed using inventory and socioeconomic data for 2008 and 2020. 2012 emissions were estimated using the same methods that were used to forecast 2008 emissions to 2020, as feasible. Socioeconomic data for 2012 was not available. This data was estimated using linear growth from 2010-2020.

Emissions Reductions

In order to calculate the reductions from this measure, a percent reduction from new development emissions from 2012 to 2020 was estimated for each city, depending on the PS percent reduction selected by each city (e.g., 29%). State measures and local mandatory measures were quantified for new development for each city. These measures achieve a certain portion of the PS goal, depending on the city. The PS contributes the remaining percent reduction required to achieve the PS goal in new developments.

The value of these state and local measures for new development were subtracted from the PS reduction to derive the net additional reductions that would result from the PS implementation. This does not mean that the other state and local measures would apply on an equal basis for every single project; individual new development projects may have higher or lower project-level burdens than the average. However, state and local mandatory measures are still expected to result in the largest share of the burden in meeting the PS reduction target for all cities (with a smaller portion from project-level reductions).

Co-Benefit Analysis

Co benefits will depend on the exact measures selected by individual project proponents, but would be the same as the corresponding strategies described below, i.e., if a project proponent were to select energy-efficiency measures as part of meeting their project reductions, the benefits would be similar in character to those described below for energy efficiency retrofits.

Energy-1: Energy Efficiency Incentives and Programs to Promote Retrofits for Existing Buildings [V]

Measure Description

Promote energy efficiency in existing residential buildings and nonresidential buildings, and remove funding barriers for energy efficiency improvements. Actions may include, but are not limited to: implementing a low-income weatherization program, launching energy efficiency outreach/education campaigns targeted at residents and businesses, promoting the smart grid, leveraging funding mechanisms and grant funding, scheduling energy efficiency tune-ups and promoting energy efficiency management services for large energy users.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The assumed market penetration rate for buildings (residential and nonresidential) performing retrofits was determined by the cities on a city-by-city basis.
- Participating residences perform weatherization for low-income households. To calculate reductions from low-income weatherization, the following assumptions were used:
    - The number of low-income households in each city was determined by multiplying the total number of households in each city (Southern California Association of Governments 2012b) by the percent of homes classified as extreme low income, very low income, and lower income (Southern California Association of Governments 2011). This percent ranges from 14% to 64% of households, depending on the city.
    - Weatherization only applies to low-income households.
    - Desert and Valley cities (except Needles) use 2,283 kWh per household on average for electrical heating assuming that these cities have <2,000 Cooling Degree Days (CDD) and <4,000 Heating Degree Days (HDD) (California Energy Commission 2008b; Energy Information Administration 2005).
    - Needles uses 1,182 kWh per household on average for electrical heating assuming that Needles has >2,000 CDD and <4,000 HDD (California Energy Commission 2008b; Energy Information Administration 2005).
    - Mountain cities (e.g. Big Bear) use 3,229 kWh per household on average for electrical heating assuming that these cities have <2,000 CCD and 5,500 to 7,000 HHD (California Energy Commission 2008b; Energy Information Administration 2005).
    - Energy savings from low-income weatherization are 20%, 32%, and 32% for heating electricity, natural gas, and fuel oil, respectively (Schweitzer 2005)
- Participating cities will launch energy efficiency campaigns targeted at residents and promote smart grid. This will result in a 5% energy savings (electricity and natural gas). This value was discounted from ICLEI's Climate and Air Pollution Planning Assistant (CAPPA) value of 10% for the measure "Energy Efficiency Education Targeted at Residents" in order to be more conservative (ICLEI Local Governments for Sustainability 2010).
- Participating cities will support and/or incentivize energy efficiency tune-ups and promote energy efficiency management services for large nonresidential energy users. To calculate reductions from low-income weatherization, the following assumptions were used:
    - This will result in a 10% energy savings (electricity and natural gas) from the CAPPA "Energy Efficiency Retrofits of Existing Measures" measure (ICLEI Local Governments for Sustainability 2010).
    - The penetration rate for participating nonresidential buildings, as determined by the participating cities individually, applies to the total nonresidential energy use in each city. For

example, for a penetration rate of 25%, 25% of total nonresidential energy use within a city will be reduced by 10%.

- Participating cities will launch energy efficiency campaigns targeted at businesses. This will result in a 5% energy savings (electricity and natural gas). This value was discounted from the CAPPA value of 10% for the measure "Energy Efficiency Education Targeted at Businesses" in order to be more conservative (ICLEI Local Governments for Sustainability 2010).

Analysis Details

GHG Analysis

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

<u>BAU Energy Use</u>

BAU electricity and natural gas use for residential and nonresidential buildings were used to calculate reductions for this measure. The GHG inventory documents the energy use and assumptions employed for the BAU analysis.

<u>Emissions Reductions</u>

Energy savings for each sub-measure were generally calculated by multiplying BAU energy use by a penetration rate, and then by a percent reduction in energy use. Emission reductions were then calculated by multiplying the energy savings by the appropriate emission factors.

For low-income weatherization, the total number of homes existing in 2008 (base inventory year) for each Partnership city was multiplied by the percent of low-income homes as determined by SCAG (Southern California Association of Governments 2011). The number of low-income homes was then multiplied by the penetration rate for each city. Then, the energy used for electric heating, natural gas heating, and fuel oil use was estimated by multiplying the number of low-income households by the respective energy use factors as detailed in the assumptions section above. The resulting energy use was multiplied by the percent reduction in energy use for low-income weatherization by energy source (see assumptions above) to determine energy reductions.

For efficiency campaigns targeted at residents, the total residential energy use (electricity and natural gas) in 2008 for each Partnership city was multiplied by the penetration rate for each city. The resulting energy use was then multiplied by 5% to determine energy savings for residential buildings.

For energy efficiency tune-ups and promote energy efficiency management services for large energy users, the total nonresidential energy use (electricity and natural gas) in 2008 for each Partnership city was multiplied by the penetration rate for each city. The resulting energy use was then multiplied by 10% to determine energy savings for nonresidential buildings.

For energy efficiency campaigns targeted at businesses, the total nonresidential energy use (electricity and natural gas) in 2008 for each Partnership city was multiplied by the penetration rate for each city. The resulting energy use was then multiplied by 5% to determine energy savings for nonresidential buildings.

GHG emissions savings were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

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

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

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

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

Energy-2: Outdoor Lighting Upgrades for Existing Development [CITY, V]

Measure Description

Adopt outdoor lighting standards in the Zoning Ordinance to reduce electricity consumption above and beyond the requirements of AB 1109. Require a certain percentage of residential and nonresidential outdoor lighting fixtures use high efficiency light-emitting diodes (LEDs) and a certain percentage of traffic signals use LEDs by 2020.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Approximately 5.27% of total residential electricity in each Partnership city is used for residential outdoor lighting (California Energy Commission 2006).[11]
- Approximately 6.21% of total commercial electricity in each Partnership city is used for commercial outdoor lighting (California Energy Commission 2006).[12]
- The 2020 BAU percentage of outdoor LED lights in residences is 10% (estimate).
- The percent of outdoor lights in residences and commercial buildings that will be LEDs by 2020 was identified by each Partnership city on a city-by-city basis.
- The 2020 BAU percentage of outdoor halogen lights in commercial buildings is 10% (estimate).
- Installation of an outdoor LED fixture achieves a 75% reduction in energy usage, relative to an incandescent bulb (U.S. Environmental Protection Agency 2011a). This factor was used for residential outdoor lights and traffic signals.
- LEDs consume about 90% less energy than traditional incandescent traffic lights (California Air Pollution Control Officers Association 2010). This value was used for commercial outdoor lights.
- There are approximately 0.032 traffic signals per capita in the Participating cities (Lee pers. comm. 2010).
- The wattage of an incandescent traffic light is 150 (U.S. Department of Energy 2004), and there are 3 bulbs per traffic signal.
- Traffic signals operate 24 hours per day.
- The 2020 BAU percentage of LED traffic signals is 50% (estimate).
- The percent of traffic signals that will be LEDs by 2020 was identified by each Partnership city on a city-by-city basis.

[11] For the SCE service area, Table 10-3. This value is calculated by taking the exterior lighting electricity intensity for commercial lodging (0.7kWh/ft^2-year) and dividing by the total electricity intensity (13.28 kWh/ft^2-year) = 5.27%. Residential electricity intensity was not available, so commercial lodging was used as a proxy.

[12] For the SCE service area, Table 10-3. This value is calculated by taking the exterior lighting electricity intensity for all commercial buildings (0.85 kWh/ft^2-year) and dividing by the total electricity intensity (13.69 kWh/ft^2-year) = 6.21%.

Analysis Details

GHG Analysis

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

<u>2020 BAU Emissions and 2020 Emissions with State Measures</u>

Outdoor Lights (Private)

Electricity reductions achieved by overlapping State (e.g., Title 24 and Assembly Bill [AB] 1109) were first removed to obtain energy consumption after the implementation of state measures. Electricity usage from outdoor lighting in existing residential and commercial developments was then estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 5.27% and 6.21%, respectively.

Traffic Signals

The number of existing and future traffic signals within the each Partnership city was determined using 0.032 signals per capita. BAU electricity consumption by traffic signals was calculated using the following equation.

Energy Consumption = [(City population * (0.032 traffic signals per person) * (50% non-LED lights) * (incandescent wattage per bulb) * (3 bulbs per traffic signal)] + [(City population * (0.032 traffic signals per person) * (50% LED lights) * (incandescent wattage per bulb) * (3 bulbs per traffic signal) * (90% reduction in energy use due to LED lights)] * 365 days * 24 hours

<u>Emissions Reductions</u>

Outdoor Lights (Private)

Energy reductions associated with the installation of LED blubs in existing outdoor residential and commercial lighting fixtures was calculated by multiplying the BAU outdoor lighting energy consumption by the penetration rate for each Partnership city and then by a scaling factor (city-specific penetration rate for LED lights under the measure minus 10% LED lights in the BAU case). The resulting energy use was then multiplied by 75% for residential and 90% for commercial, which are the anticipated reduction in electrical demand associated with LED lights (U.S. Environmental Protection Agency 2011a; California Air Pollution Control Officers Association 2010). GHG emissions reductions were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Traffic Lights

Energy reductions associated with the installation of LED traffic signals was calculated by first calculating the number of LED traffic signals installed in each Partnership city, which is equal to:

(City population) * (0.032 traffic signals per person) * (city-specific penetration rate for LED lights)

Electricity savings were calculated by using the following equation:

(Number of new LED traffic signals) * (incandescent wattage per bulb) * (3 bulbs per traffic signal) * (90% reduction in energy use due to LED lights) * 365 days * 24 hours

GHG emissions reductions savings were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

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

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

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

Energy-3: Green Building Ordinance For New Buildings [M]

Measure Description

Adopt a Green Building Ordinance (GBO) that exceeds Title 24 (T24) Standards (or any subsequent standards that replaces the current Title 24 Standards) by a certain percentage (e.g. 15%, which is currently the same as CALGreen Tier 1) starting in 2013 and proceeding through to 2020. This measure applies to both residential and nonresidential buildings.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent by which Energy-1 exceeds T24 standards was identified by each Partnership city on a city-by-city basis.
- All new buildings (residential and nonresidential) built in 2013 and later must comply with the GBO.
- The ratio of single-family household electricity and natural gas use to multi-family household electricity and natural gas use is 1.39 and 1.23, respectively (Energy Information Administration 2009)
- The Participating cities are in climate zone 10 (California Air Pollution Control Officers Association 2010).
- The energy reduction for a 1% improvement over 2008 T24 standards for Climate Zone 10 are as follows (California Air Pollution Control Officers Association 2010):
    - 0.18% reduction in electricity use for single-family homes
    - 0.83% reduction in natural gas use for single-family homes
    - 0.26% reduction in electricity use for multi-family homes
    - 0.80% reduction in natural gas use for multi -family homes
    - 0.30% reduction in electricity use for commercial buildings
    - 0.61% reduction in natural gas use for commercial buildings

Analysis Details

GHG Analysis

BAU Energy Use

The GHG Inventory quantified electricity and natural gas emissions associated with existing residential and commercial facilities in 2008. The 2008 values were projected to 2012 in order to determine electricity and natural gas use and emissions for all new buildings built from 2013 to 2020, which are subject to the GBO. The number of single-family and multi-family residences in 2012 was estimated by interpolating from the 2008 and 2020 values for each city.

Emissions Reductions

Energy reductions associated with State-2 (T24), State-3 (AB1109), and Energy-2 (outdoor lighting) were subtracted from the energy used by all new buildings built from 2013 to 2020. This was done in order to determine the energy used by new buildings after the implementation of preceding measures, before the application of the GBO.

New energy use (2013-2020) for single-family and multi-family homes was estimated by multiplying total residential energy use by the ratios listed in the assumptions section above, taking into consideration the number of single-family and multi-family homes within each Partnership city.

Energy reductions (electricity and natural gas) were then estimated by multiplying the new energy use for single-family homes, multi-family homes, and nonresidential buildings by the percent reduction beyond T24 as specified by the cities (e.g., 15%) and then multiplying by the appropriate factor from CAPCOA for a

1% reduction beyond 2008 T24 standards (California Air Pollution Control Officers Association 2010).

GHG emissions reductions achieved by Energy-1 were quantified by multiplying the energy reductions for each building type by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

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

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

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

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

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

Energy-4: Solar Installations in New Housing Developments [V]

Measure Description

Encourage residents to install rooftop solar using Power Purchase Agreements (PPAs) and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on new homes to be achieved before 2020. Each Partnership city will choose its own goal. Potential goals might be (or other options):

- 75% of new single-family homes have solar installations
- 50% of new single-family homes have solar installations
- 25% of new single-family homes have solar installations

Assumptions

The following assumptions were considered in the evaluation of this measure:

- This measure only affects new single-family homes (those built in 2013 and later).
- The market penetration rate for new homes installing solar was determined by the cities on a city-by-city basis.
- The energy generated by solar photovoltaics (PV) is carbon neutral (California Air Pollution Control Officers Association 2010).
- The average annual electricity generation per solar system is 7,683 kWh (National Renewable Energy Laboratory 2012).
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

Emissions Reductions

The number of single-family homes in each city in 2012 was subtracted from the projected number of single-family homes in each city in 2020 in order to determine the number of new single-family homes. This number was then multiplied by the percent penetration rate as specified by each Partnership city to determine the number of new homes installing solar PV. This number was then multiplied by 7,683 kWh, which is the annual amount of electricity provided by the average solar system in the county (National Renewable Energy Laboratory 2012). This determines the total amount of renewable energy provided by the panels, and offset from the utilities.

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by Energy-4 were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

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

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

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

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

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

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

Energy-5: Solar Installations for New Commercial/Industrial Development [V]

Measure Description

Encourage new businesses to install rooftop solar using Power Purchase Agreements and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on new buildings to be achieved before 2020. Each Partnership city will choose its own goal. Potential goals might be (or other options):

- 30% of energy requirements for new development supplied with solar power
- 15% of energy requirements for new development supplied with solar power
- 5% of energy requirements for new development supplied with solar power

Assumptions

The following assumptions were considered in the evaluation of this measure:

- This measure only affects new nonresidential buildings (buildings built in 2013 or after).
- The percent energy requirements for new development supplied with solar power were determined by the cities on a city-by-city basis.
- The energy generated by solar PV is carbon neutral (California Air Pollution Control Officers Association 2010).
- The average annual electricity generation per solar system is 1,539 kWh per kW of solar PV installed (National Renewable Energy Laboratory 2012).
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

<u>BAU Electricity Emissions</u>

The GHG Inventory quantified electricity emissions associated with existing commercial facilities in 2008. The 2008 values were projected to 2012 using employment data in order to determine electricity use and emissions for all new commercial buildings built from 2013 to 2020, which are subject to Energy-5.

<u>Emissions Reductions</u>

Energy reductions associated with State-2 (T24), State-3 (AB1109), Energy-2 (outdoor lighting), Energy-3 (Green Building Ordinance), Land Use-1 (Tree Planting Programs), and Water-1 (CALGreen Water Efficiency Measures for New Construction) were subtracted from the energy used by all new nonresidential buildings built from 2013 to 2020. This was done in order to determine the energy used by new buildings after the implementation of preceding measures, before installation of solar PV.

The remaining quantity of electricity used by new nonresidential buildings was then multiplied by the percent energy requirements for new development supplied with solar power penetration rate, as determined by the participating cities. The resulting number of kWh was assumed to be provided by solar PV under Energy-5. The amount of solar PV in kW was then determined by dividing this kWh figure by 1,539 kWh per kW of solar PV (National Renewable Energy Laboratory 2012).

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a

100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by Energy-5 were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

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

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

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

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

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

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

Energy-6: Onsite Solar Energy for New and Existing Warehouse Space [V]

Measure Description

Applies to new and existing warehouse space. Promote and incentivize solar installations on existing warehouse space through partnerships with SCE and other private sector funding sources including SunRun, SolarCity, and other solar lease or PPA companies. Establish a goal such that all new warehousing projects install solar to provide a minimum of 25% or more of the project's new on-site energy needs. This goal could be supported through non-financial incentives or streamlined permitting. The participating cities may also act as a resource for connecting project proponents with funding opportunities.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of warehouses participating in this measure and installing solar PV was determined by the cities on a city-by-city basis.
- The energy generated by solar PV is carbon neutral (California Air Pollution Control Officers Association 2010).
- The average annual electricity generation per solar system is 1,539 kWh per kW of solar PV installed (National Renewable Energy Laboratory 2012).
- Warehouses are one story; this means that for each square foot of building floor space there is one square foot of building roof space (for which to install solar PV) in warehouses.
- Each square foot of solar PV produces 8 watts of electricity (BEST Contracting Services 2010).
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

<u>Emissions Reductions</u>

The total amount of warehouse building square footage in each Partnership city was multiplied by the penetration rate to determine the total square footage of warehouses installing solar under this measure. The participating square footage was then multiplied by 8 watts per square foot of solar PV to determine the total power output in kW of solar (BEST Contracting Services 2010). The kW value was then multiplied by 1,539 kWh per kW of solar PV to determine the total annual kWh of electricity produced by the panels (National Renewable Energy Laboratory 2012).

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by Energy-6 were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-6.

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

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

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

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

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

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

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

Energy-7: Solar Installations for Existing Housing [V]

Measure Description

Encourage residents to install rooftop solar using Power Purchase Agreements and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on existing homes to be achieved before 2020. Each Partnership city will choose its own goal. Potential goals might be (or other options):

- 25% of existing single-family homes have solar installations
- 20% of existing single-family homes have solar installations
- 15% of existing single-family homes have solar installations

Assumptions

The following assumptions were considered in the evaluation of this measure:

- This measure only affects existing single-family homes (those built before 2013).
- The market penetration rate for existing homes installing solar was determined by the cities on a city-by-city basis.
- The energy generated by solar PV is carbon neutral (California Air Pollution Control Officers Association 2010).
- The average annual electricity generation per solar system is 7,683 kWh (National Renewable Energy Laboratory 2012).
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

<u>Emissions Reductions</u>

The number of single-family homes in each city in 2012 (those that are considered existing) was multiplied by the percent penetration rate as specified by each Partnership city to determine the number of new homes installing solar PV. This number was then multiplied by 7,683 kWh, which is the annual amount of electricity provided by the average solar system in the county (National Renewable Energy Laboratory 2012). This determines the total amount of renewable energy provided by the panels, and offset from the utilities.

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by Energy-7 were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-7.

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

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

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

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

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

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

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

Energy-8: Solar Installations for Existing Commercial / Industrial Buildings [V]

Measure Description

Encourage existing businesses (commercial and industrial) to install rooftop solar using Power Purchase Agreements and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on new buildings to be achieved before 2020. Each Participating City will choose its own goal. Potential goals might be:

- 25% of existing commercial/industrial buildings install solar to provide at least 15% of electricity needs
- 20% of existing commercial/industrial buildings install solar to provide at least 15% of electricity needs
- 15% of existing commercial/industrial buildings install solar to provide at least 15% of electricity needs

This measure does not apply to warehouses, which are addressed in Energy-6.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of existing commercial/industrial buildings that install solar was determined by the cities on a city-by-city basis.
- The energy generated by solar PV is carbon neutral (California Air Pollution Control Officers Association 2010).
- Each solar PV system supplies 15% of a building's total electricity demand.
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

<u>BAU Electricity Emissions</u>

The GHG Inventory quantified electricity emissions associated with existing commercial facilities in 2008. The 2008 values were projected to 2012 using employment data in order to determine electricity use and emissions for all existing commercial buildings built before 2012, which are subject to Energy-8.

<u>Emissions Reductions</u>

Energy reductions associated with State-3 (AB1109), Energy-1 (Energy Efficiency for Existing Buildings), Energy-6 (Solar Installations for Warehouses) and Water-2 (Promotion of Water-Efficiency for Existing Development) were subtracted from the energy used by all existing nonresidential buildings built before 2012. This was done in order to determine the energy used by existing nonresidential buildings after the implementation of preceding measures, before installation of solar PV.

The remaining quantity of electricity used by existing nonresidential buildings was then multiplied by the percent of existing commercial/industrial buildings that will install solar under this measure, as determined by the participating cities. This new kWh value was then multiplied by 15%, which is the amount of each existing building's energy demand that will be supplied by the solar PV panels.

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by Energy-8 were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-8.

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

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

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

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

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

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

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

Energy-9: Install Co-Generation Facilities [V]

Measure Description

Co-generation facilities simultaneously generate electricity and useful heat. They are typically used in district heating systems. As feasible, encourage co-generation facilities to supply 15% of building energy in new commercial and industrial facilities greater than 100,000 square feet. Example buildings are university campuses or large medical centers.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Only new buildings install co-gen engines (buildings built in 2013 or after).
- 36% of all nonresidential buildings in each Partnership city are greater than 100,000 square feet. This value is for the Pacific Region from the EIA's Commercial Building Energy Consumption Survey (Energy Information Administration 2008).[13]
- Energy use is approximated by square footage; since 36% of buildings are greater than 100,000 square feet, then 36% of total building energy use occurs in these buildings.
- Co-generation engines use reciprocating engine technology (100 kW rich burn with 3-way catalyst)
- The market penetration rate for existing homes installing solar was determined by the cities on a city-by-city basis.
- The percent of a building's total electricity demand supplied by co-generation engines was determined by the cities on a city-by-city basis.
- The percent reduction in CO_2 emissions for these 100 kW engines in the SCE service area is 14% (California Air Pollution Control Officers Association 2010).
- The co-gen engines operate 8,760 hours per year (24 hours per day, 365 days per year) (California Air Pollution Control Officers Association 2010).

Analysis Details

GHG Analysis

For the same level of power output, combined heat and power (CHP) systems (or co-generation systems) utilize less input energy than traditional separate heat and power (SHP) generation, resulting in fewer CO_2 emissions. In traditional SHP systems, heat created as a by-product is wasted by being released into the environment. In contrast, CHP systems harvest the thermal energy and use it to heat onsite or nearby processes, thus reducing the amount of natural gas or other fuel that would otherwise need to be combusted to heat those processes. In addition CHP systems lower the demand for grid electricity, thereby displacing the CO_2 emissions associated with the production of grid electricity (California Air Pollution Control Officers Association 2010).

<u>BAU Electricity Emissions</u>

The GHG Inventory quantified electricity emissions associated with existing nonresidential facilities in 2008. The 2008 values were projected to 2012 using employment data in order to determine electricity use and emissions for all new commercial buildings built from 2013 to 2020, which are subject to Energy-9.

<u>Emissions Reductions</u>

Energy reductions associated with State-1 (T24), State-3 (AB1109), Energy-2 (Outdoor Lighting), Energy-3

[13] The 36% is calculated as follows: 1,007 million square feet for buildings 100,001 to 200,000 square feet + 977 million square feet for buildings 200,001 to 500,000 square feet + 1,119 million square feet for buildings greater than 500,000 square feet = 3,103 million square feet, divided by 8,613 million square feet total.

(Green Building Ordinance), Land Use-2 (Rooftop Gardens), and Water-1 (Water Conservation for New Construction) were subtracted from the energy used by all new nonresidential buildings built from 2013 to 2020. This was done in order to determine the energy used by new buildings after the implementation of preceding measures, before the installation of co-gen.

The remaining quantity of electricity used by new nonresidential buildings was then multiplied by 36% in order to estimate the electricity demand of buildings greater than 100,000 square feet. This kWh value was then multiplied by the city-specific penetration rate for the amount of each participating building's energy demand that will be supplied by the co-gen engines.

GHG emissions reductions achieved by Energy-9 were quantified by multiplying the resulting go-gen electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-9.

Reduced Air Pollution: Co-generation systems use waste heat to reduce the amount of natural gas or other fuel that would otherwise need to be combusted to heat processes and also lower the demand for grid electricity. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

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

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

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

Economic Development: Development of co-generation systems and associated infrastructure would create new jobs, taxes, and revenue for the local economy.

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

Transportation-1: SB 375 Sustainable Communities Strategy [CITY,V]

Measure Description

SB 375 provides for a new planning process that coordinates land use planning, regional transportation plans (RTPs), and funding priorities in order to help California meet the GHG reduction goals established in AB 32. While Pavley/Advanced Clean Cars and LCFS seek to reduce fuel consumed and reduce the carbon content of fuel consumed, SB 375 seeks to reduce VMT through land use planning. SB 375 requires RTPs, developed by metropolitan planning organizations (MPOs) to incorporate a “sustainable communities strategy” (SCS) in their RTPs. The goal of the SCS is to reduce regional vehicle miles traveled (VMT) through land use planning and consequent transportation patterns. The regional GHG reduction target for Southern California Associated Governments (SCAG) is 9% by 2020 and a 16% reduction by 2035 compared to 2005 GHG emissions on a per capita basis. SCAG's 2012-2035 RTP/SCS successfully achieves and exceeds these targets set by ARB (Southern California Association of Governments 2012a).

This measure applies only to individual cities who decide that their local land use planning supports, in general, SCS style land use and transportation planning, that will result in VMT reductions.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percentage reduction in per-capita VMT associated with the SCS in the SCAG region is 2.4% by 2035 (Fehr and Peers 2011, Table 11).[14]
- The percentage reduction in per-capita VMT associated with the SCS in 2020 is approximately 1% (linear interpolation from 2008 to 2035)
- Each Partnership city will achieve a range of 0.5 to 1% reduction in per-capita light/medium-duty VMT based on city identification.
- The percent reduction in VMT was assumed to be commensurate with the percent reduction in GHGs.
- Needles and Twentynine Palms will not benefit from this measure since they will not be affected by the SCS due to their remote location in the county far from transit opportunities facilitated by the SCS.

Analysis Details

GHG Analysis

VMT reduction through land use planning will reduce GHG emissions associated with on-road transportation.

<u>BAU On-Road Emissions</u>

The GHG Inventory quantified emissions associated with on-road transportation in 2008 and in 2020 under BAU conditions. Population for 2008 and 2020 was used to determine per-capita light/medium-duty VMT for 2008 and 2020 BAU.

<u>Emissions Reductions</u>

The percent change in per-capita light/medium-duty VMT from 2008 to 2020 under BAU conditions was calculated for each Partnership city. Cities choosing this measure selected a percentage between 0.5 to 1%. The city-identified percentage value was subtracted from this value to determine the new percent change in per-capita light/medium-duty VMT from 2008 to 2020 with implementation of this measure. Then the per-capita light/medium-duty VMT in 2008 was multiplied by the new percent change in per-capita VMT to determine the new per-capita VMT in 2020. The new per-capita VMT in 2020 was then multiplied by the projected population in 2020 to determine a new total 2020 VMT. The VMT reduction was calculated by

[14] Percentage Reduction in VMT/HH from 2035 Trip-Based Model, in Table 11.

subtracting the new 2020 VMT from the 2020 BAU VMT.

For example, if the 2008 per-capita VMT is 10,000 and the 2020 BAU per-capita VMT is 9,000, then the change in per-capita VMT is -10%. Subtracting 1% from this yields a -11% change. A -11% change in per-capita VMT from 2008 is 8,900. So, the reduction in VMT would be 100 miles per-capita.

The percent reduction in VMT was assumed to be commensurate with the percent reduction in GHGs. Emission reductions associated with this measure were therefore calculated by multiplying the percent reduction in VMT by the BAU emissions for light-duty autos.

Co-Benefit Analysis

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

Reduced Energy Use: Increased density would reduce the number of private vehicle trips made within each city. As a result, gasoline and diesel consumption would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

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

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

Increased Quality of Life: Increased density along transit routes, employment corridors, and in downtown areas would increase the accessibility of public transportation and basic services. Reductions in the number of vehicle trips may also reduce congestion and travel times.

Smart Growth: Increased density in the urban core is a form of smart growth development that creates more walkable and accessible environments.

Transportation-2: Smart Bus Technologies [CITY]

Measure Description

Smart Bus Technologies include Automatic Vehicle Location (AVL) systems and real-time passenger information at bus stations. Omnitrans plans to implement these technologies system-wide on all bus routes serving San Bernardino Valley (Omnitrans service area) to enable information sharing, enhance rider services, and attract potential riders. The AVL system has been implemented. The Bus Arrival Prediction Information System (BAPIS) will be installed in two phases. In Phase I, real-time rider information will be available via text messaging, Quick Response (QR), website, Interactive Voice Response (IVR), and mobile phone devices. Implementation completion is slated for December 2012. In Phase II Omnitrans will be installing electronic signs at all major transit hubs and provide General Transit Feed Specification (GTFS) data to the general public to build apps for mobile devices like smartphones and tablet computers. Phase II completion is slated for December 2013 (Kuruppu pers. comm.; Omnitrans 2012).

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The growth rate in Omnitrans ridership from 2008 to 2020 is 0.56% (Onmitrans n.d.).
- Several sources in the literature suggest that these technologies may lead to a 20-50% reduction in wait times at transit stations and a 9-20% saving in fuel consumption. 50% was used as the reduction in wait time because of the systemwide deployment proposed by Omnitrans (a sensitivity analysis using a 30% reduction in wait time was also performed to verify this value).
- A 10% saving in fuel consumption was used for Smart Bus technologies.
- Omnitrans' CNG buses had an average fuel economy of 3.3 miles per gallon (GGE) in 2010 which was assumed to remain constant out to 2020 (Federal Transit Administration 2010).
- A transit wait time elasticity of -0.5 was used. This implies that a 10% reduction in transit wait time is expected to result in a 5% increase in ridership (Transportation Research Board 2004).
- All of the additional transit riders switch modes from automobiles to transit.
- Not all additional transit riders previously drove alone (to be conservative in the analysis).
- Average vehicle occupancy (AVO) data was used to estimate the light duty VMT reduction resulting from these additional transit trips (Southern California Association of Governments 2012a).
- Omnitrans system-wide improvements associated with Transportation-1 will equally affect each city served by Omnitrans.

Analysis Details

GHG Analysis

GHG emissions are expected to be reduced because the AVL technologies could lead to more fuel efficient bus operations for Omnitrans and the BAPIS technologies could potentially attract more transit riders who may switch modes from automobiles. Omnitrans' Demand Response Services, OmniLink and Access, do not operate on a fixed schedule or route and are not included in this analysis

<u>Emissions Reductions</u>

Omnitrans provided data on average weekday and annual ridership, vehicle miles, and passenger miles for all routes included in fixed route, fixed schedule service. Weekday values are for 2012, year to date through March and annual values are for 2011. Average weekday trip lengths for 2011 and 2012 are also available. The growth rate in Omnitrans ridership from 2011 to 2012 (year to date) is approximately 8% but the average annual growth rate for the last 10 years (2002-2012) is 0.56%[15]. 0.56% was used to project ridership in 2020.

System-wide VMT reductions were calculated using the following approach:

1. Calculate annual Omnitrans ridership in 2020 using average annual growth rate of 0.56% from 2002-2012. (15,333,567 riders)
2. Calculate annual increase in Omnitrans ridership from improved traveler information and reduced wait times in 2020. (3,833,392)
3. Calculate annual reduction in light duty VMT from additional transit riders switching modes from autos, using -0.5 elasticity and average passenger trip length, assumed same from 2011. (13,676,319)
4. Calculate annual reduction in CNG consumption from increased operational efficiency due to use of AVL systems. (319,280 GGE/gallons)

System-wide GHG emission reductions were calculated using the following approach:

1. Calculate annual emission benefit of light duty VMT reduction using 2020 emission factors for CO_2, CH_4, N_2O, and CO_2 equivalent. (4,253 metric tons of CO_2e)
2. Calculate annual emission benefit of CNG gallons saved using default factors from Climate Registry (2012). (2,286 metric tons of CO_2e)
3. Sum the two sources of emission reduction. (6,539 metric tons of CO_2e)

The system-wide reductions were then apportioned equally to each Partnership city that is served by Omnitrans. Since there are 15 cities served by Omnitrans, each city was assigned 436 $MTCO_2e$ of reductions. The actual benefit of this measure will not be distributed evenly, as cities with greater potential for new riders will have more benefit than those with lesser potential. However, due to limited data about the effects of this measure on a city-by-city basis, reductions were apportioned evenly.

A sensitivity analysis assuming 30% reduction in wait time (as opposed to 50%) results in a 0.07% reduction in GHG emissions. A sensitivity analysis assuming 50% reduction in wait time and 30% of additional transit riders switching modes from autos results in a 0.05% reduction in GHG emissions.

Co-Benefit Analysis

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

Reduced Energy Use: More attractive transit would encourage motorists to utilize public transportation instead of private vehicles. As a result, the number of vehicle trips made within each city, and thus gasoline and diesel consumption, would be reduced.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles within each city, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

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

[15] Based on Omnitrans data available on http://www.omnitrans.org/about/quik-facts.shtml

respiratory irritation and reduced plant productivity.

Increased Quality of Life: Increased transit service would help reduce transit passenger travel time and may make public transportation more comfortable and enjoyable. Reductions in the number of vehicle trips may also reduce congestion and travel times.

Waste-1: Increased Waste Diversion [M]

Measure Description

Continue to provide public education and collection services to community residents and business. Exceed the waste diversion goals recommended by Assembly Bill 939 and CALGreen by adopting citywide waste goals of at least 75% of waste diversion.

Assumptions

The following assumptions were considered for the quantification of this measure.

- The 2020 BAU waste diversion rate equals the 2006 diversion rate for each Partnership city (CALRecycle 2010b).[16]
- The cities participating in this measure will increase their diversion rates linearly from their 2006 rate to their selected new diversion rate goal by 2020. These rates range from 50% to 75%.

Analysis Details

GHG Analysis

Diversion programs reduce the amount of waste deposited in regional landfills. Because waste generates methane emissions during decomposition, reducing the volume of waste sent to landfills directly reduces GHG emissions. In general, waste diversion rates have risen dramatically since the early 1980s. The U.S. achieved 51% diversion in fiscal year 2009 (U.S. Environmental Protection Agency 2011b).

2020 BAU Emissions

The GHG Inventory projected 2020 waste volumes for each city using historic landfill data obtained from CalRecycle. The 2006 diversion rate for each city was assumed to remain constant under 2020 BAU conditions.

Emissions Reductions

Implementation of Waste-1 would increase the BAU diversion rate for each city by 2020 (e.g., to 75%). The amount of waste diverted by material type under BAU conditions was therefore increased by the difference between the BAU diversion rate and the new diversion rate selected by the cities. GHG emissions that would have been generated by the diverted waste if it had been deposited in regional landfills were quantified using CARB's FOD Model and new waste disposal quantities based on the new 2020 waste diversion goal for each city.

CAPCOA recommends the use of the U.S. Environmental Protection Agency's Waste Reduction Model (WARM) to quantify emissions reductions from diverting landfill waste to composting or recycling. The WARM model calculates life-cycle emission reductions, which includes emissions and avoided emissions upstream and downstream from the point of use. This approach is not consistent with the method used in the inventory, and EPA recommends against using this life-cycle approach for inventories because of the diffuse nature of the emissions and emission reductions within a single WARM emission factor. Consequently, the WARM model was not used to calculate reductions from Waste-1. CARB's FOD Model was used to calculate reductions because it is consistent with the inventory and does not have a lifecycle component.

Co-Benefit Analysis

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

[16] Diversion rates for years after 2006 are not available from CALRecycle.

Reduced Air Pollution: The decomposition of landfilled waste emits methane, which can react with other species in the atmosphere to form local smog. By sending less waste to regional landfills, methane emissions would be reduced.

Resource Conservation: Waste that is diverted to recycling centers can be converted into reusable products, thereby reducing the need for raw materials.

Agriculture-1: Methane Capture at Large Dairies [V]

Measure Description

This is a voluntary measure to be undertaken by large dairies and encourages the installation of methane digesters to capture methane emissions from the decomposition manure. The methane could be used as on-site as an alternative to natural gas in combustion, power production, or as a transportation fuel. Further, individual project proponents can sell GHG credits associated with these installations on the voluntary carbon market.

Assumptions

The following assumptions were considered for the quantification of this measure.

- The only cities with large dairies (1,000+ head of dairy cows) subject to this measure are Chino and Ontario
- 157.06 kg of methane is emitted per head of cattle per year from manure management (California Air Resources Board 2010)
- 73% of dairy cows at dairies with 1,000+ head will already be feeding digesters through voluntary action (California Air Resources Board 2008a, pg. I-64)
- The BAU methane capture rate is 0% (i.e. no methane capture)
- The methane capture rate is 75% (selected by Ontario)

Analysis Details

GHG Analysis

Dairies produce large quantities of methane from enteric fermentation and manure management of dairy cows. Capturing this methane, instead of allowing it to be released into the atmosphere, will reduce GHG emissions associated with dairies. Biodigesters recover methane from animal manure through a process called anaerobic digestion. The captured methane can be flared, combusted to produce electricity, or converted to fuel such as natural gas.

<u>2020 BAU Emissions</u>

The GHG Inventory projected 2020 dairy emissions for each city using the number of head of dairy cattle in 2008 and a growth facto obtained for the county. Only dairy emissions from Chino and Ontario could be affected by this measure (if Chino or Ontario selects this measure), because they are the only cities with large dairies.

<u>Emissions Reductions</u>

Implementation of Agriculture-1 would result in the capture of 86% of the methane generated from the manure of 73% of the dairy cows within Chino and Ontario. Total BAU emissions from dairy cows for these cities were multiplied by 73% and then by 75% (methane capture rate) to determine the quantity of methane captured within each city.

Co-Benefit Analysis

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

Reduced Air Pollution: Manure management at dairies emits methane, which can react with other species in the atmosphere to form local smog. By capturing much of this methane, emissions would be reduced.

Resource Conservation: Methane can be used to generate electricity or produce other useful fuels, thereby reducing the need for energy.

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

Agriculture-2: Utilize Methane Captured at Dairies [V]

Measure Description

Implement a program to reuse biogas (methane from manure) captured at dairies. This biogas could be destroyed on-site, transported for off-site use (e.g., through gas distribution or transmission pipeline), or used to power vehicles. Using captured biogas could potentially offset natural gas use or offroad fuel use (reductions may be achieved in the building energy sector and/or the off-road sector).

Assumptions

The following assumptions were considered for the quantification of this measure.

- The only cities with large dairies (1,000+ head of dairy cows) subject to this measure are Chino and Ontario
- 25% of methane is destroyed on site (flared) (estimate)
- 75% of methane is used for offsite use energy generation (estimate)
- Efficiency factor for converting methane into electricity is 85% (California Air Pollution Control Officers Association 2010)
- The energy content of biomethane is 1,012 btu per cubic foot (California Air Pollution Control Officers Association 2010)
- Combustion emission factors for biomethane are 52.07 kg CO_2/MMBtu, 0.032 kg CH_4/MMBtu, and 0.0042 kg N_2O/MMBtu (Climate Registry 2012)

Analysis Details

GHG Analysis

Dairies produce large quantities of methane from enteric fermentation and manure management of dairy cows. Capturing this methane, instead of allowing it to be released into the atmosphere, will reduce GHG emissions associated with dairies. Biodigesters recover methane from animal manure through a process called anaerobic digestion. The captured methane can be flared, combusted to produce electricity, or converted to fuel such as natural gas.

<u>2020 BAU Emissions</u>

The GHG Inventory projected 2020 dairy emissions for each city using the number of head of dairy cattle in 2008 and a growth facto obtained for the county. Only dairy emissions from Chino and Ontario could be affected by this measure, because they are the only cities with large dairies (and only if one or both of these cities selects this measure). The quantity of captured methane was obtained from Agriculture-1.

<u>Emissions Reductions</u>

Implementation of Agriculture-2 would result in the flaring of 25% of the methane captured from dairies (calculated in Agriculture-1) and the combustion for electricity of 75% of this methane.

The quantity of methane captured from implementation of Agriculture-1 was multiplied by 75% to determine the quantity of methane combusted for electricity. This was converted to energy units (MMBtu) and then into electricity production using the efficiency factor of 85%. GHG emissions reductions achieved by Agriculture-2 were quantified by multiplying the electricity reduction by the appropriate utility emission factors.

Co-Benefit Analysis

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

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

Resource Conservation: Methane used to generate electricity or produce other useful fuels reduces the need for energy.

Reduced Energy Use: This measure would increase the production of renewable electricity, which would reduce the amount of fossil fuels consumed to produce electricity in power plants.

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

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

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

Wastewater-1: Methane Recovery [V]

Measure Description

Work with the IEUA or other local wastewater treatment (WWT) providers to identify funding, and cooperating agencies for establishing methane recovery systems at all wastewater treatment plants that service San Bernardino County residents by 2020, as appropriate. Install equipment for the combustion of digester gas to generate electricity at all wastewater treatment plants by 2020.

Assumptions

The following assumptions were considered for the quantification of this measure.

- IEUA, which serves the cities of Chino, Chino Hills, Fontana, Rancho Cucamonga, Montclair, and Ontario, already captures 100% of generated methane and combusts 25% of this methane to generate electricity, so these cities do not benefit from this measure (Pompa pers. comm.).
- Wastewater providers that already capture methane at their plants are assumed to capture 100% of generated methane (same as IEUA). These providers include the City of San Bernardino (San Bernardino, Loma Linda, and Highland), Victor Valley Wastewater Agency (Victorville and Hesperia), Veolia Water North America Operating Services, Inc., and City of Rialto (Rialto), the City of Redlands (Redlands), and Yucaipa Valley Water District (Yucaipa) (City of San Bernardino 2013; Victor Valley Wastewater Reclamation Authority 2012; Veolia Water North America 2010; City of Redlands 2013; Yucaipa Valley Water District 2012; Big Bear Area Regional Wastewater Agency 2012).
- 29 Palms and Yucca Valley will not benefit from this measure since they are on septic systems and do not have WWTPs.
- Wastewater providers that already have cogeneration or electricity production capacity (see list above), 75% of methane is combusted and 25% of methane is flared (same as IEUA). Exceptions to this rule include:
  - Victor Valley Wastewater Agency, which has 50% combustion and 50% flaring (actual percentages are not known).
  - Veolia Water North America Operating Services, Inc., and City of Rialto, the City of Adelanto Water Department (Adelanto), and the Yucaipa Valley Water District (Yucaipa) have 0% combustion and 100% flaring (no electricity production capacity) (Veolia Water North America 2010; Yucaipa Valley Water District 2012; City of Adelanto 2012;).
- The new methane capture rate at participating plants that do not already have methane capture is 99.7% (California Air Pollution Control Officers Association 2010, measure AE-6)
- For participating plants, 75% of captured methane will be combusted to generate electricity; 25% will be flared
- Standard conversion factors were used to convert methane into energy, including: 662 grams methane per cubic meter; 35.3 cubic feet per cubic meter; 1,012 btu per cubic feet of methane; 0.00009 kWh per btu energy conversion factor (California Air Pollution Control Officers Association 2010, measure AE-6)
- The efficiency factor for converting methane into electricity is 0.85 (California Air Pollution Control Officers Association 2010, measure AE-6).
- Reductions are allocated regionally (reductions are proportionate to emissions)

If better data for the WWTP operations are available in the future, this analysis can be updated for later drafts.

Analysis Details

GHG Analysis

Wastewater treatment plants (WWTP) produce large quantities of methane from wastewater processing. Capturing this methane, instead of allowing it to be released into the atmosphere, will reduce GHG emissions associated with wastewater treatment.

<u>2020 BAU Emissions</u>

The GHG Inventory projected 2020 wastewater treatment emissions of fugitive methane using population projections for each city.

<u>Emissions Reductions</u>

The CAPCOA method for estimating emission reductions for measure AE-6 was followed in order to calculate reductions for this measure. First, the CAPCOA method was used to determine 2020 BAU emissions of methane (California Air Pollution Control Officers Association 2010). Then, the mitigated method for *Mitigation Option 1—Methane is captured and flared* was used to calculate mitigated emissions of methane. Comparing the BAU methane emissions to the mitigated methane emissions yielded a methane capture rate of 99.7%. For all cities participating that are not already served by WWTPs that capture 100% of generated methane, this represents an emission reduction (going from 0% or 50% capture to 99.7% capture; see assumptions above). For cities which are already served by WWTPs that capture 100% of generated methane, there are no emission reductions (since these plants already capture all of the methane they generate).

The amount of electricity generated through combustion of the captured methane was calculated by multiplying the total amount of methane captured by 75%, converting the resulting methane into btus of energy, and multiplying by the 0.85 efficiency factor. The following equation was used:

- Total methane captured (metric tons) * 1,000,000 grams per metric ton ÷ 662 grams methane per cubic meter * 75% combustion rate * 35.3 cubic feet per cubic meter * 1,012 btus per cubic feet of methane * 0.85 * 0.00009 kWh generated per btu of methane combusted.

GHG emissions reductions achieved by Wastewater-1 were quantified by multiplying the resulting electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

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

Reduced Air Pollution: Wastewater treatment processes emit methane, which can react with other species in the atmosphere to form local smog. By capturing much of this methane, emissions would be reduced.

Resource Conservation: Methane can be used to generate electricity or produce other useful fuels, thereby reducing the need for energy.

Economic Development: Development of renewable energy infrastructure (e.g., anaerobic digesters, methane capture systems) would create new jobs, taxes, and revenue for the local economy.

Wastewater-2: Energy Efficiency Equipment Upgrades at WWTPs [V] [17]

Measure Description

Work with the IEUA or other local WWTP operators to upgrade and replace wastewater treatment and pumping equipment with more energy efficient equipment, as is financially feasible, at the existing facilities by 2020. Require all pumping and treatment equipment to be at least 5-10% more energy efficient at the time of replacement. Utilize best management practices for the treatment of waste.

Assumptions

The following assumptions were considered for the quantification of this measure

- The IEUA agency-wide energy intensity for wastewater treatment is 3,580 kWh/MG wastewater treated (Pompa pers. comm.). This value was used as a proxy for all WWTPs.
- This measure would result in a 7.5% improvement in energy efficiency by 2020 = 269 kWh saved/MG wastewater produced versus 2008 (Pompa pers. comm.)
- If a WWTP operator already has plans to upgrade their pumps, the cities served by these operators benefit from this measure. This includes IEUA (Chino, Chino Hills, Fontana, Rancho Cucamonga, Montclair, and Ontario), Victor Valley Wastewater Agency (Victorville and Hesperia), City of Adelanto Water Department (Adelanto), and City of Colton Public Utilities Wastewater Department (Grand Terrace) (City of Colton 2012).
- If a WWTP operator does not currently have plans to upgrade their pumps but a city wants to participate in this measure, then that city will benefit from this measure.
- 29 Palms and Yucca Valley will not benefit from this measure since they are not served by a centralized WWTP.

If better data for the WWTP operations are available in the future, this analysis can be updated for later drafts.

Analysis Details

GHG Analysis

Some of the wastewater generated within the county is treated by the IEUA and other WWTP operators in a number of WWTPs. Collection and treatment of the wastewater generates fugitive methane emissions from organic decomposition, as well as GHGs from electricity consumption.

Emissions Reductions

According to the IEUA, implementation of energy efficiency measures would achieve a 7.5% reduction in energy use for wastewater treatment (Pompa pers. comm.). According to IEUA, the current energy-intensity for wastewater treatment is 3,580 kWh/MG (Pompa pers. comm.). Electricity savings associated with implementation of Wastewater-2 is therefore 269 kWh saved/MG. This factor was applied to cities that are currently served by WWTP operators that already have plans to upgrade their pumps, along with cities that want to participate in this measure (but are served by WWTP operators that don't have current plans to upgrade).

[17] GHG emissions associated with electricity consumption at IEUA WWTPs were reported in the building energy sector of the GHG Inventory (only fugitive and process emissions were reported in the wastewater sector). Consequently, emissions reductions associated with reduced electricity use will be achieved in the building energy sector. However, these emissions reductions are reported as part of Wastewater-2 as they are a direct result of implementation of Wastewater-2.

Projected 2020 wastewater generation in MG for each city in 2020 was therefore multiplied by 269 kWh saved/MG to determine the amount of electricity saved through implementation of this measure. GHG emissions reductions achieved by Wastewater-2 were quantified by multiplying the electricity reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

Reduced Energy Use: The collection and treatment of wastewater requires electricity. Improving the efficiency of pumping and treatment equipment would therefore reduce electricity consumption at the IEUA WWTPs.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

Wastewater-3: Recycled Water [V] [18]

Measure Description

Establish a goal of achieving 50% of all water used for non-potable sources (such as landscaping irrigation, dust control, or fire suppression) to be recycled (and treated) wastewater. Consider requiring all new parks and schools, or other public facilities to use 100% recycled water for non-potable outdoor uses as a first step as feasible depending on existing and planned RW infrastructure. Develop public educational materials that support and encourage the use of recycled water. Adopt a municipal goal of 100% use of recycled water for non-potable sources. Implementation will likely require coordination with regional WWTP and recycled water providers such as IEUA.

Assumptions

The following assumptions were considered for the quantification of this measure

- The percent of outdoor water use (after impact of other water measures take place) that will be recycled in 2020 was determined by the cities on a city-by-city basis.
- The electricity required to treat and distribute reclaimed water is 2,100 kWh/MG (California Air Pollution Control Officers Association 2010).

Analysis Details

GHG Analysis

Recycled water can have a lower energy intensity than high-intensity sources (such as imported water that require extensive pumping). Encouraging use of lower energy intensity water supplies to displace higher energy intensity water supplies can reduce electricity consumption and GHG emissions associated with transporting and treating that water.

California homes and businesses consume a significant amount of water through outdoor irrigation. Using recycled water instead of potable water for irrigation (and other water end-uses which can use non-potable water) can reduce the demand for fresh water conveyed to the cities from the State Water Project and other high energy intensive water resources.

<u>Emissions Reductions</u>

Outdoor water use reductions associated with Water-1 (Water Conservation for New Construction), Water-2 (Water Conservation for Existing Construction), and Water-3 (Water Efficient Landscaping Practices) were subtracted from the total 2020 BAU water outdoor use for all participating cities. This was done in order to determine the outdoor water use after the implementation of preceding measures, before the implementation of Wastewater-3. The remaining quantity of outdoor water use was multiplied by the city-specific recycled water percentage to determine the amount of water that would be replaced with recycled water due to implementation of this measure.

This quantity of water was multiplied by 2,100 kWh to determine the electricity needed to treat and distribute reclaimed water (California Air Pollution Control Officers Association 2010). This quantity of water was also multiplied by the BAU energy intensity factors for each city to determine the BAU energy use needed to convey, treat, and distribute this water in the absence of Wastewater-3. The difference in these two values represents the electricity savings associated with the implementation of Wastewater-3.

GHG emissions reductions achieved by Wastewater-3 were quantified by multiplying the electricity reductions by the appropriate utility emission factors.

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[18] GHG emissions associated with the use of recycled water were reported in the water conveyance sector of the GHG Inventory (only fugitive and process emissions were reported in the wastewater sector). Consequently, emissions reductions associated with reduced electricity use from water conveyance will be achieved in the water conveyance sector. However, these emissions reductions are reported as part of Wastewater-3 as they are a direct result of implementation of Wastewater-3.

Co-Benefit Analysis

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

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Encouraging the use of lower energy intensity water supplies to displace higher energy intensity water supplies can reduce electricity consumption.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

Resource Conservation: Using recycled water in place of freshwater would help conserve freshwater resources.

Water-1: Require Adoption of the Voluntary CALGreen Water Efficiency Measures for New Construction [M]

Measure Description

Require adoption of the Voluntary CALGreen water efficiency measures for New Construction. CALGREEN voluntary measures recommend use of certain water-efficient appliances, and plumbing and irrigation systems, as well as more aggressive water savings targets. Update building standards and codes for new buildings to require adoption of these voluntary measures, including:

- Use of low-water irrigation systems
- Installation of rainwater and graywater systems
- Installation of water-efficient appliances and plumbing fixtures, as well as composting toilets
- A 30-40% reduction over BAU conditions in indoor water use, and a 55-60% reduction in outdoor potable water use (CALGreen Tier 1 or 2)

Assumptions

The following assumptions were considered for the quantification of this measure:

- The market penetration rate for new buildings (residential and commercial) achieving CALGreen Tier 1 or 2 voluntary water efficiency measures and the penetration rate for new parks performing irrigation retrofits were determined by the cities on a city-by-city basis.
- The following voluntary CALGreen measures would be implemented by development.
  - Installation of water efficient appliances and plumbing fixtures (showerheads, faucets, toilets, urinals, and dishwashers).
  - Use of low-water irrigation systems.
  - Installation of gray water systems.
- 57% of total residential water use is for outdoor use / landscaping; the remaining 43% is used indoors (ConSol 2010)
- 35% of total nonresidential water use is for outdoor use / landscaping; the remaining 65% is used indoors (Yudelson 2010)
- Heating a gallon of hot water requires 0.0098 therms of natural gas or 0.19 kWh of electricity (ICLEI Local Governments for Sustainability 2010).
- 73% of water used in faucets and showerheads is hot water (U.S. Department of Energy 2012).
- 10.5% homes have electric water heaters (1.3 million households out of 12.4 million households used electricity to heat water in 2005 in California) (Energy Information Administration 2009, Table WH2).
- 40% of commercial buildings have electric heaters (2,771 million square feet out of 6,947 million square feet use electricity to heat water in 2003 in the Pacific Census Region) (Energy Information Administration 2009, Table B32).
- Assumptions for water-efficient faucets:
  - The current California standard residential faucet flow rate is 2.2 gallons/minute @ 60 psi; the mandatory CALGreen standard flow rate is 1.62 gallons/minute @ 60 psi (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.6 gallons/minute for each faucet replaced.
  - The current California standard nonresidential bathroom faucet flow rate is 0.5 gallons/minute @ 60 psi; the voluntary CALGreen standard flow rate is 0.35 gallons/minute @ 60 psi (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.2 gallons/minute

for each bathroom faucet replaced.

- There are 40 employees per faucet (20 employees per toilet and 2 toilets per faucet) (8 CCR Section 1526(a); 29 CFR 1910.141(c)(1)(i))
- There are 2.1 faucets per household on average (ICLEI Local Governments for Sustainability 2010).
- The average faucet use time (per capita or per employee) is 4.75 minutes use/day total: 0.75 minutes for bathroom faucets (three 0.25 minute uses for bathroom faucets) and 4 minutes for kitchen faucets (four one minute uses for kitchen faucets) (California Building Standards Commission 2011, p. 49)

- Assumptions for water-efficient showerheads:
  - The current California standard showerhead flow rate is 2.5 gallons/minute @ 60 psi; the mandatory CALGreen standard flow rate is 2.0 gallons/minute @ 60 psi (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.5 gallons/minute for each showerhead replaced.
  - The average shower use time is 8 minutes per day per capita (California Building Standards Commission 2011, p. 49).
- Assumptions for water-efficient toilets/urinals:
  - The current California standard toilet water use rate is 1.6 gallons/flush; the mandatory CALGreen standard flow rate is 1.28 gallons/flush (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.32 gallons/flush for each toilet replaced.
  - The current California standard urinal water use rate is 1.0 gallons/flush; the voluntary CALGreen standard flow rate is 0.5 gallons/flush (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.5 gallons/flush for each toilet replaced
  - 2 toilet flushes per person per day (residential) and 2 urinal flushes per male employee per day (nonresidential) (California Building Standards Commission 2011, p. 49)
- Assumptions for water-efficient dishwashers:
  - The current California standard dishwasher water use rate for standard dishwashers is 6.5 gallons/cycle/cubic foot; the voluntary CALGreen standard water use rate is 5.8 gallons/cycle/cubic foot (California Air Pollution Control Officers Association 2010). This equates to a savings of 0.7 gallons/cycle for each standard dishwasher replaced.
  - The current California standard dishwasher water use rate for compact dishwashers is 4.5 gallons/cycle/cubic foot; the ENERGY STAR water use rate is 3.5 gallons/cycle/cubic foot (California Air Pollution Control Officers Association 2010). This equates to a savings of 1.0 gallons/cycle for each compact dishwasher replaced.
  - 0.1 average dishwasher runs per person per day (Mayer and DeOreo 1999)
  - 100% of water used in dishwashers is hot water.
- Assumptions for low-water irrigation systems:
  - The average lawn size per home is 0.2 acre (Grounds Maintenance 2012) (except for Yucca Valley, for which it was assumed 0.1 acres/lawn per home in order to more accurately calculate outdoor residential water use for this city),
  - An acre of lawn requires 652,000 gallons to irrigate per year (Watson et al. n.d.).
  - 35% of total nonresidential water use is for outdoor use / landscaping; the remaining 65% is used indoors (Yudelson 2010)
  - 25% of park/open space acreage is irrigated (estimate).

- 26% savings in landscaping water use for homes and buildings installing low-water irrigation systems (U.S. Environmental Protection Agency 2007).
- 25% of residential outdoor water use is replaced with gray water; 50% of nonresidential outdoor water use is replaced with gray water (estimate).

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. Installing low-flow or high-efficiency water fixtures in buildings reduces water demand, energy demand, and associated indirect GHG emissions.

In 2010, the California Building Standards Commission unanimously adopted Title 24 Part 11 (also known as CALGreen), the mandatory green building standards code and the first such code in the nation. CALGreen requires all new buildings in the state to be more energy efficient and environmentally responsible. Effective January 1, 2011, CALGreen requires that every new building constructed in California reduce water consumption by 20%. CALGreen voluntary measures recommend a 30–40% reduction over BAU conditions in indoor water use and 55–60% reduction over BAU outdoor potable water use.

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. ConSol estimates that an average three-bedroom home uses 174,000 gallons of water each year (ConSol 2010). A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets). Recognizing that water uses a great deal of electricity to pump, treat, and transport, the state adopted SB X7-7, which requires a 20% reduction in urban per capita use by December 31, 2020 (20X2020 goal). Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

Emissions Reductions

Water savings were calculated for the installation of six different water-efficient fixtures/systems: faucets, showerheads, toilets/urinals, dishwashers, low-water irrigation systems, and gray water systems. Methods for calculating water savings for each of these are described below.

Faucets:

- Residential water savings (gallons) = total new households in 2020 * 100% market penetration rate * persons/household (varies by city) * 0.6 gallons of water saved/minute * 4.75 minutes of use/person per day * 365 days/year
- Nonresidential bathroom faucet water savings (gallons) = total number of new employees in 2020 * city-selected market penetration rate ÷ 40 employees/faucet * 0.2 gallons of water saved/minute * 0.75 minutes of use/employee per day * 260 workdays/year
- Nonresidential kitchen faucet water savings (gallons) = total number of new employees in 2020 * city-selected market penetration rate ÷ 40 employees/faucet * 1.4 gallons of water saved/minute * 4 minutes of use/employee per day * 260 workdays/year

Showerheads:

a) Residential water savings (gallons) = total new residents in 2020 * 100% market penetration rate * 0.5 gallons of water saved/minute * 8 minutes of shower use/person per day * 365 days/year

b) No savings for nonresidential

Toilets/urinals:

a) Residential water savings (gallons) = total new residents in 2020 * 100% market penetration rate * 0.32 gallons of water saved/flush * 2 flushes/person per day * 365 days/year

b) Nonresidential toilet water savings (gallons) = total number of new employees in 2020 * city-selected market penetration rate * 0.48 gallons of water saved/flush * (50% men * 1 flush/male employee per day + 50% women * 3 flushed/female employee per day) * 365 days/year

c) Nonresidential urinal water savings (gallons) = total number of new employees in 2020 * city-selected market penetration rate * 0.5 gallons of water saved/flush * 50% men * 2 flushes/male employee per day * 260 workdays/year

Dishwashers:

a) Residential water savings (gallons) = total new residents in 2020 * city-selected market penetration rate * (50% standard dishwashers * 0.7 gallons of water saved/cycle for standard dishwashers + 50% compact dishwashers * 1.0 gallons of water saved/cycle for compact dishwashers) * 0.1 dishwasher runs/person per day * 365 days/year

b) No savings for nonresidential

Low-water irrigation systems:

a) Residential water savings (gallons) = total new homes in 2020 * 0.2 acres of lawn/home average * 100% market penetration rate * 652,000 gallons used for irrigation/acre per year * 26% reduction in water use for irrigation control sensors

b) Nonresidential building water savings (gallons) = total new 2020 water use * 35% outdoor water use for office buildings on average * city-selected market penetration rate * 26% reduction in water use for irrigation control sensors

c) Parks water savings (gallons) = total new 2020 park water use * city-selected market penetration rate * 26% reduction in water use for irrigation control sensors

Gray water systems:

a) Residential water savings (gallons) (total new homes in 2020 * 0.2 acres of lawn/home average * 100% market penetration rate * 652,000 gallons used for irrigation/acre per year – water saved from irrigation control sensors) * city-selected percentage of outdoor water use that is replaced with gray water

b) Nonresidential building water savings (gallons) = (total new 2020 water use * 35% outdoor water use for office buildings on average – water saved from irrigation control sensors) * city-selected percentage of outdoor water use that is replaced with gray water

Water use savings result in energy use reductions for three different categories. Electricity savings from reduced water conveyance, treatment, distribution, and wastewater treatment were quantified by multiplying the anticipated water reductions by the appropriate energy-intensities.

Electricity savings from reduced water heating for faucets, showerheads, and dishwashers were quantified as follows:

c) Residential electricity savings (kWh) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 10.5% of homes with electric water heaters * 0.19 kWh to heat a gallon of water

d) Nonresidential electricity savings (kWh) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 40% of commercial buildings with electric water heaters * 0.19 kWh to heat a gallon of water

Natural gas savings from reduced water heating for faucets, showerheads, and dishwashers were quantified as follows:

a) Residential natural gas savings (therms) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 89.5% of homes with natural gas water heaters * 0.0098 therms to heat a gallon of water

b) Nonresidential natural gas savings (therms) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 40% of commercial buildings with electric water heaters * 0.19 kWh to heat a gallon of water

GHG savings from electricity and natural gas reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

Resource Conservation: Reduced water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Likewise, water consumed during showers, dish washing, and clothes washing require electricity and natural gas to heat the water to a comfortable temperature. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, transporting, and heating

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

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

Water-2: Implement a Program to Renovate Existing Buildings to Achieve Higher Levels of Water Efficiency [V][19]

Measure Description

Implement a program to renovate existing buildings to achieve higher levels of water efficiency. Education and outreach programs can help educate individuals on the importance of water efficiency and how to reduce water use. Rebate programs can help promote installation of water-efficient plumbing fixtures. The program could address:

- Development plans to ensure water conservation techniques are used (e.g., rain barrels, drought tolerant landscape).
- Water efficiency upgrades as a condition of issuing permits for renovations or additions of existing buildings.
- Adopt water conservation pricing, such as tiered rate structures, to encourage efficient water use.
- Incentives for projects that demonstrate significant water conservation through use of innovative water consumption technologies.

Assumptions

The assumptions described in Water-1 were used to quantify water, energy, GHG emissions reductions associated with this measure. The following assumptions were modified:

- The market penetration rate for buildings (residential and commercial) performing water efficiency retrofits and the penetration rate for parks performing irrigation retrofits were determined by the cities on a city-by-city basis.

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. Installing low-flow or high-efficiency water fixtures in buildings reduces water demand, energy demand, and associated indirect GHG emissions.

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. ConSol estimates that an average three-bedroom home uses 174,000 gallons of water each year (ConSol 2010). A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets). Recognizing that water uses a great deal of electricity to pump, treat, and transport, the state adopted SB X7-7, which requires a 20% reduction in urban per capita use by December 31, 2020 (20X2020 goal). Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

Emissions Reductions

The methods described in Water-1 were used to quantify water, energy, and GHG emissions reductions associated with this measure. The following assumptions were modified.

- BAU water flow rates were based on the 1992 Energy Policy Act.[20]

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[19] Emissions reductions associated with reduced electricity and natural gas for hot water heating will be achieved in the building energy sector. However, these emissions reductions are reported as part of Water-2 as they are a direct result of implementation of water-efficient fixtures.

[20] Because this measure applies to existing developing, assuming BAU flow rates are equivalent to the 2010 building code is inappropriate. According to the City's Housing Element and the EIA, the majority of homes and commercial developments were constructed prior to 1980. Assuming the 1992 flow rate therefore represents a conservative assumption as several developments that comply with this measure will likely replace fixtures with flow rates much higher than required in 1992.

Co-Benefit Analysis

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

Resource Conservation: Efficient appliances and fixtures would reduce water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Likewise, water consumed during showers, dish washing, and clothes washing require electricity and natural gas to heat the water to a comfortable temperature. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, transporting, and heating.

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

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

Water-3: Encourage Water-Efficient Landscaping Practices [V]

Measure Description

Encourage Water-Efficient Landscaping Practices. Adopt a landscaping water conservation plan that exceeds the requirements in the Model Landscape Ordinance (AB 1881).

Assumptions

The following assumptions were considered for the quantification of this measure:

- The market penetration rate for buildings (residential and commercial) and parks performing water-efficient landscaping practices was determined by the cities on a city-by-city basis.
- The average lawn size per home is 0.2 acre (Grounds Maintenance 2012) (except for Yucca Valley, for which it was assumed 0.1 acres/lawn per home in order to more accurately calculate outdoor residential water use for this city)
- An acre of lawn requires 652,000 gallons to irrigate per year (Watson et al. n.d.)
- Assuming an irrigation efficiency of 71% as specified in the Model Water Efficient Landscape Ordinance and no Special Landscape Area, the percent reduction in CO_2e for water-efficient landscapes is (California Air Pollution Control Officers Association 2010):
- 0% reduction if 100% of vegetation is Moderate Example Plant Factor (PF)
- 13% reduction if 40% of vegetation is Low PF, 40% is Moderate PF, and
- 20% is High PF
- 35% reduction if 50% of vegetation is Low PF and 50% is Moderate PF
- 70% reduction if 100% of vegetation is Low PF
- The average reduction in CO_2e is 30% (based on the percent reductions above).
- 6.1% reduction in CO_2e for water-efficient landscape irrigation systems (California Air Pollution Control Officers Association 2010)
- 35% of total nonresidential water use is for outdoor use / landscaping; the remaining 65% is used indoors (Yudelson 2010)
- 25% of park/open space acreage is irrigated (estimate).

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. California homes and businesses consume a significant amount of water through outdoor water use, which includes landscape irrigation. Designing water-efficient landscapes for a project site reduces water consumption and the associated indirect GHG emissions.

Examples of measures to consider when designing landscapes are reducing lawn sizes, planting vegetation with minimal water needs such as California native species, choosing vegetation appropriate for the climate of the project site, and choosing complimentary plants with similar water needs or which can provide each other with shade and/or water. Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

<u>Emissions Reductions</u>

The following steps were performed to calculate water savings:

i) Residential water savings (gallons) = total homes in 2020 * 0.2 acres of lawn/home average * city-selected market penetration rate * 652,000 gallons used for irrigation/acre per year * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

j) Nonresidential building water savings (gallons) = total 2020 water use * 22% outdoor water use for office buildings on average * city-selected market penetration rate * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

k) Parks water savings (gallons) = total 2020 park water use * city-selected market penetration rate * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

Resource Conservation: Efficient irrigation systems would reduce water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, and transporting.

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

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

Water-4: Senate Bill X7-7 The Water Conservation Act of 2009 [M]

Measure Description

SB X7-7 was enacted in November 2009 and requires urban water agencies throughout California to increase conservation to achieve a statewide goal of a 20 percent reduction in urban per capita use by December 31, 2020.

Assumptions

The assumptions described in Water-1 were used to quantify water, energy, GHG emissions reductions associated with this measure. The following additional assumptions were used:

- 20% reduction in total water use obtained by this measure.
- 33% of total residential indoor water use is hot water (Aquacraft, Inc. 2014).
- 22% of total commercial indoor water use is hot water (Yudelson 2010, U.S. Department of Energy 2012).

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. Installing low-flow or high-efficiency water fixtures in buildings reduces water demand, energy demand, and associated indirect GHG emissions.

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. ConSol estimates that an average three-bedroom home uses 174,000 gallons of water each year (ConSol 2010). A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets). Recognizing that water uses a great deal of electricity to pump, treat, and transport, the state adopted SB X7-7, which requires a 20% reduction in urban per capita use by December 31, 2020 (20X2020 goal). Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

<u>Baseline Emissions and Emissions Reductions</u>

Each urban water retailer in the county has adopted a 2010 Urban Water Management Plan (UWMP). Each plan establishes a 2020 urban water use target for the retailer’s service area. These targets vary by city and depend on the baseline per-capita water use rate identified in each UWMP. These targets represent the level of water consumption needed to achieve the 20X2020 goal for each water retailer.

Baseline per-capita water use rates range from 77 gallons per capita per day (gpcd) to 360 gpcd, and per-capita water use rate targets range from 77 gpcd to 292 gpcd. Most UWMPs specify a 20% reduction in water use rates to comply with SB X7-7, but some UWMPs state that the SB X7-7 target is already obtained in their service area. For cities served by these water retailers, no reductions were calculated for Water-4.

The following steps were performed to calculate water savings:

a) 2020 water use reductions from Water-1, 2, and 3 were subtracted from the BAU 2020 water use in order to determine the percent reduction in water use already achieved through these measures.

b) The percent reduction in per-capita water use rates due to the implementation of SB X7-7 was calculated using the baseline and target per-capita water use values for each city from the 2010 UWMPs.

c) If the water use percent reductions from Water-1, 2, and 3 exceed the SB X7-7 percent reduction from 2020 BAU water use, then Water-4 will yield no reductions.

d) If the water use percent reductions from Water-1, 2, and 3 *do not* exceed the SB X7-7 percent reduction from 2020 BAU water use, then the water use reductions achieved by Water-4 are equal to the amount of additional water reductions needed to achieve the SB X7-7 per-capita water use targets.

e) Water savings were calculated by source (SWP, groundwater, etc.) and sector (residential, commercial, indoor, outdoor) using the assumptions identified in Water-1.

f) Hot water savings were calculated (residential and commercial) using the assumptions identified above.

g) Electricity and natural gas reductions in the building energy sector (for water heating) and the water conveyance sector (conveyance, treatment, etc.) associated with the reduced water use were then calculated.

h) Wastewater treatment emission reductions associated with Water-4, taking into account reductions from Wastewater-1, Water-1, and Water-2, were then calculated.

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

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

Resource Conservation: Reduced water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Consequently, reductions in water use would reduce electricity consumption.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

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

Land Use-1: Tree Planting Programs [CITY][21]

Measure Description

Establish a city-wide tree planting goal or tree preservation goal. Possible implementation mechanisms might include a requirement to account for trees removed and planted as part of new construction and/or establishing a goal and funding source for new trees planted on city property. To maximize GHG and other environmental benefits, new trees would be targeted to the downtown and urban areas. This measure will reduce energy consumption and associated GHG emissions in the building energy sector by reducing the heat island effect.

Assumptions

The following assumptions were considered for the quantification of this measure.

- Tree planting programs begin in 2012.The number of trees planted per year was determined by the cities on a city-by-city basis.
- Annual energy savings from planting 1 tree due to decreased heat island effect = 7 kWh (ICLEI Local Governments for Sustainability 2010).
- Tree shading effects were not considered.
- Carbon sequestration was not considered.

Analysis Details

GHG Analysis

The exact location of where the trees would be planted in each city is not known at this point. Trees planted along transportation corridors and roadways, or in parks and open space areas, would not shade buildings (which can reduce summer cooling energy consumption). Therefore, to be conservative, tree shading effects were not considered for this measure. In addition, carbon sequestration benefits from new trees were not considered because the BAU inventories do not have a BAU assessment of carbon sequestration for each city.

Trees can also reduce the urban heat island effect through both shading and evapotranspiration. Thus, quantification of this measure focused on reduced urban heat island effect. The GHG benefits achieved from tree planting would vary based on the species, age, and size of tree planted.

<u>Emissions Reductions</u>

The total number of trees planted by each city per year was multiplied by 9 years of tree plantings (2012-2020 inclusive) and then by 7 kWh saved/tree per year to determine electricity reductions associated with the tree's ability to reduce the heat island effect.

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Land Use-1.

Reduced Energy Use: Trees planted adjacent to buildings shade, which cools buildings and reduces the need for summer-time air conditioning use. As a result, less electricity is consumed.

[21] Emissions reductions associated with reduced electricity for ventilation and cooling as a result of reducing the heat island effect will be achieved in the building energy sector. However, these emissions reductions are reported as part of Land Use-1 as they are a direct result of tree-planting programs.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution. Trees planted adjacent to congested roadways may also help filter particulate matter and other local pollutants.

Reduced Urban Heat Island Effect: Urban heat isalnd effect occurs when the ambient temperature in urban areas increases as a reuslt of high energy consumption (e.g., air conditioning use during the summertime). Trees provide shade, which reduces the cooling load of buildings and helps mitigate the urban heat island effect.

Increased Quality of Life: Trees improve the aesthetic quality of buildings, as well as reduce stormwater runoff during periods of heavy rain.

Land Use-2: Promote Rooftop Gardens [V] [22]

Measure Description

Encourage 5% of new multi-family residences and 15% of new commercial facilities over 100,000 square feet to construct rooftop gardens. This measure will also reduce energy consumption and associated GHG emissions in the building energy sector.

Assumptions

The following assumptions were considered for the quantification of this measure.

- The market penetration rates for the number of new multi-family residences and new commercial facilities installing rooftop gardens were determined by the cities on a city-by-city basis.
- Multi-family residential building assumptions:
  - The average per-unit floor area in new multi-family buildings is 1,107 square feet in the western region of the U.S. (U.S. Census Bureau 2011a)
  - The average number of floors per multi-family building is 2.26 [23] in the western region of the U.S. (U.S. Census Bureau 2011b).
  - The average per-unit floor area of lobby/hallway space is 100 square feet (estimate).
  - Based on the above assumptions, the average roof space per multi-family unit is 590 square feet (1,107 square feet per unit ÷ 2.26 floors per building + 100 lobby/hallway square feet)
  - 25% of the total roof space on buildings can be a green roof (estimate)
- Commercial building assumptions:
  - Total commercial building square footage in each city was estimated using the total energy consumption (electricity and natural gas) and dividing by 13.69 kWh per building square foot (California Energy Commission 2006, Table 10-1) and 0.23 therms per square foot (California Energy Commission 2006, Table 10-2) for all commercial buildings in the SCE service area and taking the average of those two results.
  - 36% of all nonresidential buildings in each Participating City are greater than 100,000 square feet. This value is for the pacific region from the EIA's Commercial Building Energy Consumption Survey (see Energy-9 for calculation details) (Energy Information Administration 2008).
  - The roof space to floor space ratio is 0.3 (estimate).
  - 50% of the total roof space on buildings can be a green roof (estimate)
  - The annual direct electricity savings per green roof square foot is 0.45 kWh
  - The annual indirect electricity savings per green roof square foot is 0.25 kWh

[22] Emissions reductions associated with reduced electricity for ventilation and cooling will be achieved in the building energy sector. However, these emissions reductions are reported as part of Land Use-2 as they are a direct result of green roof programs.

[23] 87% of multifamily buildings built in 2008 were 1-3 floors; 13% were 4 floors or more. The average number of floors was calculated as follows: 87% * 2 floors + 13% * 4 floors = 2.26 floors.

Analysis Details

GHG Analysis

A green roof or rooftop garden is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, and helping to lower urban air temperatures and mitigate the heat island effect.

Emissions Reductions

The following steps were performed to calculate electricity savings associated with green roofs:

a) Residential electricity savings (kWh) = total new multifamily homes in 2020 * market penetration rate (determined by cities) * 590 square feet of roof space per multi-family unit * 25% of roof space is a green roof * (0.45 direct kWh saved per square foot of green roof per year + 0.25 indirect kWh saved per square foot of green roof per year)

b) Nonresidential electricity savings (kWh) = total new building square footage in 2020 * 36% of buildings are greater than 100,000 square feet * market penetration rate (determined by cities) * 0.3 (roof space to floor space ratio) * 50% of roof space is a green roof * (0.45 direct kWh saved per square foot of green roof per year + 0.25 indirect kWh saved per square foot of green roof per year)

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Land Use-2.

Reduced Energy Use: Green roofs can provide cooling and heating which reduces the need for summer-time air conditioning use and winter heating. As a result, less electricity is consumed.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution. Vegetation on buildings adjacent to congested roadways may also help filter particulate matter and other local pollutants.

Reduced Urban Heat Island Effect: Urban heat isalnd effect occurs when the ambient temperature in urban areas increases as a reuslt of high energy consumption (e.g., air conditioning use during the summertime). Rooftop vegetation provides shade, which reduces the cooling load of buildings and helps mitigate the urban heat island effect.

Increased Quality of Life: Trees and vegetation improve the aesthetic quality of buildings, as well as reduce stormwater runoff during periods of heavy rain.

Off-Road-1: Electric-Powered Construction Equipment [V]

Measure Description

Offer incentives (e.g., reduced procedural requirements; preference points when bidding on city contracts, partner with CARB or the South Coast Air Quality Management District (SCAQMD) to leverage funding) to construction contractors that utilize electric equipment in a certain percentage of their fleet. Fleet percentage goals might be:

- 25% of equipment on annual projects occurring within the city
- 15% of equipment on annual projects occurring within the city
- 5% of equipment on annual projects occurring within the city

Achieving the goal would require close coordination with the air district which sets air quality related requirements on construction vehicles and also provides mitigation options related to construction vehicles through Voluntary Emission Reduction Agreement (VERA) programs which may overlap with this measure.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of construction equipment which is electric by 2020 was determined by the cities on a city-by-city basis.
- The percent emission reductions for a fully electric vehicle in SCE's service area by engine type is provided below (California Air Pollution Control Officers Association 2010):
  - Diesel: 61.8%
  - CNG: 67.9%
  - Gasoline: 2-stroke: 49.5%
  - Gasoline: 4-stroke, < 25 horsepower: 49.5%
  - Gasoline: 4-stroke, 25-50 horsepower: 72.3%
  - Gasoline: 4-stroke, 50-120 horsepower: 72.0%
  - Gasoline: 4-stroke, 120-175 horsepower: 71.2%
  - Gasoline: 4-stroke, 175-500 horsepower: 70.4%

Analysis Details

GHG Analysis

Utilizing electric power would offset direct GHG emissions from fuel combustion. Indirect emissions from electricity are significantly lower than direct emissions from fuel combustion. Electrifying construction vehicles therefore results in a reduction in GHG emissions.

<u>Emissions Reductions</u>

Emission reductions associated with State-8 (LCFS for Off-Road Equipment) were subtracted from 2020 BAU construction equipment emissions. This was done in order to determine the emissions from offroad construction equipment after the implementation of the LCFS, before the application of the Off-Road-1.

The OFFROAD2007 model calculates vehicle operating emissions by fuel type (e.g., diesel, gasoline) and average horsepower. Model emissions outputs by vehicle class were multiplied by the percent of construction equipment which is electrified by 2020 (determined by the cities) and then multiplied by CAPCOA's anticipated percent reduction in GHG emissions for switching to electric power (see assumptions above).

Co-Benefit Analysis

The following benefits are expected from implementation of Off-Road-1.

Reduced Air Pollution: Utilizing electricity in place of diesel would reduce local air pollution.

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

Increased Quality of Life: Electric equipment is quieter and typically easier to maneuver than diesel-powered equipment.

Off-Road-2: Idling Ordinance [M]

Measure Description

Adopt an Ordinance that limits idling time for heavy-duty construction equipment beyond CARB or local air district regulations and if not already required as part of CEQA mitigation. Recommended idling limit is 3 minutes (California Air Pollution Control Officers Association 2010). Encourage contractors as part of permitting requirements or city contracts to submit a construction vehicle management plan that includes such things as: idling time requirements; requiring hour meters on equipment; documenting the serial number, horsepower, age, and fuel of all onsite equipment. California state law currently requires all off-road equipment fleets to limit idling to no more than 5 minutes.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- 0.9 gallons of diesel fuel are consumed per hour of idling (U.S. Environmental Protection Agency 2009a)
- 6.32 gallons of diesel fuel are consumed per hour of operation for construction equipment.
- On average, construction equipment spend approximately 29.4% of daily operating time idling (U.S. Environmental Protection Agency 2009a)
- This measure results in a 40% reduction in idling emissions (the change from 5 minutes to 3 minutes for max idling time)

Analysis Details

GHG Analysis

Equipment idles during rest periods, which requires fuel and results in GHG emissions. Regulating idling time would therefore reduce fuel consumption and GHG emissions.

2020 BAU Emissions

BAU emissions from construction equipment idling were quantified using the ratio of idle to operating fuel consumption. Fuel consumption for off-road equipment will vary by type. However, according to the EPA, a typical mid-size track-type tractor consumes 0.9 gallon of fuel for every one hour at idle (U.S. Environmental Protection Agency 2009a). Based on an URBEMIS2007 model run for a similar equipment piece, approximately 64 kilograms of carbon dioxide are emitted. Assuming 10.21 kilograms of carbon dioxide per gallon of diesel fuel (Climate Registry 2012), 6.28 gallons of fuel are consumed per hour of operation.

CARB does not regulate idling time for off-road equipment. Anticipated BAU idling times were therefore estimated using case studies of construction equipment. The EPA (2009a) estimates that on average, construction equipment spend approximately 29.4% of daily operating time idling. Assuming an average workday of 8 hours, this equates to approximately 141 minutes per day. Based on this assumption, and the estimated gallons of fuel consumed (above), BAU idling emissions were estimated for each city.

Emissions Reductions

Emission reductions associated with State-8 (LCFS for Off-Road Equipment) and Off-Road-1 (Construction Equipment) were subtracted from 2020 BAU construction equipment emissions. This was done in order to determine the emissions from off-road construction equipment after the implementation of the LCFS, before the application of the Off-Road-2.

Implementation of Off-Road-2 would reduce idling time to no more than 3 minutes at any one time. Although construction equipment idles for over 141 minutes today, it is unlikely the idling occurs a single time. The CARB's regulations for heavy duty vehicle (5 minutes) was used a proxy to determine the percent reduction in potential idling emissions from implementation of Off-Road-2. Reducing idling time from 5 minutes to 3 minutes is a 40% reduction. Emissions savings associated with this measure were therefore calculated by multiplying BAU idling emissions by 0.40.

Co-Benefit Analysis

The following benefits are expected from implementation of Off-Road-2.

Reduced Energy Use: Equipment idles during rest periods, which requires fuel. Regulating idling time therefore reduces fossil fuel consumption.

Reduced Air Pollution: Reduced idling and fuel combustion would contribute to reductions in toxic air contaminates, ozone precursors, and other inorganic and organic air pollutants.

Public Health Improvements: Construction workers are exposed to pollutants that cause adverse health effects when they work near idling vehicles. By reducing vehicle idling time, exposure periods would be decreased, which may contribute to long-term health improvements.

Off-Road-3: Electric Landscaping Equipment [V]

Measure Description

Adopt an ordinance that reduces gasoline-powered landscaping equipment use and/or reduces the number and operating time of such equipment. Require a certain percentage (e.g., 75%) of each participating cities' landscaping equipment be electric by 2020 and 100% by 2030. Cities would work in close cooperation with the air district in drafting an ordinance or developing outreach programs to be consistent with current air district rules and CEQA guidelines. The ordinance could also include the following provisions for community landscaping equipment.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of landscaping equipment which is electric by 2020 was determined by the cities on a city-by-city basis.
- The percent emission reductions for electric landscaping equipment (compared to gasoline-powered equipment) in SCE's service area by horsepower is provided below (California Air Pollution Control Officers Association 2010):
- < 25 horsepower: 49.5%
- 25-50 horsepower: 72.3%
- 50-120 horsepower: 72.0%
- 120-175 horsepower: 71.2%
- 175-500 horsepower: 70.4%
- This measure applies to the following equipment as modeled in OFFROAD2007: lawn mowers, chainsaws, leaf blowers, trimmers, shredders, commercial turf equipment, chippers, and other lawn and garden equipment
- Converting diesel landscaping equipment to electric equipment will provide the same percent reduction in GHG emissions for gasoline equipment (it is likely that the reductions for diesel equipment would be greater, since diesel has a higher CO_2 emission factor than gasoline).

Analysis Details

GHG Analysis

Utilizing electric power eliminates 100% of direct GHG emissions from fuel combustion. Indirect emissions from electricity are significantly lower than direct emissions from fuel combustion. Electrifying landscaping vehicles therefore results in a reduction in GHG emissions.

<u>2020 BAU Emissions</u>

The GHG Inventory quantified emissions associated with off-road equipment in 2020 under BAU conditions.

<u>Emissions Reductions</u>

Emission reductions associated with State-8 (LCFS for Off-Road Equipment) were subtracted from 2020 BAU landscaping equipment emissions. This was done in order to determine the emissions from off-road landscaping equipment after the implementation of the LCFS, before the application of the Off-Road-3.

The OFFROAD2007 model calculates vehicle operating emissions by fuel type (e.g., diesel, gasoline) and average horsepower. Model emissions outputs by vehicle class were multiplied by the percent of landscaping equipment which is electrified by 2020 (determined by the cities) and then multiplied by CAPCOA's anticipated percent reduction in GHG emissions for switching to electric power (see assumptions above).

Co-Benefit Analysis

The following benefits are expected from implementation of Off-Road-3.

Reduced Air Pollution: Utilizing electricity in place of gasoline and diesel would reduce local air pollution.

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

Increased Quality of Life: Electric equipment is quieter and typically easier to maneuver than diesel- and gasoline-powered equipment.

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