# City of El Cajon
# Climate Action Plan Benefit-Cost Analysis

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Prepared for the City El Cajon

Prepared by the Energy Policy Initiatives Center

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## About EPIC

The Energy Policy Initiatives Center (EPIC) is a non-profit research center of the USD School of Law that studies energy policy issues affecting California and the San Diego region. EPIC's mission is to increase awareness and understanding of energy- and climate-related policy issues by conducting research and analysis to inform decision makers and educating law students.

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# EXECUTIVE SUMMARY

## Introduction

This report summarizes the findings of the City of El Cajon's Climate Action Plan (CAP) benefit-cost analysis (BCA) conducted by the Energy Policy Initiatives Center (EPIC) at the University of San Diego for 24 of the 28 City actions (actions) included in the CAP.[1]

The goals of this report are to:

- Estimate the benefit or cost of each CAP action to reduce a unit of greenhouse gas (GHG) emissions to compare the relative cost-effectiveness of CAP actions; and
- Identify the financial benefits received and costs incurred by those directly involved in CAP action activities to assess the impact of implementing CAP actions.

## Benefit-Cost Analysis Overview

A framework adapted from the California Standard Practice Manual (SPM)[2] was applied to the BCA to estimate the benefits and costs associated with each action. The SPM identifies four major perspectives, which help focus results on who is experiencing costs and benefits. This analysis presents results for two perspectives adapted from the SPM — the participant perspective (the City of El Cajon, business owners, commuters, etc.) and the measure perspective (participants and non-participants).

Cost-effectiveness results are presented for the measure perspective and include the benefits and costs to those who participate in activities identified in CAP actions and the costs to non-participants to subsidize rebates and incentives. Results are shown using a dollar per metric ton of carbon dioxide equivalent ($/MT $CO_2$e), which standardizes results across all actions and allows for comparison to determine the most cost-effective approaches to reducing emissions.

Primary metrics used to assess the impacts on participants (participant perspective) include the benefit-cost ratio (BCR) and discounted payback period. The BCR shows the relationship between the costs and benefits to perform an activity defined in a CAP action (e.g., the cost of installing a solar photovoltaic system relative to the energy savings received from that system). A BCR greater than one means the anticipated benefits of the action outweigh anticipated costs; if the BCR is less than one, costs outweigh benefits. The payback period describes how many years it would take for a participant (e.g., a home or business owner) to recover their costs to engage in the activity.

## Key Findings

- **CAP City actions have a collective net cost to achieve 2030 GHG reduction targets of $37/ MT $CO_2$e.** Actions included in the CAP and evaluated in this analysis have an overall net cost of $37 per MT $CO_2$e reduced, with an estimated 20,854 MT $CO_2$e reduced in target year 2030. This represents a combined net cost of $37 to participants and non-participants (measure perspective) to reduce one MT $CO_2$e in 2030. Actions associated with existing activities have a

[1] City Actions BE-3.2 (Retrofit High Pressure Sodium Street Lights) and RE-1.2 (Install Photovoltaic Systems at School Sites) have already been completed; City Action T-2.3 (Increase Preferential Parking Spaces) is considered a supporting action only and has no quantified GHG reductions); and City Action RE-2.1 (Establish or Join a Program that Increases Renewable Electricity Supply) requires a detailed comparative and/or feasibility analysis beyond the scope of this project.

[2] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. California Public Utilities Commission 2001.

combined net cost of \$121/MT $CO_2$e, and those with expanded or new activities have a combined net benefit of \$45/MT $CO_2$e.

- **City actions range in cost-effectiveness from a benefit of \$1,950/MT $CO_2$e to a net cost of \$3,655/MT $CO_2$e.** City Action WE-1.2 (Require Weather-Based Irrigation Systems) is the most cost-effective at reducing GHG emissions (benefit of \$1,950/MT $CO_2$e), while City Action T-2.4 (Convert School Bus Fleet to Electric) is the least cost-effective (cost of \$3,655/MT $CO_2$e). However, the costs for T-2.4 are shouldered mostly by non-participants at the State level, with benefits received by the local school district(s).
- **City actions impact multiple participant groups including the City of El Cajon.** Eighteen actions provide a net benefit to one or more participant group. Nine City actions have a net cost for one or more participant group. Of those nine actions, the City of El Cajon is the participant bearing some or all of the cost in four of those actions.

# 1 INTRODUCTION

The City of El Cajon (City) has developed a draft Climate Action plan (CAP) for public review. The CAP contains measures and actions with specific activities that can be implemented to reduce greenhouse gas (GHG) emissions within the City. The Energy Policy Initiatives Center (EPIC) at the University of San Diego conducted a benefit-cost analysis (BCA) of the CAP to estimate the cost-effectiveness of CAP actions and the direct financial benefits and costs associated with activities defined in each action. More specifically, it answers the questions: **how cost-effective are CAP actions at reducing one metric ton of carbon dioxide equivalent (MT $CO_2$e)** and **what are the financial impacts to those who directly participate in CAP action activities?** Understanding the monetary implications associated with implementing the CAP actions and the potential impacts to those who participate in action activities can help decision makers in the City prioritize actions and educate stakeholders on the relative benefits and costs associated with emissions reduction measures. This report summarizes the analysis findings to achieve GHG reductions in CAP target year 2030.

## 1.1 CAP Measures and Actions

The CAP comprises eight GHG reduction strategies with 15 measures and 28 City actions (actions). This analysis examines 24 actions included in the CAP (Table 1). The four actions not evaluated were identified as already complete, have no quantified GHG reductions, or require a detailed analysis beyond the scope of this project. These actions include:

- BE-3.2: Retrofit High Pressure Sodium Street Lights (action has been completed);
- RE-1.2: Install Photovoltaic Systems at School Sites (action has been completed);
- RE-2.1: Establish or Join a Program that Increases Renewable Electricity Supply (requires a detailed technical and feasibility analysis); and
- T-2.3: Increase Preferential Parking Spaces (supporting action with no quantified GHG reductions).

To estimate the incremental impact of the CAP, the 24 actions included in the analysis are categorized as having existing, expanded, or new activity (Table 1). Actions with existing activities would be implemented regardless of CAP adoption. As such, results for these actions do not represent a benefit or cost due to the CAP, but indicate the marginal impact if the level of activity were to be increased because of the CAP. Actions with expanded activity have some level of activity that would occur regardless of CAP adoption, but would have an additional level of activity occurring as a result of CAP adoption; the incremental level of activity associated with the CAP is not explicitly known. Actions with new activity are wholly a result of the CAP and all benefits and costs associated with the activity are considered incremental.

Additionally, calculations only consider the benefits and costs of activity that have occurred in or after 2019. Costs associated with previous actions are considered sunk and cannot be recovered. Including these costs and the resulting benefits can bias BCA results when considering the impact of CAP measures moving forward. For this reason, activity included in the CAP that is assumed to have already happened is not included in BCA calculations. For instance, City Action BE-1.2 (Continue the Critical Home Repair Program and Home Rehabilitation Loans) accounts for GHG reductions achieved between 2018 and 2030. This analysis only considers those projects and their associated GHG reductions that occur in or after 2019.

**Table 1. CAP Actions Included in Analysis**

| CAP Strategy, Measure, and City Action | Action Status | GHGs Reduced in 2030 (MT $CO_2e$) |
|---|---|---|
| **Strategy 1: Increase Use of Zero-Emission/Alternative Fuel Vehicles** | | |
| **Measure T-1: Transition to a More Fuel-Efficient Municipal Fleet** | | |
| City Action T-1.1: Develop a Fleet Management Program | Expanded | 24[1] |
| **Measure T-2: Increase Electric Vehicle and Electric Vehicle Charging Infrastructure Citywide** | | |
| City Action T-2.1: Install Municipal Electric Vehicle Charging Stations | Expanded | 108[1] |
| City Action T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations | New | 6,103[1] |
| City Action T-2.4: Convert School Bus Fleet to Electric | New | 53[1] |
| **Strategy 2: Reduce Fuel Use** | | |
| **Measure T-3: Use Transportation Systems Management to Reduce Fuel Use** | | |
| City Action T-3.1: Synchronize Traffic Lights | Existing | 389[1] |
| City Action T-3.2: Install Roundabouts | Existing | 306[1] |
| **Measure T-4: Reduce Fuel Use in Construction Equipment** | | |
| City Action T-4.1: Increase Renewable and Alternative Fuel Construction Equipment | New | 1,334 |
| **Strategy 3: Reduce Vehicle Miles Traveled** | | |
| **Measure T-5: Increase Alternative Modes of Travel** | | |
| City Action T-5.1: Increase Alternative Modes of Travel Through Transportation Demand Management | New | 233[1] |
| **Measure T-6: Encourage Active Transportation** | | |
| City Action T-6.1: Complete an Active Transportation Plan | Existing | 238[1] |
| **Measure T-7: Reduce Household Vehicle Miles Traveled Through Smart Growth Development** | | |
| City Action T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas | Existing | 191[1] |
| City Action T-7.2: Encourage Development in Mixed-Use Residential Overlay Zone | Existing | 608[1] |
| City Action T-7.3: Implement the Transit District Specific Plan | Existing | 531[1] |
| City Action T-7.4: Transition to an Online Submittal Permitting System | Expanded | 10[1] |
| **Strategy 4: Increase Building Energy Efficiency** | | |
| **Measure BE-1: Increase Residential Building Efficiency** | | |
| City Action BE-1.1: Require Energy Audits of Existing Residential Additions | New | 29 |
| City Action BE-1.2: Continue the Critical Home Repair Program | Existing | 40[2] |

| CAP Strategy, Measure, and City Action | Action Status | GHGs Reduced in 2030 (MT $CO_2e$) |
|---|---|---|
| **Measure BE-2: Increase Commercial Building Efficiency** | | |
| City Action BE-2.1: Require Energy Audits of Non-Residential Additions | New | 253 |
| **Measure BE-3: Increase Municipal Operation Energy Efficiency** | | |
| City Action BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities | Existing | 17 |
| **Strategy 5: Increase Renewable and Zero-Carbon Energy** | | |
| **Measure RE-1: Increase Behind-the-Meter Renewable Electricity Supply** | | |
| City Action RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings | New | 2,299 |
| **Strategy 6: Increase Water Efficiency** | | |
| **Measure WE-1: Increase Outdoor Water Efficiency** | | |
| City Action WE-1.1: Require Covers on New Pools | New | 2 |
| City Action WE-1.2: Require Weather-Based Irrigation Systems | Existing | 159[2] |
| **Strategy 7: Reduce and Recycle Solid Waste** | | |
| **Measure SW-1: Reduce Solid Waste and Increase Recycling** | | |
| City Action SW-1.1: Implement Solid Waste Reduction and Recycling Targets | Existing | 7,832 |
| **Strategy 8: Carbon Sequestration** | | |
| **Measure CS-1: Increase Urban Tree Planting** | | |
| City Action CS-1.1: Increase Shaded Landscape Area | Existing | 42[2] |
| City Action CS-1.2: Increase Tree Shade in Surface Parking Lots | Expanded | 14 |
| City Action CS-1.3: Increase Street Trees | Expanded | 39 |
| **Total for All City Actions** | | **20,854** |

[1] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

[2] GHG reductions differ from the CAP. BCA calculations only include activity for ongoing actions for 2019 and after, whereas CAP calculations also include activity in 2018.

Energy Policy Initiatives Center, USD 2019

## 1.2 Organization of Report

This report is divided into six sections and two appendices. Section 2 provides an overview of BCAs: perspectives analyzed, types of benefits and costs, key concepts, and metrics used. Section 3 presents cost-effectiveness results, and Section 4 presents results for individual City action impacts on participants. Section 5 details limitations of the analysis, and the conclusion is provided in Section 6. The appendices outline methods used and provide an extended set of tabular results with data and assumptions for individual actions.

# 2 BENEFIT-COST ANALYSIS OVERVIEW

## 2.1 Types of Benefits and Costs

The benefits and costs associated with CAP City actions fall into two broad categories: direct or external.

### 2.1.1 Direct Benefits and Costs

Direct benefits and costs are those directly related to implementing a City action or engaging in an activity defined in a City action. Direct benefits include cost savings, such as utility bill or fuel purchase reductions. Direct costs include the purchase, installation, and maintenance of equipment or other services. Financial incentives or subsidies, such as rebates, fee waivers, and tax credits, are considered cost reductions, or negative direct costs, for participants.

### 2.1.2 External Benefits and Costs

Benefits and costs associated with positive or negative externalities are the result of indirect effects of an action. Positive externalities associated with the CAP include public health benefits from reduced air pollution, increased ecosystem service value, and reductions in storm water treatment. Negative externalities include public health costs associated with poor air quality from fossil fuel combustion, and pollution created from the disposal of solar panels at the end of their useful life. External benefits and costs associated with City actions can be difficult to quantify and are included in the quantitative analysis only when sufficient data is available.

## 2.2 Perspectives

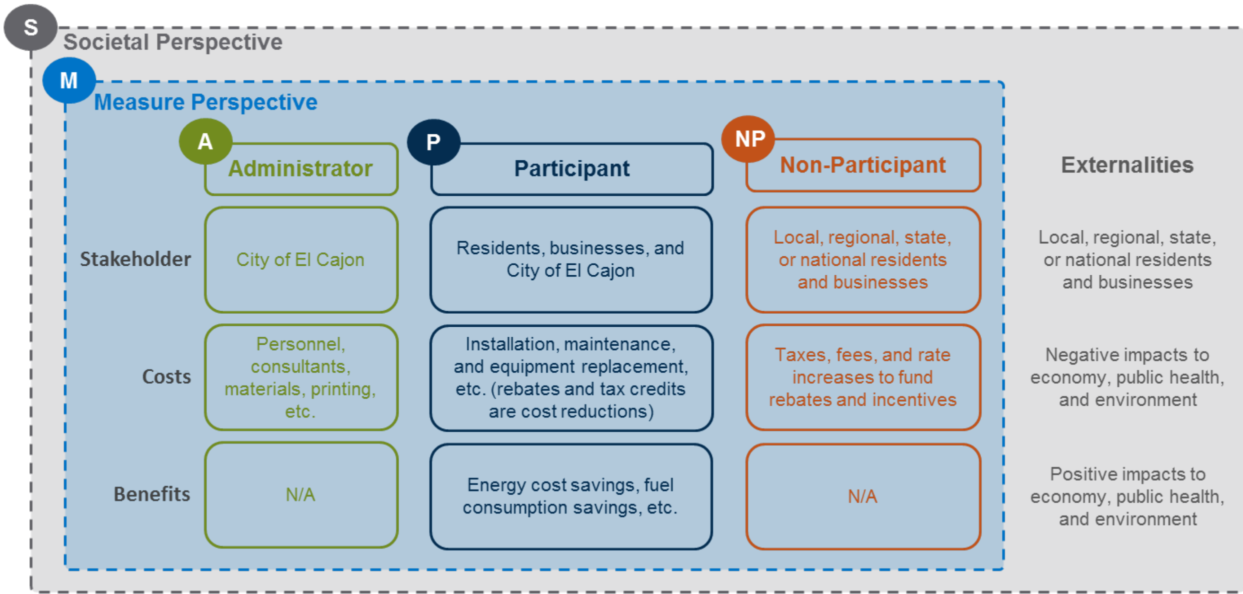
When evaluating the benefits and costs of CAP measures and City actions, one consideration is to determine whose benefits and costs are being evaluated. In the context of a City action, there are multiple perspectives that determine the scope of analysis, including the **administrator** of the program (e.g., the jurisdiction), **participants** in the program (e.g., residents and businesses within the jurisdiction), and those who pay the cost to subsidize programs (**non-participants**; e.g., taxpayers or utility ratepayers). The **measure** perspective, which combines these three main perspectives, allows for a more comprehensive view and includes costs to administer CAP programs, costs to homes and businesses, and any subsidies provided.[3] Adding externalities, which are not accounted for in the direct costs and benefits, to the measure perspective provides a broader **societal** perspective.

The framework in Figure 1 summarizes these five perspectives, identifies who is potentially affected by a City action, and provides examples of their respective benefits and costs.[4]

[3] Because no administrator costs are included in this analysis, a modified measure perspective is shown that includes only the participant and non-participant perspectives.

[4] Adapted from the California Standard Practice Manual, which is used by the California Public Utilities Commission (CPUC) to evaluate the cost-effectiveness of energy efficiency programs and has recently been adapted into a National Standard Practice Manual (CPUC, 2001; NESP, 2017).

**Figure 1. Conceptual Framework of BCA Perspectives**




### 2.2.1 Administrator Perspective

The administrator perspective answers the question: **What are the financial costs to the City of El Cajon associated with the *implementation* of CAP City actions?** Activities to administer the CAP include research, development, implementation, monitoring, and enforcement of CAP measures. These activities will be absorbed into existing work programs. Analysis of this perspective is not considered in this report.

### 2.2.2 Participant Perspective

The participant perspective answers the question: **What are the financial benefits and costs to those who participate in or act to comply with a CAP City action?** There can be direct benefits and/or costs to comply with activities defined in a CAP City action. For example, a business owner who chooses to install a solar photovoltaic (PV) system under City Action RE-1.1 (Incentivize Photovoltaic Installation on Commercial Buildings) would incur capital costs for the purchase, installation, and operation of the system. The reduction in energy purchased from the local utility would then provide the business owner with benefits in the form of energy bill reductions over the lifetime of that system. Participants can also receive cost reductions in the form of rebates, incentives, and tax credits, which are considered a cost to non-participants.

For actions where the City of El Cajon is a participant, this perspective includes all capital costs directly associated with the City's participation in or compliance with the City action, as well as the resulting benefits, if any, received by the City.

### 2.2.3 Non-Participant Perspective

The non-participant perspective answers the question: **What are the financial benefits and costs, if any, to subsidize activities of participants?** Residents, businesses, and the City of El Cajon could incur indirect costs even though they are not engaging in an activity defined in a CAP action. In general, non-participant costs are defined as the cost to subsidize activities taken by participants through rebates, incentives, and tax credits. Non-participants can incur this cost through taxes, fees, and/or utility surcharges. Who is defined as a non-participant can vary and is not limited to those within the geographic boundary of the City of El Cajon (Table 2).

**Table 2. Examples of Non-Participants at Various Levels**

| Level | Incentive Type | Revenue Source | Geographic Scope | Non-Participants |
|---|---|---|---|---|
| National | Federal tax credit | Federal tax revenue | U.S. | Federal taxpayers |
| State | State grant | State tax or other revenue | California | California taxpayers |
| Regional | Utility incentive | SDG&E surcharge | SDG&E territory | SDG&E customers |
| Local | City permit fee waiver | General fund revenue | City of El Cajon | City residents and businesses |

### 2.2.4 Measure Perspective

The measure perspective answers the question: **What are the total direct financial benefits and costs associated with a CAP measure or City action?** The three perspectives defined above provide discrete and valuable insights, but individually represent an incomplete view of the monetary impacts of a CAP measure or City action. For instance, looking solely at the participant perspective may obscure the true cost of an action, particularly if an activity is highly subsidized. Because no administrator costs are included in this analysis, results shown provide a modified measure perspective that includes only the participant and non-participant perspectives.

### 2.2.5 Societal Perspective

The societal perspective answers the question: **What is the overall financial benefit or cost to society as a whole for a given CAP measure or City action?** This is the broadest perspective; it adds the benefits and costs associated with external impacts to the measure perspective. The difference between the measure and societal perspectives is the total benefit or cost of externalities. Potential externalities include impacts to the economy, public health, and the environment. In general, externalities are more difficult to quantify, and a qualitative assessment is incorporated where sufficient quantitative data is not available (see Appendix B).

Externalities for transportation-related City actions include positive local health impacts associated with reduced criteria pollutants (e.g., $CO_2$, particulates, nitrogen oxides, reactive organic gases, and sulfur dioxide). Externalities for urban forestry-related City actions include positive health impacts associated with reduced criteria pollutants (e.g., ozone, nitrogen dioxide, sulfur dioxide, particulates, and volatile organic compounds) and reductions in storm water treatment from enhanced rainfall interception. In addition to these action-specific externalities, the EPA's social cost of carbon (SCC) is applied to all actions to estimate a base level of avoided environmental damages and health costs associated with the reduction of $CO_2$.

This analysis provides a modified societal perspective that includes externalities in addition to a modified measure perspective (participant and non-participant perspectives only; no administrator perspective) in Appendix B.

## 2.3 Key Concepts

The following key concepts were used in developing CAP BCA calculations used in this report.

### 2.3.1 Target Year

The target year represents a point in time when CAP City action impacts are considered. While the BCA considers all benefits and costs over the useful life of specified activities, results are specific to activities that lead to GHG reductions in the target year. This report analyzes CAP impacts during target year 2030.

Dollar values expressed in a target year are not necessarily actual benefits or costs to be realized in that particular year. The total benefits and costs accrued over the useful life are apportioned to the GHG reductions associated with that action. The values in the target year reflect the value of the GHGs reduced in that year and are used in lieu of actual cash flows assigned to the target year, because costs and benefits in earlier years are partially responsible for GHG reductions in the target year. For instance, a solar PV system installed in 2020 will still be reducing GHGs in 2030; however, the bulk of capital costs were spent earlier.

### 2.3.2 Installation Year

The installation[5] year is the initial year in which an action occurs. City actions can include multiple installation years. For example, the year in which a business installs a solar PV system is that business's install year; however, not all solar PV systems will be installed in a single year to achieve GHG reductions in the CAP, but over several years. This analysis considers the benefits, costs, and GHG reductions associated with all installation years leading up to the target year.

### 2.3.3 Useful Life

A useful life (project life) is the operating life of a project and represents how long a project will last before it must be replaced. Some actions identified in the City's CAP have project lives that extend well past the target year analyzed. This analysis examines the benefit and cost streams over the entire useful life to accurately capture all benefits and costs associated with an action. Restricting the analysis to the target year would significantly undervalue or overvalue an action; ending the analysis before the project has reached its useful life typically reduces the associated benefits and places a higher emphasis on costs.

### 2.3.4 Normalized Dollars

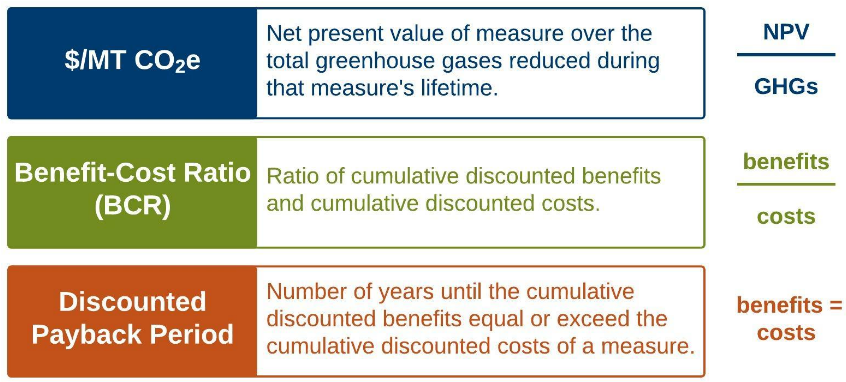
Dollar values are normalized to a constant year to accurately analyze historic and current benefit and cost data. This process reduces the interannual impact of external influences, such as inflation and deflation, on the value of a good or service. While several indices exist to normalize dollar values, the Consumer Price Index (CPI) is one of the most common and is applied in this analysis (FRB Dallas 2017). The base year 2019 is used for normalization for all actions for consistency and for comparison across actions.

## 2.4 Benefit-Costs Analysis Metrics

The metrics used to analyze results for City action cost-effectiveness and impacts on participants are shown in Figure 2. Cost-effectiveness is assessed using dollar per metric ton of carbon dioxide equivalent ($/MT $CO_2$e) for the measure perspective. Impacts on participants are assessed using the benefit-cost ratio (BCR), discounted payback period, and $/MT $CO_2$e for the participant perspective. Methods used to calculate BCA metrics are provided in Appendix A.

[5] Note: the term 'installation' is being used here to refer to any general type of activity that begins, not necessarily the direct install of equipment. This can also include an alternative fuel vehicle purchase, home retrofit, water rate increase, etc.

**Figure 2. Metrics for the CAP Cost-Effectiveness and Benefit-Cost Analyses**




Results may not be available for all metrics for all City actions. For example, if a participant only incurs costs or only receives benefits, a BCR and payback period cannot be calculated. Similarly, a BCR and payback cannot be calculated for participants who only receive benefits.

All metrics are calculated using present value dollars. Using the present value[6] addresses the time value of money (e.g., receiving ten dollars today is worth more than receiving ten dollars in the future) by applying a discount rate to the benefits and costs. A five percent discount rate is applied in this analysis, and a sensitivity analysis is performed using a three and seven percent discount rate.[7] Higher discount rates lessen the impact of future dollars in the analysis relative to lower discount rates.

### 2.4.1 Dollar per Metric Ton of $CO_2$e

The $/MT $CO_2$e is used to show the cost-effectiveness of City actions in reducing one MT $CO_2$e. This metric standardizes results to allow for comparisons across actions and provides a way to estimate the annual value of a City action in relation to its GHG reductions in that year. A positive value indicates a net benefit per ton reduced, whereas a negative value indicates a net cost per ton reduced.

A weighted average $/MT $CO_2$e of all the activities that contribute to GHG reductions is used since the GHGs reduced in the target year are not always equal for all actions in previous years. Most actions will have multiple install years associated with their defined action(s), and the benefits, costs, and GHGs reduced from an activity in one year could be different from the same type of activity in the following year (e.g., changes in installation price, rebates that have since expired). For example, for all PV systems that reduce emissions in 2030 but were installed between 2020 and 2030, a weighted average of the $/MT $CO_2$e would be used. By calculating the weighted average, all benefits and costs associated with the actions taken to achieve the GHG reductions in the target year are scaled according to their contribution to GHG reductions in the target year.

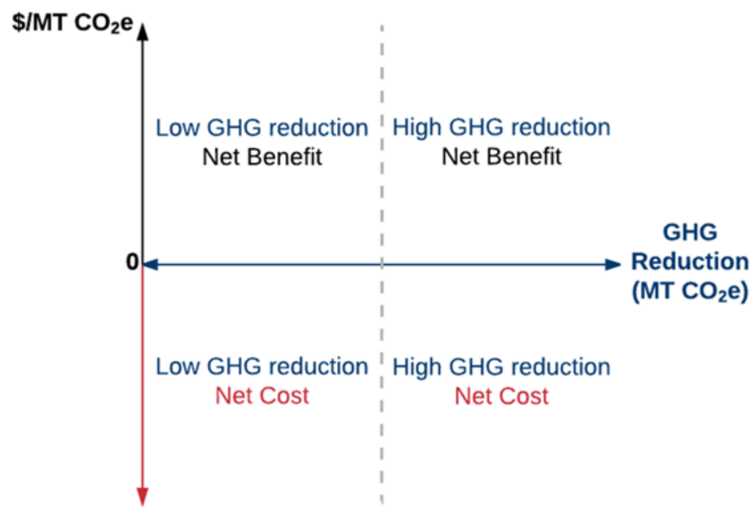
While the $/MT $CO_2$e results allow for comparison across all CAP actions, this metric can be misleading if not presented in combination with the total amount of GHG emissions reduced. Plotting the $/MT $CO_2$e for each action in conjunction with its GHG reductions in the target year shows a comparison of cost

[6] In this context and moving forward, present value represents the value in the start year of the analysis, 2019.

[7] According to the U.S. EPA, projects within a short to medium lifespan (less than 50 years) are assigned a discount rate of approximately 3%, derived from consumer-time preferences based on the interest rate of a risk-free asset such as a government bond (U.S. EPA 2010). Conversely, the federal Office of Management and Budget (OMB) assigns a standard discount rate of 7%, derived from the opportunity cost of private capital, measured by the before-tax rate of return to investment, for projects with similar lifespans (OMB 2000). A 5% discount rate was selected to account for this range in recommendations.

effectiveness (Figure 3). The higher an action is on the plot, the more cost effective it is; the lower a point is, the less cost effective it is. City actions to the right reduce more GHGs than those on the left.

Figure 3. Interpreting Results of a Scatterplot



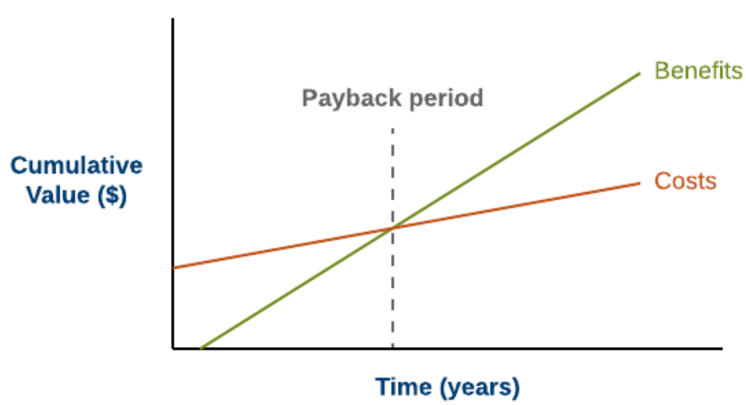

### 2.4.2 Benefit-Cost Ratio

The BCR is used to assess the relationship between the benefits and costs of a project or action. A BCR that is greater than one means the anticipated benefits of the action outweigh anticipated costs; if it is less than one, the anticipated costs outweigh benefits. This metric illustrates the relative cost-effectiveness when comparing multiple City actions; actions with higher BCR values tend to be more cost-effective. BCRs can only be shown for actions that have both benefits and costs for a given group of participants. How subsidies (rebates and incentives) are calculated for the participant perspective will impact the result; this analysis identifies all subsidies as cost reductions to participants.

### 2.4.3 Payback Period

A payback period is the amount of time required for the cumulative benefits of a project to equal or surpass the cumulative costs of an action or measure (Figure 4). Payback periods can only be shown for actions where the benefits are equal to or greater than the associated costs.

Figure 4. Conceptual Diagram of an Action’s Payback Period



There are two types of payback periods: simple and discounted. The simple payback period is the easiest to calculate but ignores the time value of money. The discounted payback period does take into consideration the time value of money and, by discounting future values, the time required for benefits to exceed costs is extended further into the future. The discounted payback period is calculated in this analysis.

# 3 COST-EFFECTIVENESS RESULTS

This section presents cost-effectiveness results for (1) existing and (2) expanded and new CAP actions in target year 2030. GHG reductions are based on calculations in the City of El Cajon CAP Appendix B (GHG Emissions Reduction Targets and Measures) and assume an incremental level of activity is achieved each year, which is necessary to achieve reduction targets identified in the CAP. A positive value indicates a net benefit per ton reduced, whereas a negative value indicates a net cost per ton reduced. Results demonstrate the cost-effectiveness of City actions to reduce GHGs only. Included in the analysis are benefits and costs to participants in addition to the cost of providing any subsidies (e.g., rebates, incentives, and tax credits) to participants through utility, state, federal, or other funding sources. Actions included in the CAP may seek to achieve additional goals (e.g., increase the recycled water supply to reduce demand pressure on the potable water supply, increase the resiliency of the urban forest); the cost-effectiveness to achieve those goals are not included in this analysis. Results are not meant to individually assess each City action, but to illustrate the cost-effectiveness of CAP City actions at reducing GHG emissions relative to one another.

All results shown here are in present dollars using a five percent discount rate and normalized to 2019 dollars. Additionally, results indicate the value associated with GHG emissions reduced in that year considering the lifetime benefits and costs associated with the activity; they do not indicate actual cash flows for the given year. For further discussion on inputs and assumptions used in this analysis and an extended set of results, see Appendix B.

## 3.1 Existing Activity

Actions with existing activities have already been implemented or are planned to be implemented regardless of CAP adoption. As such, results for these actions do not represent a benefit or cost as a result of the CAP, but indicate the marginal impact if the level of activity were to be increased beyond what is already planned because of the CAP. Eleven City actions are included here.

Table 3 summarizes results in \$/MT $CO_2$e for the measure perspective (participants and non-participants) for each action to achieve the estimated 2030 GHG reductions. Results indicate an overall net cost for existing actions in 2030 of \$121/MT $CO_2$e and an estimated 10,353 MT $CO_2$e reduced in that year. Red dollar values indicate a net cost per MT $CO_2$e reduced, whereas black dollar values indicate a net benefit per MT $CO_2$e reduced.

City action WE-1.2 (Require Weather-Based Irrigation Systems) is the most cost-effective existing action with existing activity. The high net benefit per MT reduced for WE-1.2 (\$1,950/MT $CO_2$e) can be attributed to the relatively high savings for water customers paired with low GHG reductions relative to some other actions (159 MT $CO_2$e). City action CS-1.1 (Increase Shaded Landscape Area) is the least cost-effective for achieving GHG reductions with a net cost of \$498/MT $CO_2$e. This cost can be attributed to the actions lack of direct monetary benefits and relatively low GHG reductions. City action SW-1.1 (Implement Solid Waste Reduction and Recycling Targets) has the overall greatest effect for existing activity, reducing an estimated 7,832 MT $CO_2$e at a net cost of \$280/MT $CO_2$e.

**Table 3. Measure Perspective Cost-Effectiveness Results for Existing Activity**

| CAP City Action (Existing Activity) | 2030 | |
|---|---|---|
| | Measure Perspective ($/MT $CO_2e$) | GHGs Reduced (MT $CO_2e$) |
| **Transportation** | | |
| T-3.1: Synchronize Traffic Lights | $190 | 389[1] |
| T-3.2: Install Roundabouts | ($338) | 306[1] |
| T-6.1: Complete an Active Transportation Plan | $65 | 238[1] |
| T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas | $254 | 191[1] |
| T-7.2: Encourage Development in Mixed-Use Residential Overlay Zone | $782 | 608[1] |
| T-7.3: Implement the Transit District Specific Plan | $254 | 531[1] |
| **Energy and Buildings** | | |
| BE-1.2: Continue the Critical Home Repair Program | $230 | 40[2] |
| BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities | $192 | 17 |
| **Water and Wastewater** | | |
| WE-1.2: Require Weather-Based Irrigation Systems | $1,950 | 159[2] |
| **Solid Waste** | | |
| SW-1.1: Implement Solid Waste Reduction and Recycling Targets | ($280) | 7,832 |
| **Carbon Sequestration** | | |
| CS-1.1: Increase Shaded Landscape Area | ($498) | 42[2] |
| **Net for City Actions with Existing Activity** | ($121) | 10,353 |

[1] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

[2] GHG reductions differ from the CAP. BCA calculations only include activity for ongoing actions for 2019 and after, whereas CAP calculations also include activity in 2018.

All dollar values are in 2019 dollars Energy Policy Initiatives Center, USD 2019

## 3.2 Expanded and New Activity

Expanded actions are an expansion of existing City programs or requirements and new actions have been developed specifically for the CAP. Thirteen City actions are included here. Results show action cost-effectiveness as it relates to GHG reductions; however, actions with expanded and/or new activities can significantly contribute towards achieving non-CAP related goals identified by the City.

Table 4 summarizes results in \$/MT $CO_2$e for the measure perspective (participants and non-participants) for each action to achieve estimated 2030 GHG reductions. Results indicate an overall net benefit for expanded and new actions in 2030 of \$45/MT $CO_2$e and an estimated 10,501 MT $CO_2$e reduced in that year. Red dollar values indicate a net cost per MT $CO_2$e reduced, whereas black dollar values indicate a net benefit per MT $CO_2$e reduced.

**Table 4. Measure Perspective Cost-Effectiveness Results for Expanded and New Activity**

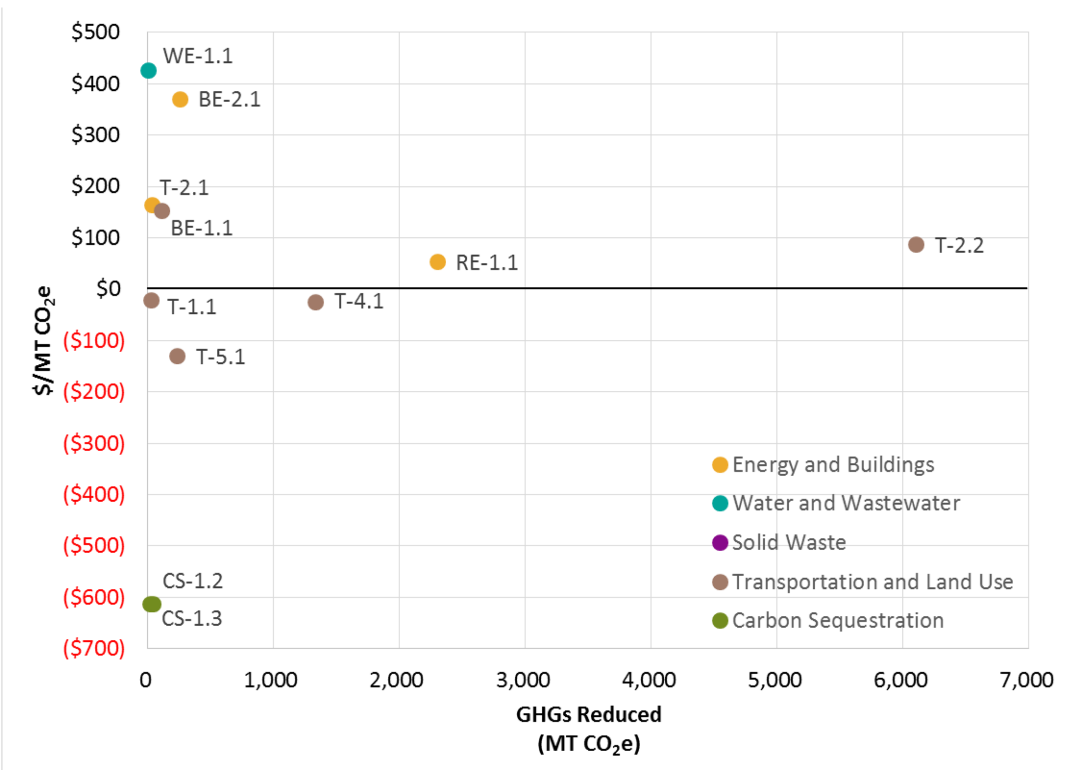
| CAP City Action (Expanded and New Activity) | 2030 | |
|---|---|---|
| | Measure Perspective (\$/MT $CO_2$e) | GHGs Reduced (MT $CO_2$e) |
| **Transportation** | | |
| T-1.1: Develop a Fleet Management Program (expanded) | (\$20) | 24[1] |
| T-2.1: Install Municipal Electric Vehicle Charging Stations (expanded) | \$153 | 108[1] |
| T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations | \$87 | 6,103[1] |
| T-2.4: Convert School Bus Fleet to Electric | (\$3,655) | 53[1] |
| T-4.1: Increase Renewable and Alternative Fuel Construction Equipment | (\$25) | 1,334 |
| T-5.1: Increase Alternative Modes of Travel Through Transportation Demand Management | (\$130) | 233[1] |
| T-7.4: Transition to an Online Submittal Permitting System (expanded) | (\$886) | 10[*] |
| **Energy and Buildings** | | |
| BE-1.1: Require Energy Audits of Existing Residential Additions | \$164 | 29 |
| BE-2.1: Require Energy Audits of Non-Residential Additions | \$371 | 253 |
| RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings | \$54 | 2,299 |
| **Water and Wastewater** | | |
| WE-1.1: Require Covers on New Pools | \$426 | 2 |
| **Carbon Sequestration** | | |
| CS-1.2: Increase Tree Shade in Surface Parking Lots (expanded) | (\$612) | 14 |
| CS-1.3: Increase Street Trees (expanded) | (\$612) | 39 |
| **Net for City Actions with New and Expanded Activity** | \$45 | 10,501 |

[1] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

All dollars are in 2019 dollars Energy Policy Initiatives Center, USD 2019

Figure 5 provides a scatterplot of each action's cost-effectiveness at reducing GHG emissions ($/MT $CO_2$e) against its corresponding GHG reductions (MT $CO_2$e) in 2030. Actions further to the right have higher GHG reductions. Actions above zero dollars indicate a net benefit per MT $CO_2$e reduced, and actions below zero indicate a net cost. City Action T-2.2 (Incentivize the Installation of Electric Vehicle Charging Stations) reduces the most GHG emissions in 2030 (6,103 MT $CO_2$e) and is cost-effective with an overall net benefit of $87 per MT $CO_2$e reduced. City Action T-2.4 (Convert School Bus Fleet to Electric) is the least cost-effective at the measure perspective with a net cost of $3,655/MT $CO_2$e. This net cost can be attributed to the high upfront purchase costs associated with electric school buses. However, this cost is primarily shouldered by non-participants at the State level rather than the local school district(s).[8]

**Figure 5. Measure Perspective Scatterplot for Expanded and New Activity in 2030[9]**




[8] Refer to Section **Error! Reference source not found.** for a discussion on costs and benefits to the school district(s) (action participants).

[9] City Action T-2.4 (Convert School Bus Fleet to Electric) was removed from the plot to more effectively show the relationship among all actions with expanded and new activity.

# 4 INDICATORS OF FINANCIAL IMPACTS ON PARTICIPANTS

This section presents a series of tables for each action, summarizing indicators of financial impacts on City action participants. Some actions have more than one participant group (e.g., commercial vs. residential). The benefit-cost ration (BCR), discounted payback period, and \$/MT $CO_2e$ are provided by participant group(s) for each action to describe the financial effects of City actions. For some participants, not all metrics are available. For instance, if a participant has only costs or only benefits, a BCR and payback period cannot be calculated.

For additional results and a detailed discussion on inputs and assumptions used in this analysis, refer to Appendix B.

## 4.1 Measure T-1: Transition to a More Fuel-Efficient Municipal Vehicle Fleet

### 4.1.1 City Action T-1.1 Develop a Fleet Management Program

GHG reductions associate with City Action T-1.1 assume two trucks, seven plug-in hybrid electric (PHEV), and three battery electric (BEV) vehicles are purchased to replace vehicles in the City fleet in lieu of gasoline vehicles between 2022 and 2026. This measure is cost-effective for the City (BCR=1.13) and the incremental purchase price associated with more fuel efficient and alternative fuel vehicles is expected to be recovered within four years because of decreased fuel expenditures.

**Table 5. City Action T-1.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| **T-1.1: Develop a Fleet Management Program** | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *City of El Cajon* | 1.13 | 3.7 | \$38 | 24 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

## 4.2 Measure T-2: Increase Electric Vehicle and Electric Vehicle Charging Infrastructure Citywide

### 4.2.1 City Action T-2.1 Install Municipal Electric Vehicle Charging Stations

City Action-2.1 is associated with the installation of electric vehicle (EV) charging infrastructure at municipal facilities and available to the public. Costs to the City of El Cajon are restricted to the costs of providing electricity to EV drivers who utilize the chargers.[10] This provides a direct benefit to EV drivers who avoid purchasing gasoline and receive electricity from the EV chargers.

[10] The City has an agreement with SDG&E, where SDG&E covers the purchase and maintenance costs for the chargers (included as non-participant costs).

**Table 6. City Action T-2.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-2.1: Install Municipal Electric Vehicle Charging Stations | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *City of El Cajon* | - | - | (\$126) | 108 |
| *EV Drivers* | - | - | \$297 | |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

### 4.2.2 City Action T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations

GHG reductions for City Action T-2.2 are associated with the installation of public EV charging stations at commercial and multi-family residential development projects. Those who own and manage the charging stations incur costs associated with installing and maintaining the chargers and receive benefits by charging a markup on electricity provided through the chargers. Drivers receive benefits in the form of reduced fuel expenditures. For both participant groups, the action is cost-effective (BCR= 1.66 and 1.17, respectively) and owners of the chargers can expect to recuperate costs within three years.

**Table 7. City Action T-2.2 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Commercial and Multi-Family Developments* | 1.66 | 3.0 | \$47 | 6,103 |
| *EV Drivers* | 1.17 | < 1 | \$43 | |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

### 4.2.3 City Action T-2.4: Convert School Bus Fleet to Electric

City Action T-2.4 involves school districts operating in the City of El Cajon replacing diesel school buses with an electric alternative. School districts are currently relying on State funding to offset the purchase cost of electric buses and the associated charging infrastructure. As such, costs are minimal to the district(s), which also receives benefits in the form of reduced fuel expenditures. This action is considered cost-effective for participating school districts (BCR=2.22).

**Table 8. City Action T-2.4 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-2.4: Convert School Bus Fleet to Electric | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *School District(s)* | 2.22 | < 1 | \$164 | 53 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

## 4.3 Measure T-3: Improve Fuel Use Efficiency through Transportation Systems Management

### 4.3.1 City Action T-3.1: Synchronize Traffic Lights

City Action T-3.1 continues the City's efforts to synchronize traffic lights in priority areas. GHG reduction calculations included in the CAP assume 30 additional intersections will be synchronized in 2020. The costs to retime the signal lights are incurred by the City of El Cajon. The benefits are received by a second participant group – drivers. Drivers can expect reduced fuel consumption because of more efficient signal timing, resulting in decreased fuel expenditures. Since the costs and benefits are incurred by separate groups, a BCR and discounted payback period is not available for either.

**Table 9. City Action T-3.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-3.1: Synchronize Traffic Lights | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2$e** | **GHGs Reduced in 2030 (MT $CO_2$e)** |
| *City of El Cajon* | - | - | (\$23) | 389 |
| *Drivers* | - | - | \$213 | |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

### 4.3.2 City Action T-3.2: Install Roundabouts

GHG reductions for City Action T-3.2 are the result of reduced fuel use associated with the construction of roundabouts at City intersections. The CAP assumes three roundabouts are constructed between 2020 and 2030, which increase vehicle flow through intersections and reduce fuel consumption. The City has secured grant funding (non-participant costs) to offset all construction costs for one roundabout and is pursuing grant funding for the remainder. Since external funding sources are used to offset all costs, there are no metrics to show for the City. Benefits are received by drivers who utilize the intersections. A BCR and discounted payback period are not available for drivers as they only receive benefits with no costs.

**Table 10. City Action T-3.2 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-3.2: Install Roundabouts | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2$e** | **GHGs Reduced in 2030 (MT $CO_2$e)** |
| *Drivers* | - | - | \$151 | 306 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

## 4.4 Measure T-4: Improve Fuel Use Efficiency in Construction Equipment

### 4.4.1 City Action T-4.1: Increase Renewable and Alternative Fuel Construction Equipment

City Action T-4.1 requires the use of renewable and alternative fuel in construction equipment. This analysis assumes that a percentage of diesel consumption in construction equipment is switched to renewable diesel, resulting in GHG emission reductions. This switch requires construction equipment operators to incur a cost associated with the premium price of renewable diesel.

**Table 11. City Action T-4.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-4.1: Increase Renewable and Alternative Fuel Construction Equipment | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Construction Equipment Operators* | - | - | ($25) | 1,334 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.5 Measure T-5: Increase Alternative Modes of Travel

### 4.5.1 City Action T-5.1: Increase Alternative Modes of Transportation Through Transportation Demand Management

GHG reductions from City Action T-5.1 are a result of reduced vehicle miles traveled (VMT) by commuters in the City of El Cajon. This analysis assumes commuters switch to one of several alternative commute methods that lead to reductions in VMT due to participation in a workplace-provided transportation demand management (TDM) program. There are direct costs to TDM managers to operate these programs, which lead to fuel reduction benefits for participating commuters. For some commuters, there are also costs associated with purchasing mass transit passes or renting a vanpool vehicle. Results for the commuters vary by the type of alternate transportation mode selected, but the average for all commuters irrespective of their alternative commute method results in a slight overall cost (BCR=0.87). This can be attributed to the higher costs associated with mass transit passes and the assumption that mass transit will be the preferred commute alternative.

**Table 12. City Action T-5.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-5.1: Increase Alternative Modes of Transportation Through Transportation Demand Management | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *TDM Program Managers* | - | - | ($4) | 233 |
| *Commuters* | 0.87 | - | ($37) | |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.6 Measure T-6: Encourage Active Transportation

### 4.6.1 City Action T-6.1: Complete an Active Transportation Plan

Under City Action T-6.1, the City of El Cajon will complete an active transportation plan that emphasizes a sidewalk master plan and updated bicycle master plan. GHG reduction calculations included in the CAP only consider the reductions associated with an increase in bicycle mode share in lieu of single-occupancy vehicles. Two participant groups were identified with this action – the City of El Cajon and bicycle commuters. The City incurs the costs associated with the installation and maintenance of new miles of bike lane throughout the City, and bicyclists receive the benefit of reduced fuel expenditures, as they can shift their commute mode from a vehicle to bicycle. Since the costs and benefits are incurred by separate groups, a BCR and discounted payback period is not available for either.

**Table 13. City Action T-5.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-6.1: Complete an Active Transportation Plan | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *City of El Cajon* | - | - | ($135) | 238 |
| *Bicycle Commuters* | - | - | $201 | |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.7 Measure T-7: Reduce Household Vehicle Miles Traveled Through Smart Growth Development

### 4.7.1 City Action T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas

City Action T-7.1 anticipates the development of a multi-family residential development project on the Metropolitan Transit System (MTS) parking lot adjacent to the El Cajon Transit Center. Specifics of the project are not yet known or available to determine the overall cost implications of the housing project to developers and future tenants. However, case studies have shown that development costs for medium-density and infill development in urban areas tend to be lower than development costs for more sprawl-type projects since they rely on current infrastructure (roads, sewer, etc.), as opposed to expanding infrastructure further out. Those who receive the direct benefits associated with this action include residents of the housing development who experience reduced fuel costs associated with reduced VMT through shorter commute distances and/or use of alternative modes of transportation.

**Table 14. City Action T-7.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Residents in Transit Oriented Developments* | - | - | $254 | 191 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.7.2 City Action T-7.2: Encourage Development in Mixed-Use Residential Overlay Zone

City Action T-7.2 encourages residential development projects in a mixed-use overlay zone to reduce VMT by residents. The costs and benefits associated with this measure are like T-7.1. Development projects within the mixed-use overlay zone are not yet known and, thus, cannot be estimated. However, there will be direct benefits associated with this action for residents who experience reduced fuel costs associated with reduced VMT through shorter commute distances and/or use of alternative modes of transportation.

**Table 15. City Action T-7.2 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-7.2: Encourage Development in Mixed-Use Residential Overlay Zone |
|---|

| Participant Group | BCR | Payback Period (years) | Participant $/MT $CO_2e$ | GHGs Reduced in 2030 (MT $CO_2e$) |
|---|---|---|---|---|
| *Developers in Mixed-Use Overlay Zone* | - | - | $527 | 608 |
| *Residents in Mixed-Use Overlay Zone* | - | - | $255 | |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.7.3 City Action T-7.3: Implement the Transit District Specific Plan

City Action T-7.1 is another smart growth measure that seeks to reduce VMT by encouraging development projects within the Transit District Specific Plan's proposed area. Similar to other smart growth measures, project details are not yet known, and costs can vary significantly on a project by project basis. As such, they cannot be estimated here. However, there will be direct benefits associated with this action for residents who experience reduced fuel costs associated with reduced VMT through shorter commute distances and/or use of alternative modes of transportation.

**Table 16. City Action T-7.3 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-7.3: Implement the Transit District Specific Plan | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Residents* | - | - | $254 | 531 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.7.4 City Action T-7.4: Transition to an Online Submittal Permitting System

City Action T-7.4 introduces an online permitting system for the submittal of permit applications to be processed by the City. GHG reduction calculations included in the CAP assume that all VMT to the City to process a permit application will be avoided because of the new system. Costs associated with this action are incurred by the City of El Cajon to develop the online submittal system. Benefits are received by permit applicants who avoid the costs of fuel previously required to drive to a City building to process their permit application. Since the costs and benefits are incurred by separate groups, a BCR and discounted payback period is not available for either.

**Table 17. City Action T-7.4 Impacts on Participants to Achieve 2030 GHG Reductions**

| T-7.4: Transition to an Online Submittal Permitting System | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |

| | | | | |
|---|---|---|---|---|
| *City of El Cajon* | - | - | ($1,148) | 10 |
| *Permit Applicants* | - | - | $262 | |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.8 Measure BE-1: Increase Residential Building Efficiency

### 4.8.1 City Action BE-1.1: Require Energy Audits of Existing Residential Additions

City Action BE-1.1 requires an energy audit be conducted for qualifying residential additions over 500 square feet. GHG reductions included in the CAP estimate that a certain percentage of residential units that undergo a whole-home energy efficiency audit will include some level of energy efficiency upgrades in their project. This action is considered cost-effective with a BCR of 1.58, and costs associated with energy efficiency upgrades are expected to be offset by utility bill reductions within 11 years. This timeframe will decrease if reduced permitting fees and/or expedited permitting are made available through the City.

**Table 18. City Action BE-1.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| **BE-1.1: Require Energy Audits of Existing Residential Additions** | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Homeowners* | 1.58 | 10.8 | $164 | 29 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.8.2 City Action BE-1.2: Continue the Critical Home Repair Program

City Action BE-1.2 is like BE-1.1 in that it assumes a certain number of homes that apply for and receive funding through the Critical Home Repair Program or Home Rehabilitation Loan Program integrate energy efficiency improvements into their project. Qualifying homeowners can expect reduced utility bills within the first year with the costs being deferred to a later date (e.g., point of sale). Results will vary based on project-specific conditions, but the average homeowner can expect a net benefit as a result.

**Table 19. City Action BE-1.2 Impacts on Participants to Achieve 2030 GHG Reductions**

| **BE-1.2: Continue the Critical Home Repair Program** | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Homeowners* | 6.13 | < 1 | $264 | 40 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.9 Measure BE-2: Increase Commercial Building Efficiency

### 4.9.1 City Action BE-2.1: Require Energy Audits of Non-Residential Additions

City Action BE-2.1 requires an energy audit be conducted for qualifying non-residential additions and tenant improvements. GHG reductions included in the CAP estimate that a certain percentage of non-residential properties that undergo an energy efficiency audit will engage in activity, such as retrocommissioning, to increase building energy efficiency. While actual savings will depend on project-specific conditions, it is estimated that commercial buildings can recover the costs associated with the audit and retrocommissioning activities within three years. This timeframe will decrease if reduced permitting fees and/or expedited permitting are available through the City for the entire project.

**Table 20. City Action BE-2.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| **BE-2.1: Require Energy Audits of Non-Residential Additions** | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Existing Non-Residential Buildings* | 2.20 | 2.6 | $264 | 253 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.10 Measure BE-3: Increase Municipal Operation Energy Efficiency

### 4.10.1 City Action BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities

City Action BE-3.1 assumes the City of El Cajon implements municipal energy efficiency retrofit projects identified in its 2013 Energy Roadmap. This includes lighting retrofits at ten City facilities and upgrading pumps at the East County Performing Arts Center. Costs include purchase and installation, less SDG&E lighting rebates. Benefits to the City include reduced utility expenditures. Collectively, these actions are cost-effective to the City with a BCR of 1.64 and a discounted payback period of approximately six years.

**Table 21. City Action BE-3.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| **BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities** | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *City of El Cajon* | 1.64 | 6.3 | 203 | 17 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.11 Measure RE-1: Increase Behind-the-Meter Renewable Electricity Supply

### 4.11.1 City Action RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings

GHG reduction estimates included in the CAP for City Action RE-1.1 are for commercial customers only. Two participant groups were analyzed — commercial entities who own the PV system they are operating, and those who enter into a power purchase agreement (PPA). Under a PPA, participants purchase electricity generated by a solar PV system installed and maintained by a third-party. Both participant groups achieve a positive BCR, indicating the benefits outweigh the costs associated with the activity. Commercial and industrial entities that purchase their PV system can expect a discounted payback period of roughly 17 years.

Table 22. City Action RE-1.1 Impacts on Participants to Achieve 2030 GHG Reductions

| RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Commercial Buildings (system-owned solar PV)* | 1.22 | 16.5 | \$75 | 2,043 |
| *Commercial Buildings (power purchase agreement)* | 4.55 | < 1 | \$33 | 255 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

## 4.12 Measure WE-1: Increase Outdoor Water Efficiency

### 4.12.1 City Action WE-1.1: Require Covers on New Pools

City Action WE-1.1 applies to new residential pool projects. This can include a new residential development project that includes a pool or existing residential properties that install a pool. Costs include the purchase of a pool cover and, in some instances, a reel system. Benefits include the reduced purchase of water because of decreased evaporation. This action has a BCR of 1.21 for new residential pool projects, indicating the action is cost-effective for the participant.

Table 23. City Action WE-1.1 Impacts on Participants to Achieve 2030 GHG Reductions

| WE-1.1: Require Covers on New Pools | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *New Residential Pool Projects* | 1.21 | 7 | \$426 | 2 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD 2019

### 4.12.2 City Action WE-1.2: Require Weather-Based Irrigation Systems

City Action WE-1.2 applies to new commercial or residential landscape projects over 500 square feet or rehabilitated landscape areas over 2,500 square feet. Costs include the purchase and installation of weather-based irrigation controllers, and benefits are received in the form of reduced water bills. This action has a BCR of 3.76, indicating the action is cost-effective for the participant. Additionally, there is a discounted payback period of less than one year, indicating that projects can expect to recuperate the cost of weather-based irrigation controllers within the first year through water bill reductions.

Table 24. City Action WE-1.2 Impacts on Participants to Achieve 2030 GHG Reductions

| WE-1.2: Require Weather-Based Irrigation Systems | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2e$** | **GHGs Reduced in 2030** |

| | | | | (MT $CO_2$e) |
|---|---|---|---|---|
| *Commercial Landscape Projects* | 3.76 | < 1 | $1,955 | 159 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.13 Measure SW-1: Reduce Solid Waste and Increase Recycling

### 4.13.1 City Action SW-1.1: Implement Solid Waste Reduction and Recycling Targets

The participant(s) directly impacted by City Action SW-1.1 are not known, as specific waste diversion programs have not yet been identified. Costs included in this analysis align with waste diversion programs that are part of California Climate Investments. Depending on how programs are designed in the City of El Cajon, the costs could be incurred by one participant (e.g., the waste hauler) or shared across multiple participants (e.g., the waste hauler and waste generators).

**Table 25. City Action SW-1.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| SW-1.1: Implement Solid Waste Reduction and Recycling Targets | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2$e** | **GHGs Reduced in 2030 (MT $CO_2$e)** |
| *Waste Diversion Program(s)* | - | - | ($280) | 7,832 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

## 4.14 Measure CS-1: Increase Urban Tree Planting

### 4.14.1 City Action CS-1.1: Increase Shaded Landscape Area

GHG reductions included in the CAP for City Action CS-1.1 account for activity taken by multi-family residential and non-residential development projects. Both types of projects incur direct costs associated with the purchase, planting, and maintenance of trees on development sites. While there are many external benefits associated with tree planting, there are no direct financial benefits to participants that have been identified. As such, there is no BCR or payback period to report.

**Table 26. City Action CS-1.1 Impacts on Participants to Achieve 2030 GHG Reductions**

| CS-1.1: Increase Shaded Landscape Area | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant \$/MT $CO_2$e** | **GHGs Reduced in 2030 (MT $CO_2$e)** |
| *Multi-Family Residential Development Projects* | - | - | ($498) | 15 |
| *Non-Residential Development Projects* | - | - | ($498) | 27 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.14.2 City Action CS-1.2: Increase Tree Shade in Surface Parking Lots

GHG reductions included in the CAP for City Action CS-1.2 account for activity taken by non-residential development projects. These projects incur direct costs associated with the purchase, planting, and maintenance of trees on development sites. While there are many external benefits associated with tree planting, there are no direct financial benefits to participants that have been identified. As such, there is no BCR or payback period to report.

**Table 27. City Action CS-1.2 Impacts on Participants to Achieve 2030 GHG Reductions**

| CS-1.2: Increase Tree Shade in Surface Parking Lots | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Non-Residential Development Projects* | - | - | ($614) | 14 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

### 4.14.3 City Action CS-1.3: Increase Street Trees

GHG reductions included in the CAP for City Action CS-1.3 account for activity taken by single-family residential, multi-family residential, and non-residential development projects. All types of projects incur direct costs associated with the purchase, planting, and maintenance of trees on development sites. While there are many external benefits associated with tree planting, there are no direct financial benefits to participants that have been identified. As such, there is no BCR or payback period to report.

**Table 28. City Action CS-1.3 Impacts on Participants to Achieve 2030 GHG Reductions**

| CS-1.3: Increase Street Trees | | | | |
|---|---|---|---|---|
| **Participant Group** | **BCR** | **Payback Period (years)** | **Participant $/MT $CO_2e$** | **GHGs Reduced in 2030 (MT $CO_2e$)** |
| *Single-Family Residential Development Projects* | - | - | ($611) | 18 |
| *Multi-Family Residential Development Projects* | - | - | ($612) | 5 |
| *Non-Residential Development Projects* | - | - | ($612) | 16 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD 2019

# 5 LIMITATIONS

There are inherent limitations with any BCA which result in a degree of uncertainty that should be considered. This BCA uses the best information, data, and methods available at the time. Nonetheless, when considering the benefit and cost impacts of each CAP action, the limitations outlined in the following sections should be considered.

## 5.1 Available Data and Literature

### 5.1.1 Estimating Benefits and Costs

Estimates for current and future benefits and costs are limited to the data presently available. For some City actions, extensive datasets exist with historic costs associated with installation and operation that can be applied at a local level. However, not all actions have readily available data to apply to BCA calculations. Case studies are applied where necessary, as they are representative of the best available literature; however, they may not be entirely reflective of current and/or future conditions experienced. Additionally, costs and benefits associated with CAP actions are subject to changes in future conditions, such as:

- Population growth and demands;
- Technological advancements and available technology;
- Energy/fuel availability;
- Residential and commercial development stock; and
- Trends in consumer demands and producer supply.

### 5.1.2 Monetizing Externalities

Methods described here emphasize the inclusion of as many externalities as possible to calculate the societal perspective within the geographic scope of the City of El Cajon. However, not all externalities can be readily monetized, and their lack of inclusion in the quantitative assessment can skew the results of the BCA by reducing the potential benefits and/or costs experienced under the societal perspective. Externalities included in these analyses were restricted to the best available data and literature; not all externalities were captured, potentially under or overvaluing the cost-effectiveness of City actions at the societal perspective; Appendix B discusses individual action externalities further.

## 5.2 Scope of Impacts

The approach detailed in this document considers only those benefits and costs anticipated to be experienced within the City of El Cajon. There are other benefits and costs that can accrue outside of the City because of CAP implementation. For instance, the production and disposal of materials (e.g., solar PV panels and hybrid vehicle batteries) can have multiple costs and benefits associated with them. These can include:

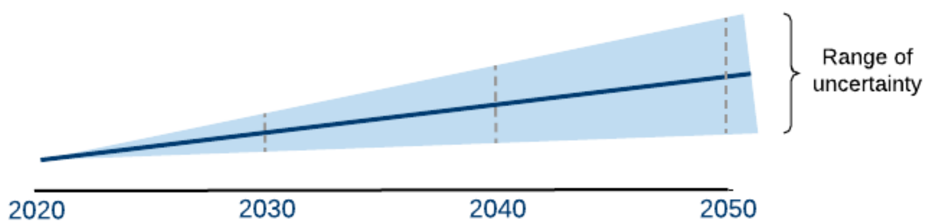
- Financial gain by manufacturers;
- Increase in industry sector jobs;
- Pollution external impacts from hazardous waste disposal at end of useful life; and
- Reduction in pollution caused by traditional energy production (e.g., coal).

While the methods described in this document can be applied to these additional benefits and costs, the time and resources needed to consider benefits and costs outside of the City of El Cajon are prohibitive.

## 5.3 Target Year Selection

Any analysis that involves future projections will have to acknowledge some level of uncertainty, which typically increases the farther into the future the projection goes (Figure 6). To reduce increased uncertainty associated with projections made further out, the BCA was restricted to a near-term interim target year (e.g., 2030 in lieu of 2040 or 2050). As an example, a PV system has a useful life of 25 years. Using a target year of 2030, future projections extend to 2055 to capture the benefits and costs of that action. If a later target year were selected for the BCA analysis, projections would need to extend to past 2055. For actions with even longer useful lives, this would require extending projections even more, significantly increasing the uncertainty associated with the results.

**Figure 6. Increasing Uncertainty with Future Projections (Stylized Example)**



# 6 CONCLUSION

This report summarized the findings of the City of El Cajon Draft Climate Action Plan (CAP) Benefit-Cost Analysis (BCA) conducted by the Energy Policy Initiatives Center (EPIC) at the University of San Diego for 24 of the 28 CAP City actions. The overall goal of the report is to examine the cost-effectiveness of and benefits and costs related to the City's CAP actions.

The cost-effectiveness of all 24 actions included in this analysis is a net cost of \$37/MT $CO_2e$ reduced in 2030, with an estimated 20,854 MT $CO_2e$ reduced. This represents a combined net cost of \$37 to CAP participants and non-participants (measure perspective) to reduce once MT $CO_2e$ in target year 2030. Eighteen actions provide a net benefit to one or more participant group. Nine City actions have a net cost for one or more participant group. Of those nine actions, the City of El Cajon is the participant bearing some or all of the cost in four of those actions.

Together, those actions leveraging existing programs have an estimated net cost of \$121 per MT reduced, and an estimated 10,353 MT $CO_2e$ reduced in 2030. Activities in these actions are already planned, but still contribute toward CAP emission targets. City Action WE-1.2 (Require Weather-Based Irrigation Systems) is the most cost-effective action with a net benefit per metric ton reduced (\$1,950/MT $CO_2e$), while City Action CS-1.1 (Increase Shaded Landscape Area) is the least cost-effective for achieving GHG reductions with a net cost of \$498/MT $CO_2e$. Of the existing actions, City Action SW-1.1 (Implement Solid Waste Reduction and Recycling Targets) reduces the most GHGs in 2030 (7,832 MT $CO_2e$) at a net cost of \$280/MT $CO_2e$.

City actions with expanded and new activity collectively have a net benefit of \$45 per MT reduced, and an estimated 10,501 MT $CO_2e$ reduced in 2030. City Action T-2.2 (Incentivize the Installation of Electric Vehicle Charging Stations) reduces the most GHG emissions in 2030 (6,103 MT $CO_2e$) and is cost-effective with an overall net benefit of \$87 per MT $CO_2e$ reduced.

Given the uncertainty associated with future conditions, updates may be necessary to incorporate updated forecasts based on actual benefits and costs experienced within the City of El Cajon as measures are implemented and to integrate any updates to CAP measures and actions over time.

## REFERENCES

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# Appendix A. BENEFIT-COST ANALYSIS METHODS

The benefit-cost analysis (BCA) for each City action in the City of El Cajon's Climate Action Plan (CAP) follow the same general methods outlined in Figure A1.

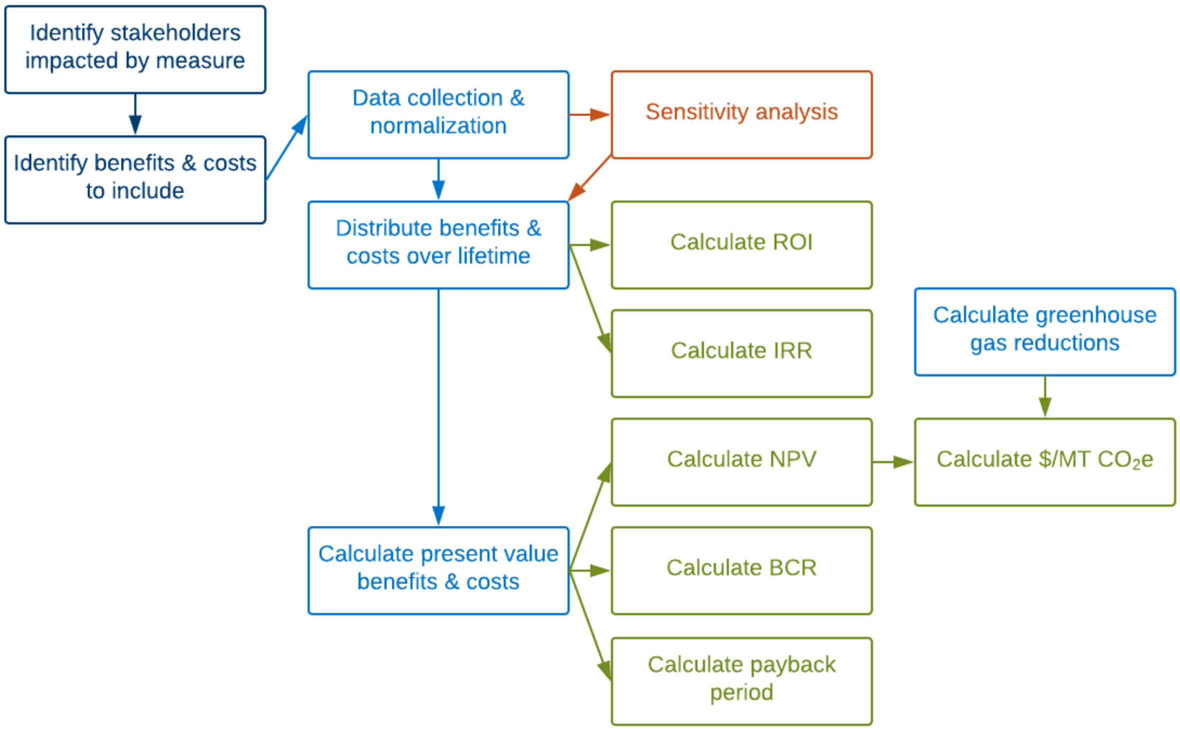



**Figure A1. Climate Action Plan Benefit-Cost Analysis General Methods**

For all actions, greenhouse gas (GHG) calculations are consistent with those used in estimating GHG reductions for the CAP.[11] In some instances, additional data were required beyond what is used to estimate GHG reductions to apply calculated GHG reductions at an individual activity level (e.g., average GHGs per solar photovoltaic [PV] system installed). Requirements vary by action, but defining assumptions and data collection follow the same methods detailed in this appendix.

## Identify Stakeholders Impacts and Corresponding Benefits and Costs

The data collection process is guided by identifying stakeholders impacted in each perspective. The following sections help to identify those groups and the benefits/costs included in the analysis that are received/incurred by each.

### Participant Perspective

An individual City action can have multiple participant groups that are impacted depending on the level of specificity for each CAP action. The solar PV system example in Figure A2 shows that, at a higher level, stakeholders include residential and commercial customers, and more specific sub-stakeholders are identified based on the type of construction. For the solar PV action, the costs associated with installations on existing construction can vary greatly compared to the costs of installing solar PV systems during

[11] City of El Cajon Climate Action Plan Appendix B – Greenhouse Gas Emissions Reduction Targets and Measures

construction of a new home or commercial building. The individuals who comprise the two types of construction groups can also vary; existing construction typically refers to current home or business owners, whereas new construction can include developers. For some actions, the City of El Cajon is also a participant.

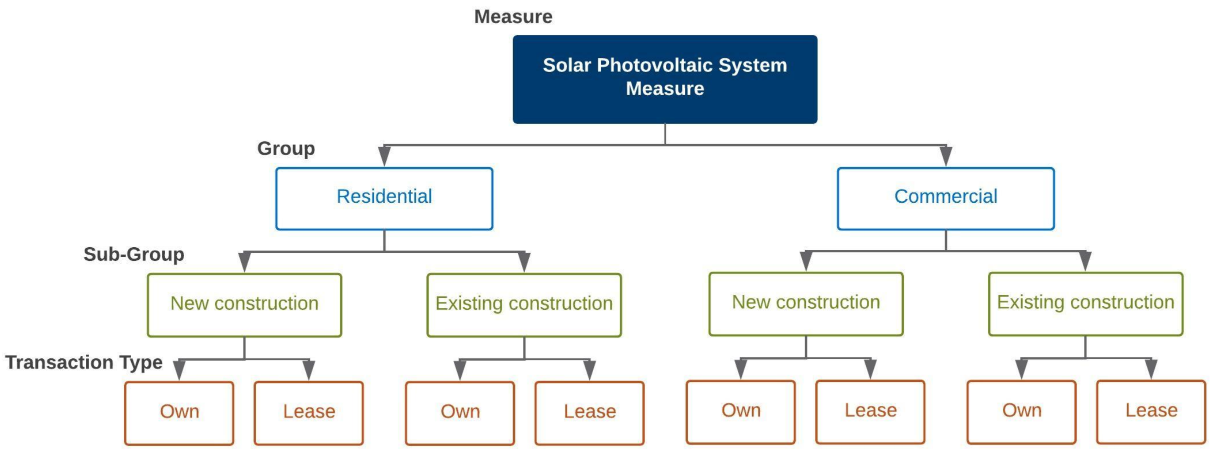



Figure A2. Potential Stakeholders Impacted by a Solar PV System Ordinance

Key questions asked for each identified participant include:

- Are there any upfront costs for purchase/installation?
- Are there any ongoing maintenance costs and, if so, at what frequency are they incurred (e.g., annually, biannually)?
- Does the activity reduce consumption (e.g., electricity, natural gas, water, fuel)?
- What rebates and incentives are available?
- What rate schedules apply to participant groups?
- What type of transaction is involved (e.g., purchase or lease)?
- Are there permitting requirements associated with the measure?

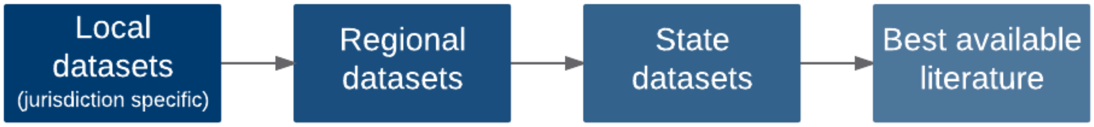
### Non-Participant Perspective

Non-participants are those who fund rebates and incentives (through taxes, fees, etc.) that participants use to offset costs. Data needed to estimate the impact on non-participants are the same as that for any rebates or incentives identified for participants (shown as cost reductions for participants and costs for non-participants).

## Data Collection and Normalization

Data collection followed the hierarchy outlined in Figure A3. Data specific to the City of El Cajon are used whenever possible for benefit and cost values, as well as for key assumptions. In instances where data specific to the City are unavailable or incomplete (e.g., little historic activity), regional or statewide data are applied. In the absence of sufficient regional or statewide data, estimates provided in current literature are used. Regional datasets are not specific to the City, but to the local region (e.g., county-level data or water district program data). Statewide datasets refer to data and/or case studies at the state level; case studies might not include the jurisdiction. Examples of best available literature include reports from federal agencies (e.g., USDA Forest Service) applicable to regions broader than the state level.

Figure A3. Data Collection Hierarchy for Climate Action Plan Benefit-Cost Analyses




All collected data values were normalized to 2018 dollars (2018$) using the Consumer Price Index (CPI; Table A1). Normalization reduces interannual impacts of outside influences (e.g., inflation, deflation) on dollar values. Failing to normalize the data can skew the results of the analysis.

Table A1. San Diego Region Consumer Price Index

| San Diego Region CPI | |
|---|---|
| Year | CPI Value |
| *2010* | 245 |
| *2011* | 253 |
| *2012* | 257 |
| *2013* | 260 |
| *2014* | 265 |
| *2015* | 269 |
| *2016* | 275 |
| *2017* | 283 |
| *2018* | 288 |

All dollar values were normalized before being integrated into BCA calculations using the following equation:

Equation A1. Normaliztion of Data Values Using Consumer Price Index

$$X_0 = X_t * \frac{CPI_0}{CPI_t}$$

Where,
$X_0$ = normalized dollar value in base year
$X_t$ = nominal dollar value in year *t*
$CPI_0$ = Consumer Price Index in base year
$CPI_t$ = Consumer Price Index in year *t*

When the dollar year is not specified for a data value(s) in a report or literature used, the year of publication is applied for normalization.

## Distribution of Benefits and Costs Over Useful Life

For each City action, the benefit and cost streams are laid out over the entire lifetime associated with that particular activity for the particular perspective(s) being analyzed. In the example in Figure A4, 2015 is considered the first installation year and the useful life is seven years (2015-2022). The year 2016 is considered the second install year and the benefits and costs go out through 2023 (a seven-year life). This example does not differentiate between perspectives, but the same process is applied to each by adding or removing the appropriate benefits and costs for that perspective and action. Additionally, each install year will have corresponding GHGs that are reduced annually. Annual GHG reductions for a particular install year will not vary by perspective.

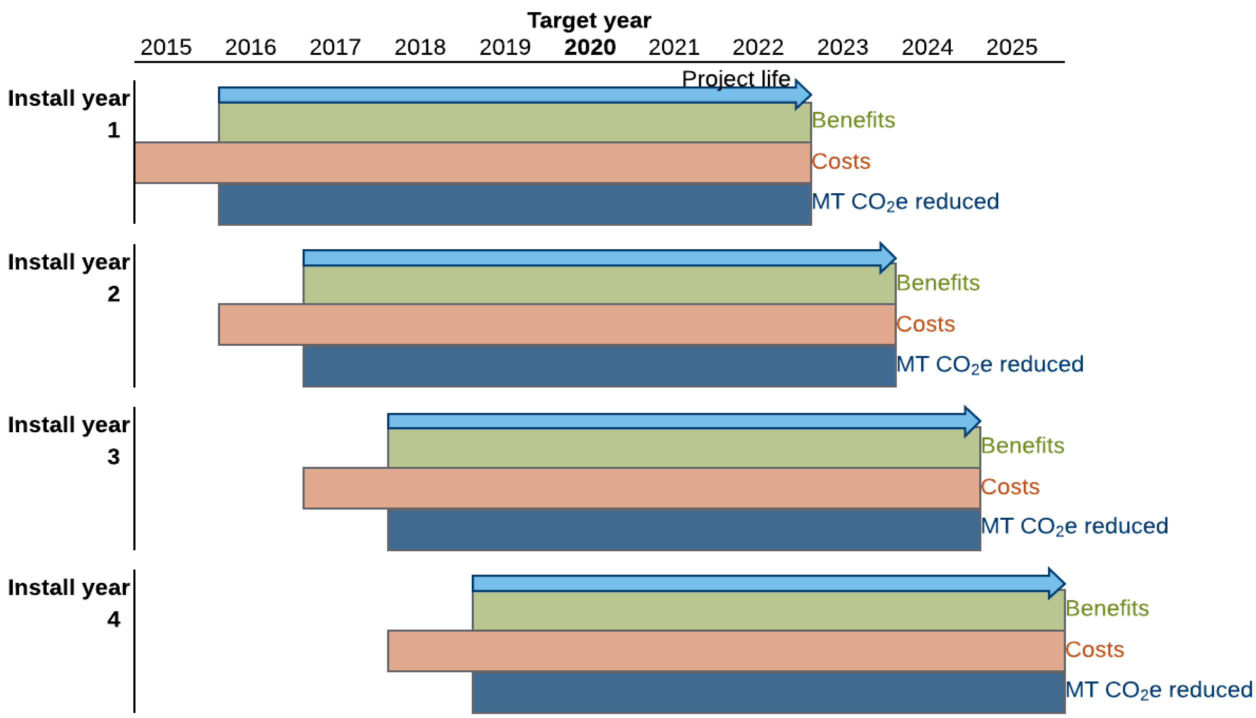



Figure A4. Example of Benefits and Costs Laid Out Over Useful Lives for Multiple Install Years

## Calculate Present Value Benefits and Costs

Once all benefits and costs have been laid out over the action's useful life, the discount rate is applied to both the benefit and cost streams for each installation year to calculate their respective present values (Equation A2 and Equation A3, respectively).

Equation A2.Present Value Benefits Calculation

$$PV_{benefits} = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t}$$

Equation A3. Present Value Costs Calculation

$$PV_{costs} = \sum_{t=0}^{T} \frac{C_t}{(1+r)^t}$$

Where,

$PV_{benefits}$ = present value of benefits stream

$B_t$ = benefits in year $t$

| | |
|---|---|
| $PV_{costs}$ | = present value of costs stream |
| $C_t$ | = costs in year $t$ |
| $r$ | = discount rate |
| $T$ | = useful life of measure/action |

### Present Value Benefits and Costs in Target Year

Present value benefits and costs represent the total of either benefits or costs over an action's useful lives. However, a CAP BCA is meant to show results with respect to a specific target year. To achieve this, the present value benefits and costs are apportioned to the GHGs reduced over each install year's useful life and then multiplied by the GHGs reduced in the target year for that install year (Equation A4 and Equation A5). Results are totaled for all install years to calculate the total benefit and cost in the target year for a given City action.

**Equation A4. Present Value Benefits in Target Year Calculation**

$$PV_{benefits}\ in\ target\ year = \frac{PV_{benefits}}{\sum_{t=0}^{T} GHGs_t} * GHGs_{t=target\ year}$$

**Equation A5. Present Value Costs in Target Year Calculation**

$$PV_{costs}\ in\ target\ year = \frac{PV_{costs}}{\sum_{t=0}^{T} GHGs_t} * GHGs_{t=target\ year}$$

Where,

| | |
|---|---|
| $PV_{benefits}$ | = present value of benefits stream |
| $PV_{costs}$ | = present value of costs stream |
| $GHGs_t$ | = greenhouse gases reduced in year $t$ |
| $T$ | = useful life of measure/action |

## Calculate Net Present Value (NPV)

Net present value (NPV) is calculated as the difference between the present value benefits and the present value costs for each install year (Equation A6).

**Equation A6. Net Present Value Calculation**

$$NPV = PV_{benefits} - PV_{costs}$$

Where,

| | |
|---|---|
| $NPV$ | = net present value |
| $PV_{benefits}$ | = present value of benefits stream |
| $PV_{costs}$ | = present value of costs stream |

### Net Present Value in Target Year

Similar to the present value benefits and costs, NPV must be apportioned across all GHGs to find the NPV in the target year. This can be done using Equation A4 and substituting *NPV* in for $PV_{benefits}$, or by subtracting the target year's present value costs from the target year's present value benefits (Equation A7).

**Equation A7. Net Present Value in Target Year Calculation**

$$\begin{aligned} &Anticipated\ NPV\ in\ target\ year \\ &\qquad = Anticipated\ PV_{benefits}\ in\ target\ year - Anticipated\ PV_{costs}\ in\ target\ year \end{aligned}$$

## Calculate Dollar per Metric Ton of $CO_2e$

The dollar per metric ton is calculated by dividing the NPV for each install year by the total GHGs reduced over its useful life (Equation A8).

**Equation A8. Dollar per Metric Ton of $CO_2e$ Calculation**

$$Dollar\ per\ MT\ CO_2e = \frac{NPV}{\sum_{t=0}^{T} GHGs_t}$$

Where,

| | |
|---|---|
| $NPV$ | = net present value |
| $GHGs_t$ | = greenhouse gases reduced in year *t* |
| $T$ | = useful life of measure/action |

### Weighted Average Dollar per Metric Ton of $CO_2e$

Since GHG reductions in the target year are not necessarily the same for each install year[12], weighted average values must be calculated to accurately reflect the dollar per metric ton of carbon dioxide equivalent ($/MT $CO_2e$) of a particular action in the target year. The weighted average can be found using Equation A9.

**Equation A9. Weighted Average Dollar per Metric Ton of $CO_2e$ Calculation**

$$Weighted\ average\ \$/MT\ CO_2e = \frac{\sum_{j=1}^{k}(\$/MT_j * GHGs_{target\ year;j})}{\sum_{j=1}^{k} GHGs_{target\ year;j}}$$

Where,

| | |
|---|---|
| $\$/MT_j$ | = dollar per metric ton of install year *j* |
| $GHGs_{target\ year;j}$ | = greenhouse gases reduced in target year by actions in install year *j* |
| $j$ | = install year |
| $k$ | = number of install years |

## Calculate Benefit-Cost Ratio

The BCR is calculated by dividing the present value benefits by the present value costs for a given install year (Equation A10).

**Equation A10. Benefit-Cost Ratio Calculation**

$$BCR = \frac{PV_{benefits}}{PV_{costs}}$$

[12] E.g., reductions from a solar PV system installed in 2015 will offset fewer GHGs in 2020 than a system of the same size installed in 2019 when a system degradation rate is applied.

Where,

| | |
|---|---|
| $BCR$ | = benefit-cost ratio |
| $PV_{benefits}$ | = present value of benefits stream |
| $PV_{costs}$ | = present value of costs stream |

### Weighted Average Benefit-Cost Ratio

Since GHG reductions in the target year are not necessarily the same for each install year[12], weighted average values must be calculated to accurately reflect the BCR of a particular action in the target year. The weighted average can be found using Equation A11.

**Equation A11. Weighted Average Benefit-Cost Ratio Calculation**

$$Weighted\ average\ BCR = \frac{\sum_{j=1}^{k}(BCR_j * GHGs_{target\ year;j})}{\sum_{j=1}^{k} GHGs_{target\ year;j}}$$

Where,

| | |
|---|---|
| $BCR_j$ | = benefit-cost ratio of install year *j* |
| $GHGs_{target\ year;j}$ | = greenhouse gases reduced in target year by actions in install year *j* |
| $j$ | = install year |
| $k$ | = number of install years |

## Calculate Discounted Payback Period

Determining the payback period requires calculating the cumulative flow of discounted benefits and discounted costs for a given install year (Equation A12). The cumulative cash flow for any given year is the sum of the benefits and costs (both discounted) for that year and all previous years. The number of years with a negative cumulative discounted cash flow, *n*, starts in Year One and goes up to the year before cumulative discounted benefits are greater than cumulative discounted costs.

**Equation A12. Discounted Payback Period Calculation**

$$DPP = n + \frac{CF_n}{CF_{n+1}}$$

Where,

| | |
|---|---|
| $DPP$ | = discounted payback period |
| $n$ | = number of years with a negative cumulative discounted cash flow |
| $CF_n$ | = discounted cash flow in year *n* |
| $CF_{n+1}$ | = discounted cash flow in year *n + 1* |

### Weighted Average Discounted Payback Period

Since GHG reductions in the target year are not necessarily the same for each install year[13], weighted average values must be calculated to accurately reflect the discounted payback period of a particular action in the target year. The weighted average can be found using Equation A13.

[13] E.g., reductions from a solar PV system installed in 2015 will offset fewer GHGs in 2020 than a system of the same size installed in 2019 when a system degradation rate is applied.

**Equation A13. Weighted Average Discounted Payback Period Calculation**

$$Weighted\ average\ DPP = \frac{\sum_{j=1}^{k}(DPP_j * GHGs_{target\ year;j})}{\sum_{j=1}^{k} GHGs_{target\ year;j}}$$

Where,

| | |
|---|---|
| $DPP_j$ | = discounted payback period of install year *j* |
| $GHGs_{target\ year;j}$ | = greenhouse gases reduced in target year by actions in install year *j* |
| $j$ | = install year |
| $k$ | = number of install years |

## Calculate Return on Investment

Unlike most other calculations, the return on investment (ROI) is found using non-discounted benefits and costs. The ROI is a ratio between (1) the difference of all benefits and costs and (2) the costs (Equation A14).

**Equation A14. Return on Investment Calculation**

$$ROI = \frac{\sum_{t=0}^{T}(B_t - C_t)}{\sum_{t=0}^{T} C_t}$$

Where,

| | |
|---|---|
| $ROI$ | = return on investment |
| $B_t$ | = benefits in year *t* |
| $C_t$ | = costs in year *t* |
| $T$ | = useful life of measure/action |

### Weighted Average Return on Investment

Since GHG reductions in the target year are not necessarily the same for each install year[14], weighted average values must be calculated to accurately reflect the ROI of a particular action in the target year. The weighted average can be found using Equation A15.

**Equation A15. Weighted Average Return on Investment Calculation**

$$Weighted\ average\ ROI = \frac{\sum_{j=1}^{k}(ROI_j * GHGs_{target\ year;j})}{\sum_{j=1}^{k} GHGs_{target\ year;j}}$$

Where,

| | |
|---|---|
| $ROI_j$ | = discounted payback period of install year *j* |
| $GHGs_{target\ year;j}$ | = greenhouse gases reduced in target year by actions in install year *j* |
| $j$ | = install year |
| $k$ | = number of install years |

[14] E.g., reductions from a solar PV system installed in 2015 will offset fewer GHGs in 2020 than a system of the same size installed in 2019 when a system degradation rate is applied.

## Calculate Internal Rate of Return

The internal rate of return (IRR) is found by setting the NPV equal to zero and solving for the discount rate, *r* (Equation A16).

**Equation A16. Internal Rate of Return Calculation**

$$NPV = 0 = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t}$$

Where,

| | |
|---|---|
| $NPV$ | = net present value |
| $B_t$ | = benefits in year *t* |
| $C_t$ | = costs in year *t* |
| $r$ | = discount rate to be solved for (IRR) |
| $T$ | = useful life of measure/action |

Excel or other analytical software is used to accurately calculate the IRR. Manually solving for the IRR requires inputting a series of estimated values for the IRR into Equation A16 until an approximate IRR is found that yields and NPV of approximately zero.

### Weighted Average Internal Rate of Return

Since GHG reductions in the target year are not necessarily the same for each install year[14], weighted average values must be calculated to accurately reflect the IRR of a particular action in the target year. The weighted average can be found using Equation A17.

**Equation A17. Weighted Average Internal Rate of Return Calculation**

$$Weighted\ average\ IRR = \frac{\sum_{j=1}^{k}(IRR_j * GHGs_{target\ year;j})}{\sum_{j=1}^{k} GHGs_{target\ year;j}}$$

Where,

| | |
|---|---|
| $IRR_j$ | = discounted payback period of install year *j* |
| $GHGs_{target\ year;j}$ | = greenhouse gases reduced in target year by actions in install year *j* |
| $j$ | = install year |
| $k$ | = number of install years |

## Conduct Sensitivity Analysis

A sensitivity analysis is used to estimate the impact of a select input on BCA results, while holding all other inputs constant. For this BCA, a sensitivity analysis was conducted to understand how the \$/MT $CO_2e$ responds to changes in the discount rate (three, five, and seven percent). Aside from varying the discount rate, all inputs were held constant and the same calculations detailed in previous sections were performed to calculate results

# Appendix B. MEASURE INPUTS, ASSUMPTIONS, AND FURTHER DISCUSSION

This appendix provides an extended set of benefit-cost analysis (BCA) tabular results, data inputs and assumptions used in the analysis, and additional discussion for each City action included in the BCA. Four actions were not evaluated because they were identified as already complete, have no quantified GHG reductions, or require a detailed analysis beyond the scope of this project. These actions are not discussed here and include:

- BE-3.2: Retrofit High Pressure Sodium Street Lights (action has been completed);
- RE-1.2: Install Photovoltaic Systems at School Sites (action has been completed);
- RE-2.1: Establish or Join a Program that Increases Renewable Electricity Supply (requires a detailed comparative and/or feasibility analysis); and
- T-2.3: Increase Preferential Parking Spaces (supporting action with no quantified GHG reductions).

## Measure T-1: Transition to a More Fuel-Efficient Municipal Vehicle Fleet

This section includes discussion on the following City action:

- T-1.1: Develop a Fleet Management Program

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[15] Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality; and
- Improved public health.

### City Action T-1.1: Develop a Fleet Management Program

City Action T-1.1 expands upon existing City efforts to replace vehicles in the City fleet with alternative fuel options. The CAP assumes that 12 fleet vehicles are replaced between 2022 and 2026 with a battery electric (BEV) or plug-in hybrid electric (PHEV) alternative, resulting in 24 MT $CO_2$e reduced in 2030.[16]

The City of El Cajon is the sole participant in this action. It is assumed that the City will purchase alternative fuel replacement vehicles as current vehicles come up for replacement. As such, this analysis examines the incremental cost of purchasing a BEV or PHEV in lieu of a gasoline vehicle. To offset some of the purchase cost, the City can leverage currently available rebates that vary according to the type of vehicle. The City receives benefits in the form of reduced fuel costs – the cost to charge new vehicles less the cost of gasoline that would have been purchased otherwise. Vehicles considered in this analysis include the replacement of two Ford F-150 extended cab pick-up trucks with two Workhorse W-15 Pickup trucks, replacing seven Ford Escapes with Mitsubishi Outlander PHEVs, and replacing three Ford Fusions with Ford Focus BEVs.

[15] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to vehicle miles traveled (VMT) using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.

[16] GHG reductions are net of tailpipe emissions avoided and electricity emissions from electric vehicle (EV) charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

Non-participant costs include the cost to fund alternative fuel rebates (excluding rebate program overhead costs). Current rebates included in this analysis are generally made available by the California Air Resources Board and administered by a local third-party (e.g., Center for Sustainable Energy).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-1.1 are provided in Table B1.

**Table B1. Cost-Effectiveness for City Action T-1.1 Perspectives in 2030**

| T-1.1: Develop a Fleet Management Program | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 24 | | | | |
| $/MT $CO_2e$ | 3% | $60 | ($64) | ($4) | $69 |
| | 5% | $38 | ($59) | ($20) | $42 |
| | 7% | $21 | ($54) | ($33) | $21 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-1.1 are documented in Table B2. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B2. Data Inputs and Assumptions for City Action T-1.1**

| T-1.1: Develop a Fleet Management Program | | |
|---|---|---|
| **Description** | **Input**[1] | **Source** |
| **Direct Costs** | | |
| Electric truck incremental cost ($/truck) | *($11,997)* | CSE, 2018; Review of comparables through Kelly Blue Book |
| PHEV incremental cost ($/PHEV) | *($6,392)* | CSE, 2018; Review of comparables through Kelly Blue Book |
| BEV incremental cost ($/BEV) | *($4,847)* | CSE, 2018 |
| Electric truck rebate ($/truck) | *$2,500* | CA DGS, 2018 |
| PHEV rebate ($/PHEV) | *$1,500* | CA DGS, 2018 |
| BEV rebate ($/BEV) | *$2,500* | CA DGS, 2018 |
| Fuel cost – electricity ($/kWh) | *($0.14)* | SDG&E, 2019f |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |

| | | |
|---|---|---|
| Avoided criteria pollutants – $PM_{10}$ (\$/MT) | \$151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ (\$/MT) | \$7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG (\$/MT) | \$6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ (\$/MT) | \$41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Vehicles replaced in 2022 | *2* | CAP Appendix B |
| Vehicles replaced in 2024 | *5* | CAP Appendix B |
| Vehicles replaced in 2025 | *2* | CAP Appendix B |
| Vehicles replaced in 2026 | *3* | CAP Appendix B |
| Fuel saved – gasoline (gal/yr) | *Varies by year* | CAP Appendix B |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2e$/yr) | | CAP Appendix B |
| Useful life (yrs) | *10* | Matches replacement assumptions in CAP |

[1]All dollar values are in 2018\$ Energy Policy Initiatives Center, USD

## Measure T-2: Increase Electric Vehicle and Electric Vehicle Charging Infrastructure Citywide

This section includes discussion on the following City actions:

- T-2.1: Install Municipal Electric Vehicle Charging Stations
- T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations
- T-2.4: Convert School Bus Fleet to Electric

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[17] Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality; and
- Improved public health.

### City Action T-2.1: Install Municipal Electric Vehicle Charging Stations

City Action T-2.1 expands upon existing activity currently happening within the City of El Cajon. Under this action, the City will increase the number of publicly available electric vehicle (EV) charging stations at municipal facilities by 21 chargers by 2030. This is expected to increase the number of miles driven by EVs in lieu of gasoline vehicles, resulting in a reduction of 108 MT $CO_2e$ in 2030.[18]

Participants include the City of El Cajon and EV drivers who utilize the publicly available chargers at municipal facilities. The City has a current contract with SDG&E to fully fund the installation and maintenance of the EV charging infrastructure at City facilities, resulting in no net cost to the City for the chargers. However, the City plans to offer electricity to EV drivers at no cost, resulting in increased utility bills for the City. For EV drivers, there are no costs for electricity purchases, but they receive a benefit in avoided gasoline purchases that they would have made otherwise. The useful life included in calculations (10 years) represents the current length of the contract between the City and SDG&E.

Non-participant costs include the costs to purchase and maintain the EV chargers at municipal facilities incurred by SDG&E. It does not include overhead costs associated with operating chargers at municipal facilities (e.g., contract management).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-2.1 are provided in Table B3.

**Table B3. Cost-Effectiveness for City Action T-2.1 Perspectives in 2030**

| T-2.1: Install Municipal Electric Vehicle Charging Stations | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced (MT $CO_2e$) | 108 | | | | |

[17] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to VMT using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.
[18] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

| | | | | | |
|---|---|---|---|---|---|
| \$/MT $CO_2e$ | 3% | \$217 | (\$21) | \$196 | \$271 |
| | 5% | \$171 | (\$18) | \$153 | \$212 |
| | 7% | \$136 | (\$16) | \$121 | \$168 |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-2.1 are documented in Table B4. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B4. Data Inputs and Assumptions for City Action T-2.1**

| **T-2.1: Install Municipal Electric Vehicle Charging Stations** | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Level II EV charger purchase (\$/charger) | *(\$2,932)* | U.S. DOE, 2015 |
| Percent of cost covered by SDG&E | *100%* | Provided through discussion with City staff |
| Electricity rate (\$/kWh) | *(\$0.14)* | SDG&E, 2019f |
| **Direct Benefits** | | |
| Fuel savings – gasoline (\$/gal) | *\$3.51* | U.S. EIA, 2019b |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ (\$/MT) | \$498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ (\$/MT) | \$151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ (\$/MT) | \$7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG (\$/MT) | \$6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ (\$/MT) | \$41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2020* | CAP Appendix B |
| Chargers installed – 2020 | *16* | CAP Appendix B |
| Chargers installed – 2025 and 2030 | *5* | CAP Appendix B |
| EV miles per charger (mi/charger/yr) | *49,343* | CAP Appendix B |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2e$/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *10* | Provided through discussion with City staff |

[1]All dollar values are in 2018\$ Energy Policy Initiatives Center, USD

### City Action T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations

City Action T-2.2 incentives the installation of EV charging stations at multi-family residential and non-residential development projects through reduced fees and expedited permitting. GHG reductions included in the CAP estimate that 183 new EV charging stations will be installed between 2021 and 2030 (specifically, 55 at multi-family residential developments and 128 at commercial developments). This activity is expected to lead to an estimated reduction of 6,103 MT $CO_2e$ in 2030.[19]

Participants include EV charger installers at multi-family residential and non-residential developments, and EV drivers who utilize the publicly available infrastructure. Installers incur the cost to purchase and install chargers and recuperate costs through the sale of electricity to EV drivers.[20] It is assumed that Level II pedestal chargers are installed. Additionally, the cost per charger for installation could potentially decrease for a project as more chargers are installed since they can rely on some of the same electric hardware. EV drivers incur costs for purchased electricity, but experience a benefit associated with reduced fuel (gasoline) demand.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-2.2 are provided in Table B5.

**Table B5. Cost-Effectiveness for City Action T-2.2 Perspectives in 2030**

| T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced (MT $CO_2e$) | 6,103 | | | | |
| $/MT $CO_2e$ | 3% | $117 | ($4) | $114 | $189 |
| | 5% | $90 | ($3) | $87 | $145 |
| | 7% | $70 | ($3) | $67 | $113 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-2.2 are documented in Table B6. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B6. Data Inputs and Assumptions for City Action T-2.2**

| T-2.2: Incentivize the Installation of Electric Vehicle Charging Stations |
|---|

[19] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.
[20] SDG&E is currently fully subscribed for EV charger rebates. If more rebates and incentives become available, the cost-effectiveness of installations will increase.

| Description | Input[1] | Source |
|---|---|---|
| **Direct Costs** | | |
| Level II EV charger purchase ($/charger) | *($2,932)* | U.S. DOE, 2015 |
| Installation cost ($/charger) | *($980)* | Energy Solutions, 2016 |
| Permit fee | *($490)* | Provided by City staff |
| Electricity rate – multi-family residential ($/kWh) | *($0.25)* | SDG&E, 2019a |
| Electricity rate – commercial ($/kWh) | *($0.14)* | SDG&E, 2019f |
| Percent of permit fee waived | *100%* | Provided by City staff |
| Software service fee ($/charger/yr) | *($900)* | U.S. DOE, 2015 |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Chargers installed – multi-family residential (chargers/yr) | *Varies by year* | CAP Appendix B |
| Chargers installed – commercial (chargers/yr) | *Varies by year* | CAP Appendix B |
| EV miles per charger – multi-family residential (mi/charger/yr) | *6,771* | CAP Appendix B |
| EV miles per charger – commercial (mi/charger/yr) | *84,223* | CAP Appendix B |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *10* | U.S. DOE, 2015 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## City Action T-2.4 Convert School Bus Fleet to Electric

City Action T-2.4 supports the Cajon Valley Unified School District (CVUSD) and Grossmont Union High School District (GUHSD) in the conversion of their school bus fleets to electric buses. It is estimated that

12 school buses can be replaced between 2020 and 2030, reducing diesel fuel consumption and resulting in approximately 53 MT $CO_2e$ being reduced in 2030.[21]

Participants in this action include school districts within El Cajon (CVUSD and GUHSD). The school districts incur costs associated with the purchase of electric school buses to replace current diesel models and the infrastructure necessary to support those buses (e.g., charging stations). However, both districts are actively pursuing grants and other funding opportunities available through the State and have already been awarded the funding necessary to offset costs associated with five buses.[22] This analysis assumes the districts are able to continue receiving grants necessary to offset the entire purchase cost for the buses and accompanying infrastructure, reducing the net cost to the districts to the purchase costs for electricity. Additionally, the districts receive benefits through reduced maintenance expenses associated with electric buses and avoided diesel fuel purchases.

Non-participant costs include the costs to the State to provide grants and other funding opportunities to local school districts. For this action, it includes the full cost of purchase for an electric school bus and the required infrastructure necessary to operate the bus. Funding opportunities include the California Energy Commission's School Bus Replacement Program.

An extended set of cost-effectiveness results for City Action T-2.4 are provided in Table B7.

**Table B7. Cost-Effectiveness for City Action T-2.4 Perspectives in 2030**

| T-2.4: Convert School Bus Fleet to Electric | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced (MT $CO_2e$) | 53 | | | | |
| $/MT $CO_2e$ | 3% | $208 | ($4,100) | ($3,892) | ($3,792) |
| | 5% | $164 | ($3,819) | ($3,655) | ($3,570) |
| | 7% | $133 | ($3,573) | ($3,441) | ($3,368) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-2.4 are documented in Table B8. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B8. Data Inputs and Assumptions for City Action T-2.4**

| T-2.4: Convert School Bus Fleet to Electric | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |

[21] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.
[22] An additional two applications have recently been submitted.

| | | |
|---|---|---|
| Electric bus purchase ($/bus) | *($400,000)* | CEC, 2017; Provided through discussion with City staff |
| Supporting infrastructure ($/bus) | *($60,000)* | CEC, 2017 |
| Percent of costs covered by external funding sources | *100%* | CEC, 2017; Provided through discussion with City staff |
| Fuel purchase – EV ($/kWh) | *($0.14)* | SDG&E, 2019f |
| **Direct Benefits** | | |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Reduction in maintenance costs ($/mi/yr) | *($0.17)* | CEC, 2017 |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Busses replaced annually (2020, 2025, and 2030 only) | *5* | CAP Appendix B |
| Fuel saved (gal diesel/bus/yr) | *482* | CAP Appendix B |
| Electric bus fuel efficiency (mi/DGE) | *19.6* | CEC, 2017 |
| Electricity rate increase (annual %) | *1.05%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2e$/yr/bus) | *5* | CAP Appendix B |
| Useful life (yrs) | *20* | CEC, 2017 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

### Measure T-3: Improve Fuel Use Efficiency Through Transportation Systems Management

This section includes discussion on the following City actions:

- T-3.1: Synchronize Traffic Lights
- T-3.2: Install Roundabouts

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[23] Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Improved public health;
- Reduced traffic congestion;
- Enhanced safety; and
- Enhanced community character.

#### City Action T-3.1: Synchronize Traffic Lights

Under City Action T-3.1, the City will synchronize traffic signal lights at intersections. The number of intersections synchronized are aligned with CAP GHG reduction calculations, which assume lights at 30 intersections are synchronized in 2020. Reductions in fuel consumption associated with increased traffic flow are expected to reduce an estimated 389 MT $CO_2e$ in 2030.[24]

Participants include the City of El Cajon and drivers within the City. The City incurs a onetime cost for a City traffic engineer to synchronize each intersection. Studies suggest that synchronization is effective for approximately five years, at which point changes in traffic flow patterns require lights to be resynchronized. This analysis assumes that the 30 intersections synchronized in 2020 are resynchronized every five years to maintain GHG reductions through 2030. There are no direct monetary benefits identified for the City. Drivers within the City receive the benefits associated with this action in the form of reduced fuel consumption because of increased traffic flow and, consequently, reduced fuel expenditures. The benefits received are spread out among all drivers who travel through synchronized intersections, and no direct costs have been identified for them.

No non-participant costs were identified for this action, and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action T-3.1 are provided in

[23] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to VMT using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.

[24] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

Table B9.

**Table B9. Cost-Effectiveness for City Action T-3.1 Perspectives in 2030**

| T-3.1: Synchronize Traffic Lights | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced ($MT\ CO_2e$) | 389 | | | | |
| $/MT $CO_2e$ | 3% | $244 | - | $244 | $309 |
| | 5% | $190 | - | $190 | $240 |
| | 7% | $148 | - | $148 | $188 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-3.1 are documented in Table B10. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B10. Data Inputs and Assumptions for City Action T-3.1**

| T-3.1: Synchronize Traffic Lights | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Signal light retiming cost ($/intersection) | *($2,500)* | Provided through discussion with City staff |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Signal lights retimed annually (2020 only) | *30* | CAP Appendix B |
| Fuel saved (gal/intersection/yr) | *Varies by year* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |

| | | |
|---|---|---|
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Weighted average fuel efficiency (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *5* | Tarnoff and Ordonez, 2004 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## City Action T-3.2: Install Roundabouts

Under City Action T-3.2, the City will install roundabouts. The number of roundabouts installed are aligned with CAP GHG reduction calculations, which assume three roundabouts are installed (one each in 2020, 2025, and 2030). Reductions in fuel consumption associated with increased traffic flow through roundabouts are expected to reduce an estimated 306 MT $CO_2$e in 2030.[25]

Participants include the City of El Cajon and drivers within the City. The City incurs a one-time cost for each roundabout installed, including design and construction. This analysis condenses upfront expenditures into the first year; however, actual costs may be spread out over a multi-year development process. Additionally, the City is pursuing external funding opportunities to offset costs (e.g., grants). A SANDAG smart growth incentive grant has already been secured for one roundabout. It is assumed that the City will use external funding for the remaining roundabouts as well. No direct monetary benefits associated with this action have been identified for the City; however, drivers within the City receive the benefits in the form of reduced fuel consumption through increased traffic flow and, consequently, reduced fuel expenditures. The benefits received are spread out among all drivers who travel through the roundabouts and no direct costs have been identified for them.

Non-participant costs include the cost to fund grants (e.g., SANDAG smart growth incentive grants) and other external funding opportunities the City uses to offset all construction costs for roundabouts.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-3.2 are provided in Table B11.

[25] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

**Table B11. Cost-Effectiveness for City Action T-3.2 Perspectives in 2030**

| T-3.2: Install Roundabouts | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 306 | | | | |
| $\$/MT\ CO_2e$ | 3% | $223 | ($543) | ($320) | ($266) |
| | 5% | $151 | ($490) | ($338) | ($301) |
| | 7% | $109 | ($445) | ($336) | ($310) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-3.2 are documented in Table B12. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B12. Data Inputs and Assumptions for City Action T-3.2**

| T-3.2: Install Roundabouts | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |
| Roundabout construction cost ($/roundabout) | *($2,500,00)* | Provided through discussion with City staff |
| Construction costs offset by external funding sources | *100%* | Provided through discussion with City staff |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Roundabouts installed annually (2020, 2025, 2030 only) | *1* | CAP Appendix B |
| Fuel saved (gal/intersection/yr) | *Varies by year* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |

| | | |
|---|---|---|
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Weighted average fuel efficiency (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *40* | Yang and Magalotti, 2016 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure T-4: Improve Fuel Use Efficiency in Construction Equipment

This section includes discussion on the following City action:

- T-4.1: Increase Renewable and Alternative Fuel Construction Equipment

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality; and
- Improved public health.

### City Action T-4.1: Increase Renewable and Alternative Fuel Construction Equipment

Under City Action T-4.1, the City will require new construction projects to reduce emissions from construction vehicles and equipment by 10%. This analysis assumes the requirement goes into effect in January 2021 and continues through the 2030 CAP target year, reducing an estimated 1,334 MT $CO_2e$ in 2030.

Participants include developers engaging in new construction projects. There are two identified ways for developers to reduce construction-related emissions. The first is to switch from petroleum diesel (diesel) to renewable diesel in applicable vehicles and equipment. The second is to replace existing gasoline and/or diesel equipment with alternative fuel equipment (e.g., all electric). Alternative fuel construction vehicles and equipment available today are limited and pricing is not entirely cost-competitive. As such, this analysis assumes that all emission reductions are associated with converting from diesel to renewable diesel. The cost to construction equipment operators is the differential in fuel price (renewable diesel minus diesel). There are currently no direct monetary benefits; however, this could change if renewable diesel becomes cheaper than diesel in the future.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action T-4.1 are provided in Table B13.

**Table B13. Cost-Effectiveness for City Action T-4.1 Perspectives in 2030**

| T-4.1: Increase Renewable and Alternative Fuel Construction Equipment | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced (MT $CO_2e$) | 1,334 | | | | |
| $/MT $CO_2e$ | 3% | ($29) | - | ($29) | $12 |
| | 5% | ($25) | - | ($25) | $10 |
| | 7% | ($22) | - | ($22) | $9 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-4.1 are documented in Table B14. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B14. Data Inputs and Assumptions for City Action T-4.1**

| T-4.1: Increase Renewable and Alternative Fuel Construction Equipment | | |
|---|---|---|
| **Description** | **Input**[1] | **Source** |
| **Direct Costs** | | |
| Fuel cost – diesel to renewable diesel differential ($/gal) | *($0.38)* | Chelan County PUD, n.d. |
| **Direct Benefits** | | |
| NA | - | - |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Percent GHG reductions from diesel to renewable diesel conversion | *100%* | - |
| Fuel price increase – renewable diesel (annual %) | | U.S. EIA, 2019a |
| Diesel emission factor (lbs CO2e/gal) | *22.38* | CAP Appendix B; U.S. EIA, 2018 |
| GHGs reduced (MT $CO_2e$/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure T-5: Increase Alternative Modes of Travel

This section includes discussion on the following City action:

- T-5.1 Increase Alternative Modes of Travel through Transportation Demand Management

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[26] Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Improved public health;
- Reduced fuel use;
- Reduced traffic congestion; and
- Improved access to low-cost transportation options.

### City Action T-5.1 Increase Alternative Modes of Travel through Transportation Demand Management

City Action T-5.1 requires the City to adopt an ordinance for new non-residential development projects to develop a transportation demand management (TDM) plan. This analysis assumes the ordinance goes into effect in January 2021 and continues through the 2030 CAP target year, reducing commuter VMT and leading to an estimated reduction of 232 MT $CO_2e$ in 2030.[27]

Participants include businesses in new non-residential developments who adopt a TDM program and their employees who elect to participate in the TDM programs. For businesses, costs include contracting with a TDM account executive to manage the program and distribute incentives provided by the employer (e.g., a transit pass subsidy). There are no direct monetary benefits received by employers; however, the City is currently looking at possible incentives for employers (e.g., reductions in parking requirements).

For participating employees, costs are dependent on the alternative transportation mode used for commuting. Costs to commute by mass transit include the purchase of a monthly transit pass. Costs to commute by vanpool include the cost to lease a vehicle; it is assumed that leasing costs are shared equally among all vanpool riders.[28] There are no identified costs for those who switch to walking, cycling, or telecommuting. Employees also receive incentives (cost reductions) dependent upon the type of transportation used. Incentives have been identified for mass transit and vanpool riders. For vanpool riders, it is assumed that the incentive is shared equally among all riders. All participating employees, regardless of transportation mode, receive benefits in the form of reduced fuel (gasoline or diesel) expenses. Commuters could experience other benefits in addition to those included in this analysis, such as reduced vehicle ownership costs (e.g., maintenance and insurance) because of switching their primary commute mode.

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[26] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to VMT using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.

[27] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

[28] CAP GHG reductions estimate the combined reductions from carpool and vanpool commuters; however, the percentage of emissions reductions due to each type of activity was not specified. This analysis conservatively estimates that all reductions are achieved through vanpooling. If a share were attributed to carpooling, cost-effectiveness would increase since carpooling does not incur a vehicle leasing cost.

Non-participant costs include the cost to fund incentives not provided by the employer (e.g., SANDAG's vanpool subsidy). These are existing programs that TDM plans can leverage to achieve their VMT reduction goals. These costs do not, however, include overhead costs associated with operating the third-party program.

Costs to the City to administer and implement this action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-5.1 are provided in Table B15.

**Table B15. Cost-Effectiveness for City Action T-5.1 Perspectives in 2030**

| T-5.1: Increase Alternative Modes of Travel Through Transportation Demand Management | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced ($MT\ CO_2e$) | 233 | | | | |
| $\$/MT\ CO_2e$ | 3% | ($48) | ($103) | ($152) | ($79) |
| | 5% | ($41) | ($89) | ($130) | ($67) |
| | 7% | ($35) | ($77) | ($112) | ($58) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-5.1 are documented in Table B16. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B16. Data Inputs and Assumptions for City Action T-5.1**

| T-5.1: Increase Alternative Modes of Travel Through Transportation Demand Management | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| TDM account executive fee ($/employee/yr) | *($4)* | NCTR, 2010 |
| Mass transit pass ($/commuter/yr) | *($864)* | MTS, 2019a |
| Mass transit incentive ($/commuter/yr) | *$86* | MTS, 2019b |
| Vanpool lease ($/van/yr) | *($8,100)* | OCTA, 2017; Edison, 2015; SANDAG, 2018 |
| Vanpool incentive ($/vanpool/yr) | *$4,800* | SANDAG, 2018 |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |

| | | |
|---|---|---|
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | |
| Commuters participating in TDM programs | *Varies by year* | CAP Appendix B |
| VMT reductions | *Varies by year* | CAP Appendix B |
| Percent of VMT reduction from walking | *1%* | CAP Appendix B |
| Percent of VMT reduction from cycling | *15%* | CAP Appendix B |
| Percent of VMT reduction from mass transit | *28%* | CAP Appendix B |
| Percent of VMT reductions from vanpool | *54%* | CAP Appendix B |
| Percent of VMT reductions from telecommute | *2%* | CAP Appendix B |
| Vanpool ridership (commuters/van) | *6* | OCTA, 2017 |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure T-6: Encourage Active Transportation

This section includes discussion on the following City action:

- T-6.1: Complete an Active Transportation Plan

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[29] Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Improved public health;
- Reduced fuel use;
- Reduced traffic congestion;
- Improved access to low-cost transportation options;
- Increased access to walkable environments;
- Enhanced safety; and
- Enhanced community character.

### City Action T-6.1: Complete an Active Transportation Plan

Under City Action T-6.1, the City will develop an Active Transportation Plan to include a sidewalk master plan and update the current bicycle master plan. This analysis only considers the benefits and costs associated with constructing Class II bicycle lanes, consistent with assumptions made in CAP GHG reduction calculations. In addition, this analysis assumes construction of new bicycle lanes begins in 2021 and continues through the 2030 CAP target year, reducing commuter VMT and leading to an estimated reduction of 236 MT $CO_2e$ in 2030.[30]

Participants include the City of El Cajon and commuters who switch to cycling as their preferred commute mode because of the newly installed bike lanes. The City incurs costs associated with the construction and ongoing maintenance of new bicycle lanes. Construction costs may be lowered as the City explores external funding sources (e.g., State and federal grants); however, no funds have currently been allocated to the City for bicycle lanes and so they are not included here. There are no direct monetary benefits received by City.

For commuters switching their commute mode from vehicle to bicycle, benefits are received in the form of reduced fuel (gasoline or diesel) expenses. Commuters could experience other benefits in addition to those included in this analysis, including reduced vehicle ownership costs (e.g., maintenance and insurance). There are no costs assigned to these commuters because of the shift of commute mode.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action T-6.1 are provided in Table B17.

[29] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to VMT using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.
[30] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

**Table B17. Cost-Effectiveness for City Action T-6.1 Perspectives in 2030**

| T-6.1: Complete an Active Transportation Plan | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 238 | | | | |
| $\$/MT\ CO_2e$ | 3% | $90 | - | $90 | $154 |
| | 5% | $65 | - | $65 | $114 |
| | 7% | $49 | - | $49 | $86 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-6.1 are documented in Table B18. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B18. Data Inputs and Assumptions for City Action T-6.1**

| T-6.1: Complete an Active Transportation Plan | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |
| Class II bike lane construction cost ($/mi) | *($10,000)* | Provided through discussion with City staff |
| Class II bike lane maintenance cost ($/mi/yr) | *($6,000)* | Provided through discussion with City staff |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Class II bike lanes installed (mi/yr) | *1.1* | CAP Appendix B |
| VMT reductions | *Varies by year* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |

| | | |
|---|---|---|
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *20* | CARB, 1995 |

[1]All dollar values are in 2019$

Energy Policy Initiatives Center, USD

## Measure T-7: Reduce Household Vehicle Miles Traveled Through Smart Growth Development

This section includes discussion on the following City actions:

- T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas
- T-7.2: Encourage Development in Mixed-Use Residential Overlay Areas
- T-7.3: Implement the Transit District Specific Plan
- T-7.4: Transition to an Online Submittal Permitting System

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon and the value of avoided criteria pollutants associated with fossil fuel combustion.[31] Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Improved public health;
- Reduced fuel use;
- Reduced traffic congestion;
- Improved access to low-cost transportation options;
- Increased access to walkable environments;
- Enhanced safety;
- Enhanced community character; and
- Conservation of resources.

### City Action T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas

City Action T-7.1 is a continuation of current efforts in the City to encourage residential development near mass transit. A mixed-use residential development project is anticipated to be developed on a Metropolitan Transit System (MTS) parking lot adjacent to the El Cajon Transit Center. The CAP assumes that the 126 residential units identified in preliminary plans are developed by 2030, reducing an estimated 191 MT $CO_2e$ as residents shift towards alternative modes of transportation.[32]

Specific details about the proposed mixed-use development project at the MTS parking lot site are not yet available. As such, the associated costs and benefits are not included in this analysis. However, case studies have shown that development costs for medium-density and infill development in urban areas tend to be lower than development costs for more sprawl-type projects (Boyko and Cooper, 2011; Winkelman et al., 2010; Burchell and Mukherji, 2003) since they rely on current infrastructure (roads, sewer, etc.) as opposed to expanding infrastructure further out. Those who receive the direct benefits associated with this action include residents of the new project who experience reduced fuel costs associated with shorter drive distances and, consequently, reduced purchases of fuel. By encouraging mixed-use development, VMT can be reduced by shortening commute distances and encouraging alternate forms of transportation (e.g., bike or walk).

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

[31] The volume of criteria pollutants emitted were calculated by converting gallons of fuel saved to VMT using the weighted average annual fuel efficiency rate (mpg) used in CAP calculations.

[32] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

An extended set of cost-effectiveness results for City Action T-7.1 are provided in Table B19.

**Table B19. Cost-Effectiveness for City Action T-7.1 Perspectives in 2030**

| T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 191 | | | | |
| $/MT $CO_2e$ | 3% | $294 | - | $294 | $366 |
| | 5% | $254 | - | $254 | $316 |
| | 7% | $220 | - | $220 | $275 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-7.1 are documented in Table B20. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B20. Data Inputs and Assumptions for City Action T-7.1**

| T-7.1: Increase Residential Dwelling Units in Transit Oriented Development Areas | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| NA | - | - |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants - $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants - $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants - ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants –$SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Number of new residential units (units/yr) | *13* | CAP Appendix B |
| VMT reductions (VMT/yr) | *Varies by year* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |

| | | |
|---|---|---|
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants - PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

### City Action T-7.2: Encourage Development in Mixed-Use Residential Overlay Areas

City Action T-7.2 is a continuation of current efforts in the City to reduce residential parking requirements for development projects in mixed-use residential overlay areas, leading to reductions in household VMT. This analysis assumes parking reductions are made at qualifying development projects beginning in 2020 through 2030, resulting in a reduction of 605 MT $CO_2$e.[33]

Participants include developers in mixed-use residential overlay zones and residents who will occupy the new developments. By reducing parking requirements, developers can avoid the construction and ongoing maintenance costs associated with the reduced number of parking stalls. In addition, minimum parking requirements tend to reduce the profitability of development projects (measured in profit per acre) and, when limited land is available, reduce the capacity for additional units; reducing requirements can have the opposite effect (VTPI, 2016). This analysis only captures the direct benefits associated with reduced construction and maintenance costs. Increases in profit and capacity to construct additional units are dependent on the size of the development project and the total number of parking stalls reduced specific to the project site; individual project details for future developments are currently unclear. No direct costs have been identified for developers.

By reducing parking requirements, residential occupants of these developments will be encouraged to pursue alternative modes of transportation (e.g., bicycling, walking, transit). Since these projects are in mixed-use areas and details on new mode shares are unavailable, this analysis assumes no increased costs for residents.[34] Benefits are received in the form of reduced fuel (gasoline or diesel) expenses. Additional benefits that may be received but are not included in the quantitative analysis include reduced rents and/or housing prices associated with lower project construction costs (Gabbe and Pierce 2016; VTPI, 2016). There are no direct costs identified for residents.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

[33] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.
[34] Examples of potential costs that could be incurred include a monthly mass transit pass, bicycle purchase and maintenance, and/or rideshare expenses.

An extended set of cost-effectiveness results for City Action T-7.2 are provided in Table B21.

**Table B21. Cost-Effectiveness for City Action T-7.2 Perspectives in 2030**

| T-7.2: Encourage Development in Mixed-Use Residential Overlay Areas | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 608 | | | | |
| $\$/MT\ CO_2e$ | 3% | \$893 | - | \$893 | \$965 |
| | 5% | \$782 | - | \$782 | \$845 |
| | 7% | \$689 | - | \$689 | \$744 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-7.2 are documented in Table B22. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B22. Data Inputs and Assumptions for City Action T-7.2**

| T-7.2: Encourage Development in Mixed-Use Residential Overlay Areas | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| NA | - | - |
| **Direct Benefits** | | |
| Avoided parking construction costs (\$/stall) | *\$4,801* | VTPI, 2018a; VTPI 2018b |
| Avoided parking maintenance costs (\$/stall/yr) | *\$320* | VTPI, 2018a; VTPI 2018b |
| Fuel savings – gasoline (\$/gal) | *\$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel (\$/gal) | *\$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV (\$/kWh) | *\$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ (\$/MT) | \$498,371 | SANDAG, 2015 |
| Avoided criteria pollutants - $PM_{10}$ (\$/MT) | \$151,900 | SANDAG, 2015 |
| Avoided criteria pollutants - $NO_x$ (\$/MT) | \$7,926 | SANDAG, 2015 |
| Avoided criteria pollutants - ROG (\$/MT) | \$6,911 | SANDAG, 2015 |
| Avoided criteria pollutants –$SO_2$ (\$/MT) | \$41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Number of parking stalls reduced – 2020 (stalls/yr) | *45* | CAP Appendix B |
| Number of parking stalls reduced – 2021-2025 (stalls/yr) | *27* | CAP Appendix B |
| Number of parking stalls reduced – 2026-2030 (stalls/yr) | *66* | CAP Appendix B |
| VMT reductions (VMT/stall/yr) | *Varies by year* | CAP Appendix B |

| | | |
|---|---|---|
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants - PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2e$/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *24* | VTPI, 2018b |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

### City Action T-7.3: Implement the Transit District Specific Plan

City Action T-7.3 is a continuation of current efforts in the City to implement the Transit District Specific Plan (TDSP) and encourage development within the TDSP's proposed area. GHG reductions included in the CAP rely on the TDSP's traffic impact study and estimates a reduction in VMT of 5,131 miles per weekday by 2030. This results in approximately 531 MT $CO_2e$ reduced as residents shift towards alternative modes of transportation.[35]

Potential development projects as they relate to this action are not yet known and, consequently, estimated costs and benefits are not included in this analysis. However, case studies have shown that development costs for medium-density and infill development in urban areas tend to be lower than development costs for more sprawl-type projects (Boyko and Cooper, 2011; Winkelman et al., 2010; Burchell and Mukherji, 2003) since they rely on current infrastructure (roads, sewer, etc.) as opposed to expanding infrastructure further out. Those who receive the direct benefits associated with this action include drivers and commuters who experience reduced fuel costs associated with shorter drive distances. By encouraging mixed-use development, VMT can be reduced by shortening commute distances and encouraging alternate forms of transportation (e.g., biking, walking). Commuters and other drivers experience a benefit in the form of avoided fuel purchases because of the reduction in VMT.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action T-7.1 are provided in Table B23.

[35] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

**Table B23. Cost-Effectiveness for City Action T-7.2 Perspectives in 2030**

| T-7.3: Implement the Transit District Specific Plan | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 531 | | | | |
| $/MT $CO_2e$ | 3% | $294 | - | $294 | $366 |
| | 5% | $254 | - | $254 | $316 |
| | 7% | $220 | - | $220 | $274 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-7.3 are documented in Table B24. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B24. Data Inputs and Assumptions for City Action T-7.3**

| T-7.3: Implement the Transit District Specific Plan | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| NA | - | - |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants - $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants - $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants - ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants –$SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| VMT reductions (VMT/yr) | *Varies by year* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |

| | | |
|---|---|---|
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants - PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants - SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## City Action T-7.4: Transition to an Online Submittal Permitting System

Under City Action T-7.4 the City will develop an online submittal system for all permit applications. Through discussion with the City and to be consistent with CAP GHG calculations, it was determined that the permitting system will be developed in 2020 and go online in 2021. Submitting permits online is expected to reduce 32,400 VMT annually, leading to an estimated reduction of 10 MT $CO_2$e in 2030.[36]

Participants include the City of El Cajon and individuals and/or businesses who will submit a permit application to the City. The City incurs costs associated with the development and ongoing operation of the online permit submittal system. No direct monetary benefits have been identified for the City, although they may experience reduced costs associated with more streamlined permit processing and handling. The City has identified EnerGov software, a subscription based program for use. EnerGov is a subscription based program and the City will incur upfront costs necessary to tailor the system to meet the City's needs. Additional costs include ongoing annual operations through target year 2030. Those submitting permit applications will receive benefits in the form of reduced fuel (e.g., gasoline or diesel) expenses as they no longer need to drive to a City facility to submit the application. There are no costs assigned to these participants as a result of the change.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action T-7.4 are provided in Table B25.

[36] GHG reductions are net of tailpipe emissions avoided and electricity emissions from EV charging. These GHG values may differ from those in the CAP which attribute EV charging emissions to the electricity sector, not to the action.

**Table B25. Cost-Effectiveness for City Action T-7.4 Perspectives in 2030**

| T-7.4: Transition to Online Submittal Permitting System | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 10 | | | | |
| $\$/MT\ CO_2e$ | 3% | ($981) | - | ($981) | ($907) |
| | 5% | ($886) | - | ($886) | ($820) |
| | 7% | ($805) | - | ($805) | ($746) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action T-7.4 are documented in Table B26. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B26. Data Inputs and Assumptions for City Action T-7.4**

| T-7.4: Transition to Online Submittal Permitting System | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Online submittal system development cost | *($20,000)* | Provided through discussion with City staff |
| Online submittal system operations ($/yr) | *($15,000)* | Provided through discussion with City staff |
| **Direct Benefits** | | |
| Fuel savings – gasoline ($/gal) | *$3.51* | U.S. EIA, 2019b |
| Fuel savings – diesel ($/gal) | *$3.87* | U.S. EIA, 2019c |
| Fuel savings – EV ($/kWh) | *$0.27* | SDG&E, 2019e |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $PM_{2.5}$ ($/MT) | $498,371 | SANDAG, 2015 |
| Avoided criteria pollutants – $PM_{10}$ ($/MT) | $151,900 | SANDAG, 2015 |
| Avoided criteria pollutants – $NO_x$ ($/MT) | $7,926 | SANDAG, 2015 |
| Avoided criteria pollutants – ROG ($/MT) | $6,911 | SANDAG, 2015 |
| Avoided criteria pollutants – $SO_2$ ($/MT) | $41,151 | SANDAG, 2015 |
| **Other Inputs and Assumptions** | | |
| Development year of online submittal system | *2020* | Provided through discussion with City staff |
| Start year of permit submittals online | *2021* | Provided through discussion with City staff; CAP Appendix B |
| VMT reductions | *32,400* | CAP Appendix B |
| Percent of VMT reductions – gasoline-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |

| | | |
|---|---|---|
| Percent of VMT reductions – diesel-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Percent of VMT reductions – EV-related | *Varies by year* | CAP Appendix B; CARB EMFAC2014 Database |
| Fuel efficiency – gasoline (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – diesel (mpg) | *Varies by year* | CARB EMFAC2014 Database |
| Fuel efficiency – EV (mi/kWh) | *0.32* | U.S. DOE, 2017 |
| Fuel price increase – gasoline (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – diesel (annual %) | *1.1%* | U.S. EIA, 2019 |
| Fuel price increase – electricity (annual %) | *1.06%* | CEC, 2019 |
| Avoided criteria pollutants – PM2.5 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – PM10 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – NOx (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – ROG (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| Avoided criteria pollutants – SO2 (g/mi) | *Varies by year* | CARB EMFAC2014 Database |
| GHGs reduced (MT $CO_2$e/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure BE-1: Increase Residential Building Efficiency

This section includes discussion on the following City actions:

- BE-1.1: Require Energy Audits of Existing Residential Additions
- BE-1.2: Continue the Critical Home Repair Program and Home Rehabilitation Loans

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Reduced energy use;
- Reduced local air pollution near grid electricity generation sources;
- Increased public health;
- Enhanced community character;
- Increased local green jobs; and
- Improved resiliency to climate change impacts.

### City Action BE-1.1: Require Energy Audits of Existing Residential Additions

City Action BE-1.1 requires the City to adopt an ordinance mandating a whole home energy audit for residential additions over 500 square feet. GHG reduction calculations in the CAP estimate that 25 residential units will be required to complete an audit each year beginning in 2021, with five of those units electing to integrate energy efficiency upgrades into their overall project. This is expected to reduce an estimated 29 MT $CO_2e$ in 2030.

Participants included in this action are homeowners who undertake a qualifying residential addition. These homeowners incur the cost associated with conducting a whole home energy audit, and it is estimated that a percentage of those audits will lead the homeowner to include some identified energy efficiency retrofits and/or upgrades in their project. This analysis relies on the types of retrofit activities identified in the CAP for GHG reductions, which include: fixing HVAC leakage, retrofitting lighting, and adjusting the AC unit's refrigerant charge. There are currently no rebates or incentives available for these types of energy efficiency projects. In addition to the costs, the homeowner receives a benefit; this activity leads to reduced energy consumption (electricity and natural gas), resulting in reduced utility bills.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action BE-1.1 are provided in Table B27.

**Table B27. Cost-Effectiveness for City Action BE-1.1 Perspectives in 2030**

| BE-1.1: Require Energy Audits of Existing Residential Additions | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 29 | | | | |
| $/MT $CO_2e$ | 3% | $276 | - | $276 | $313 |
| | 5% | $164 | - | $164 | $192 |
| | 7% | $90 | - | $90 | $112 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action BE-1.1 are documented in Table B28. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B28. Data Inputs and Assumptions for City Action BE-1.1**

| BE-1.1: Require Energy Audits of Existing Residential Additions | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Energy audit ($/home) | *($650)* | Review of existing vendor and contractor prices |
| Retrofit package cost ($/home) | *($1,241)* | Review of existing vendor and contractor prices |
| **Direct Benefits** | | |
| Electricity savings ($/kWh) | *$0.25* | SDG&E, 2019a |
| Natural gas savings ($/therm) | *$1.36* | SDG&E, 2019b |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Energy audits conducted annually | *25* | CAP Appendix B |
| Retrofits conducted annually | *5* | CAP Appendix B |
| Electricity saved (kWh/yr/home) | *1,278* | CAP Appendix B; CPUC, n.d. |
| Natural gas saved (therms/yr/home) | *88* | CAP Appendix B; CPUC, n.d. |
| Electricity rate increase (annual %) | *1.06%* | CEC, 2019 |
| Natural gas rate increase (annual %) | *1.42%* | CEC, 2019 |
| GHGs reduced ($MT\ CO_2e/yr$) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *20* | DNV KEMA, 2014 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## City Action BE-1.2: Continue the Critical Home Repair Program and Home Rehabilitation Loans

City Action BE-1.2 is a continuation of current efforts in the City to assist qualifying low-income homeowners in obtaining financing for home repairs and retrofits. GHG reduction calculations included in the CAP account for activity beginning in 2018 through 2030. This analysis excludes activity that is assumed to have already occurred and only considers those retrofits anticipated in 2019 through 2030. This action assumes six retrofits occur each year with an energy efficiency component, reducing an estimated 40 MT $CO_2e$ in 2030.[37]

Participants in this City action included homeowners who qualify for funding under the Critical Home Repair Program (CHRP) or for a Home Rehabilitation Loan (HRL) and incorporate energy efficiency upgrades and/or retrofits into their project. This analysis relies on the types of retrofit activities identified in the CAP for GHG reductions, which include: fixing HVAC leakage, retrofitting lighting, and adjusting the AC unit's refrigerant charge. Using historic activity levels, it is assumed that 50% of the projects are under the CHRP and 50% under an HRL. These homeowners receive funding pursuant to the terms of each program to cover the costs of the identified energy efficiency items in their retrofit project. Because of this activity, they reduce their monthly energy consumption (electricity and natural gas), resulting in reduced utility bills. It should be noted that energy reductions will generally be part of a much larger retrofit project. Homeowners will likely receive funding to cover the entirety of the project; this analysis only considers the portion relating to energy efficiency.

Non-participant costs include the associated with CHRP and HRL funding provided to qualifying homeowners. They do not capture the overhead costs associated with operating the CHRP and HRL programs. In addition, this analysis only captures those costs directly related to energy efficiency activity captured in the CAP; a homeowner may receive a larger amount of funding for other, non-energy related retrofit items.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action BE-1.2 are provided in Table B29.

**Table B29. Cost-Effectiveness for City Action BE-1.2 Perspectives in 2030**

| BE-1.2: Continue the Critical Home Repair Program and Home Rehabilitation Loans | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced ($MT\ CO_2e$) | 40 | | | | |
| $/MT $CO_2e$ | 3% | $343 | ($26) | $317 | $355 |
| | 5% | $264 | ($34) | $230 | $260 |
| | 7% | $207 | ($38) | $169 | $193 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

[37] The CAP estimates 43 MT $CO_2e$ to be reduced in 2030 (3 MT $CO_2e$ from retrofits in 2018 and 40 MT $CO_2e$ from retrofits between 2019 and 2030)

General data inputs for City Action BE-1.2 are documented in Table B30. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B30. Data Inputs and Assumptions for City Action BE-1.2**

| BE-1.2: Continue the Critical Home Repair Program and Home Rehabilitation Loans | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Retrofit package cost ($/home) | *($1,241)* | Review of existing vendor and contractor prices |
| Percent of retrofit covered by HRLP or CHRP funding | *100%* | City of El Cajon, 2018 |
| **Direct Benefits** | | |
| Electricity savings ($/kWh) | *$0.15* | SDG&E, 2019c |
| Natural gas savings ($/therm) | *$1.09* | SDG&E, 2019b,d |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2019* | CAP Appendix B |
| Retrofits conducted annually | *6* | CAP Appendix B |
| Percent of retrofits with HRL funding | *50%* | Based on historic activity levels |
| Percent of retrofits with CHRP funding | *50%* | Based on historic activity levels |
| CHRP loan term (years) | *10* | - |
| Electricity saved (kWh/yr/home) | *1,278* | CAP Appendix B; CPUC, n.d. |
| Natural gas saved (therms/yr/home) | *88* | CAP Appendix B; CPUC, n.d. |
| Electricity rate increase (annual %) | *1.06%* | CEC, 2019 |
| Natural gas rate increase (annual %) | *1.42%* | CEC, 2019 |
| GHGs reduced (MT $CO_2e$/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *20* | DNV KEMA, 2014 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure BE-2: Increase Commercial Building Efficiency

This section includes discussion on the following City action:

- BE-2.1: Require Energy Audits of Non-Residential Additions and Improvements

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Reduced energy use;
- Reduced local air pollution near grid electricity generation sources;
- Increased public health;
- Enhanced community character;
- Increased local green jobs; and
- Improved resiliency to climate change impacts.

### City Action BE-2.1: Require Energy Audits of Non-Residential Additions and Improvements

City Action BE-2.1 requires the City to adopt an ordinance mandating a whole building energy audit for non-residential additions and tenant improvements valued at over $80,000 or over 1,000 square feet. GHG reduction calculations in the CAP estimate that 50 non-residential projects will be required to complete an audit each year beginning in 2021, with 18 of those projects electing to integrate energy efficiency upgrades into their overall project. This is expected to reduce an estimated 253 MT $CO_2$e in 2030.

Participants for this City action include non-residential building owners and tenants who undertake an addition or building improvement project that qualifies under the proposed energy audit mandate. These participants incur the cost associated with conducting a whole building energy audit, and it is estimated that a percentage of those audits will lead to the inclusion of some identified energy efficiency retrofits and/or upgrades in their project. This analysis assumes that buildings will be retrocommissioned to address any operational inefficiencies or areas for improvement. There is an additional cost associated with retrocommissioning; however, the building owner and/or tenant will receive benefits through reduced utility bills (electricity and natural gas).

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action BE-2.1 are provided in Table B31.

**Table B31. Cost-Effectiveness for City Action BE-2.1 Perspectives in 2030**

| BE-2.1: Require Energy Audits of Non-Residential Additions and Improvements | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 253 | | | | |
| $/MT $CO_2e$ | 3% | $335 | $131 | $466 | $506 |
| | 5% | $264 | $107 | $371 | $404 |
| | 7% | $210 | $88 | $298 | $326 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action BE-2.1 are documented in Table B32. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B32. Data Inputs and Assumptions for City Action BE-2.1**

| BE-2.1: Require Energy Audits of Non-Residential Additions and Improvements | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Energy audit ($/sqft) | *($0.36)* | U.S. DOE, 2011 |
| Retrocommissioning ($/sqft) | *($0.60)* | Mills, 2009; U.S. EPA, 2016 |
| **Direct Benefits** | | |
| Electricity savings ($/kWh) | *$0.14* | SDG&E, 2019f |
| Natural gas savings ($/therm) | *$0.74* | SDG&E, 2019g |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Energy audits conducted annually | *40* | CAP Appendix B |
| Retrofits conducted annually | *18* | CAP Appendix B |
| Commercial project square feet (sqft/project) | *1,800* | CAP Appendix B |
| Electricity saved (kWh/yr/sqft) | *4.18* | CAP Appendix B |
| Natural gas saved (therms/yr/home) | *0.10* | CAP Appendix B |
| Electricity rate increase (annual %) | *1.06%* | CEC, 2019 |
| Natural gas rate increase (annual %) | *1.42%* | CEC, 2019 |
| GHGs reduced ($MT\ CO_2e/yr$) | *Varies by year* | Cap Appendix B |
| Useful life (yrs) | *10* | Roberts and Tso, 2010 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## Measure BE-3: Increase Municipal Operation Energy Efficiency

This section includes discussion on the following City action:

- BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Reduced energy use;
- Reduced local air pollution near grid electricity generation sources;
- Increased public health;
- Enhanced community character;
- Increased local green jobs; and
- Improved resiliency to climate change impacts.

### City Action BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities

City Action BE-3.1 is a continuation of current efforts in the City to retrofit municipal facilities with more energy efficient technologies. The City's 2013 Energy Roadmap identifies several opportunities to increase energy efficiency in municipal buildings including lighting retrofits and replacing pump systems. Activity in the Energy Roadmap that has been deemed feasible to implement is expected to reduce an estimated 17 MT $CO_2e$ in 2030.

The City of El Cajon is the sole participant in this action. It is assumed that the City will complete retrofits at City-owned facilities identified in the 2013 Energy Roadmap audits. These retrofits include replacing existing indoor and outdoor lighting with more energy efficient LED lighting technologies and replacing pump systems. Buildings to receive lighting retrofits include: Fire Stations 6, 8, and 9; the Kennedy, Bostonia, Hillside, and Renette Recreation Centers; and the East County Performing Arts Center (ECPAC). In addition, the ECPAC will have a pump system upgraded. Discussion with City staff determined that 80% of lighting retrofits are feasible and Energy Roadmap activity was scaled accordingly. Costs to the City include the upfront cost of each retrofit activity less rebates and incentives. The analysis assumes the City leverages currently available incentives through SDG&E for lighting projects. As a result of these energy efficiency projects, the City can expect reduced electricity and natural gas consumption, leading to reduced utility expenses.

Non-participant costs include the cost of rebates and incentives provided through SDG&E for basic lighting retrofits. It does not, however, include any overhead costs associated with managing SDG&E energy efficiency programs.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action BE-3.1 are provided in Table B33.

**Table B33. Cost-Effectiveness for City Action BE-3.1 Perspectives in 2030**

| BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 17 | | | | |
| $/MT $CO_2e$ | 3% | $264 | ($12) | $252 | $294 |
| | 5% | $203 | ($11) | $192 | $229 |
| | 7% | $154 | ($11) | $143 | $176 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action BE-3.1 are documented in Table B34. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B34. Data Inputs and Assumptions for City Action BE-3.1**

| BE-3.1: Continue Energy Efficiency Projects in Municipal Facilities | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |
| Fire Station 6 lighting retrofits ($/project) | *($8,766)* | City of El Cajon, 2013; Review of online prices |
| Fire Station 8 lighting retrofits ($/project) | *($4,252)* | City of El Cajon, 2013; Review of online prices |
| Fire Station 9 lighting retrofits ($/project) | *($8,622)* | City of El Cajon, 2013; Review of online prices |
| Kennedy Recreation Center lighting retrofits ($/project) | *($13,931)* | City of El Cajon, 2013; Review of online prices |
| Hillside Recreation Center lighting retrofits ($/project) | *($5,241)* | City of El Cajon, 2013; Review of online prices |
| Bostonia Recreation Center lighting retrofits ($/project) | *($5,241)* | City of El Cajon, 2013; Review of online prices |
| Renette Recreation Center lighting retrofits ($/project) | *($17,307)* | City of El Cajon, 2013; Review of online prices |
| East County Performing Arts Center lighting and pump retrofits ($/project) | *($20,435)* | City of El Cajon, 2013; Review of online prices |
| SDG&E lighting rebate ($/kWh) | *0.03* | SDG&E, 2018 |
| **Direct Benefits** | | |
| Electricity savings ($/kWh) | *$0.14* | SDG&E, 2019f |
| Reduced lighting replacement cost ($/projects) | *$511* | Review of online bulb costs |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| East County Performing Arts Center retrofit | *2019* | CAP Appendix B |
| All other retrofits | *2021* | CAP Appendix B |

| | | |
|---|---|---|
| Fire Station 6 electricity saved (kWh/yr) | *16,228* | CAP Appendix B; City of El Cajon, 2013 |
| Fire Station 8 electricity saved (kWh/yr) | *4,360* | CAP Appendix B; City of El Cajon, 2013 |
| Fire Station 9 electricity saved (kWh/yr) | *8,893* | CAP Appendix B; City of El Cajon, 2013 |
| Kennedy Recreation Center electricity saved (kWh/yr) | *18,963* | CAP Appendix B; City of El Cajon, 2013 |
| Hillside Recreation Center electricity saved (kWh/yr) | *9,834* | CAP Appendix B; City of El Cajon, 2013 |
| Bostonia Recreation Center electricity saved (kWh/yr) | *9,834* | CAP Appendix B; City of El Cajon, 2013 |
| Renette Recreation Center electricity saved (kWh/yr) | *11,038* | CAP Appendix B; City of El Cajon, 2013 |
| East County Performing Arts Center electricity saved (kWh/yr) | *37,454* | CAP Appendix B; City of El Cajon, 2013 |
| GHGs reduced (MT $CO_2e$/yr) | *Varies by year* | Cap Appendix B |
| Useful life (yrs) | *12* | City of El Cajon, 2013 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## Measure RE-1: Increase Behind-the-Meter Renewable Energy Supply

This section includes discussion on the following City action:

- RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Increased property values;
- Reduced local air pollution near grid electricity generation sources;
- Reduced energy price volatility;
- Increased energy diversity and security; and
- Increased local green jobs.

### City Action RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings

City Action RE-1.1 incentives the installation of solar photovoltaic (PV) systems on commercial buildings beginning in 2021. Installations estimated in the CAP are expected to increase City-wide PV capacity by 7.6MW and reduce an estimated 2,299 MT $CO_2$e in 2030.

Participants include commercial property owners or developers who install an operator-owned PV system or who enter into a power purchase agreement (PPA). Participants with operator-owned systems incur costs related to the purchase, installation, and maintenance of the PV system. Additional costs include lost tax deductions associated with reduced utility bills. However, system-owners can receive cost reductions through tax credits and deductions including the federal Solar Investment Tax Credit (ITC), modified accelerated cost recovery system (MACRS) tax deductions, and bonus tax deductions. For PPA systems, this analysis only considers the costs and benefits to the commercial entity and does not include costs and benefits to the third-party PV installer. Under a PPA, costs associated with the PV system are covered by a third-party and the commercial entity can purchase the electricity, generally at a reduced rate form the utility. An average useful life of 25 years was used in this analysis to capture the benefits and costs over the entire useful life of the PV system (30 years) or PPA term (20 years).

Non-participant costs include the cost to federal taxpayers, as tax burdens are reduced through tax credits. However, some of this burden is offset through reduced utility tax deductions associated with reduced utility bills.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action RE-1.1 are provided in Table B35.

**Table B35. Cost-Effectiveness for City Action RE-1.1 Perspectives in 2030**

| RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 2,299 | | | | |
| $/MT $CO_2$e | 3% | $151 | $1 | $152 | $188 |
| | 5% | $70 | ($17) | $54 | $78 |
| | 7% | $20 | ($26) | ($6) | $12 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action RE-1.1 are documented in Table B36. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B36. Data Inputs and Assumptions for City Action RE-1.1**

| RE-1.1: Incentivize Photovoltaic Installation on Commercial Buildings | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |
| Purchase and installation ($/kW) | *($3488)* | Barbose et al., 2018 |
| Operations and maintenance ($/kW/yr) | *($12)* | Barbose et al., 2018 |
| Inverter replacement ($/kW) | *($103)* | NREL, 2017 |
| Lost utility deductions | *Varies by year* | U.S. Treasury, 2017a; CEC 2019; SDG&E 2019f |
| Federal solar ITC (2021 only) | *22%* | SEIA, 2016 |
| Federal solar ITC (2022 and after) | *10%* | SEIA, 2016 |
| MACRS Tac deduction | *See Table B7* | SEIA, 2017; U.S. Treasury, 2017a; U.S. Treasury, 2017b |
| **Direct Benefits** | | |
| Electricity savings – System owner ($/kWh) | *0.14* | SDG&E, 2019f |
| Electricity savings – PPA ($/kWh) | *Varies by year* | SDG&E, 2019f; Navigant, 2014; Davidson et al., 2015; Review of third party websites |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| PV Systems installed (systems/yr) | *18* | CAP Appendix B |
| Percent of systems owned | *89%* | CADGStats, 2017 |
| Percent of systems in PPA | *11%* | CADGStats, 2017 |
| PV system size (kW-DC/system) | *42* | CAP Appendix B; CADGStats, 2017 |

| | | |
|---|---|---|
| Electricity generated (MWh/system/yr) | *74* | CAP Appendix B; CADGStats, 2017 |
| Inverter replacement frequency (yrs) | *10* | NREL et al., 2016 |
| Effective commercial tax rate | *22%* | U.S. Treasury, 2016 |
| Electricity rate increase (annual %) | *1.05%* | CEC, 2019 |
| GHGs reduced (MT $CO_2e$/system/yr) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *25* | NREL, 2018; Navigant, 2014 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

**Table B37. MACRS Schedule**

| MACRS Schedule | |
|---|---|
| **Year** | **Depreciation** |
| *1* | 20.00% |
| *2* | 32.00% |
| *3* | 19.20% |
| *4* | 11.52% |
| *5* | 11.52% |
| *6* | 5.76% |

Energy Policy Initiatives Center, USD

## Measure WE-1: Increase Outdoor Water Efficiency

This section includes discussion on the following City actions:

- WE-1.1 Require Covers on New Pools
- WE-1.2 Require Weather-Based Irrigation Systems

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Reduced water use;
- Reduced energy use;
- Improved water quality;
- Enhanced community character
- Increased local green jobs; and
- Improved resiliency to climate change impacts.

### City Action WE-1.1 Require Covers on New Pools

City Action WE-1.1 requires the City to amend the municipal code to require pool covers on new residential swimming pools. This analysis assumes the ordinance goes into effect in January 2021 and continues through the 2030 CAP target year, reducing an estimated 2.4 MT $CO_2e$ in 2030.

Participants include homeowners who install a new pool or individuals who purchase a newly constructed home with a pool.[38] Costs include the purchase of a pool cover and pool cover reel. While many pool industry experts recommend the use of a reel system, it has been reported that reels are rarely purchased when buying a pool cover (MWD, 2003). This analysis conservatively estimates that half (50%) of those buying a pool cover for the first time also purchase a reel. Additionally, it is assumed that homeowners purchase a new pool cover at the end of its useful life (seven years). BCA calculations include the purchase of replacement pool covers up to and including 2030. Benefits are received as reduced water bills; installing a pool cover reduces the need to refill pools because of evaporation. Annual water bill savings are estimated by multiplying the water demand reduction by the applicable water rate. Single-family residential water utility customers can pay one of three rates (tier 1, tier 2, or tier 3) according to their monthly demand. It is unclear what the average monthly water demand is for a residential unit, thus this analysis conservatively applies the lowest (tier 1) rate.[39] Literature also suggests that pool covers reduce the energy demand associated with pool heating; however, this analysis did not include any associated energy reductions to align with assumptions made in CAP GHG reduction calculations.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action WE-1.1 are provided in Table B38.

[38] It is assumed that pool covers are accessory products purchased by the homeowner and not the developer in the case of new single-family residential construction with a pool.
[39] Use of a higher tier rate would increase the benefits received and, consequently, the measure's cost-effectiveness.

**Table B38. Cost-Effectiveness for City Action WE-1.1 Perspectives in 2030**

| WE-1.1: Require Covers on New Pools | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced ($MT\ CO_2e$) | 2 | | | | |
| $/MT $CO_2e$ | 3% | $657 | - | $657 | $697 |
| | 5% | $426 | - | $426 | $459 |
| | 7% | $257 | - | $257 | $284 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action WE-1.1 are documented in Table B39. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B39. Data Inputs and Assumptions for City Action WE-1.1**

| WE-1.1: Require Covers on New Pools | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Pool cover cost ($/pool) | *($162)* | Review of online retailers |
| Pool cover reel cost ($/pool) | *($217)* | Review of online retailers |
| **Direct Benefits** | | |
| Water bill savings ($/HCF) | *$4.82* | Helix Water District, 2018 |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Number of new pools installed (pools/yr) | *19* | CAP Appendix B |
| Water savings (gal/pool/yr) | *7,863* | CAP Appendix B; MWD, 2003 |
| Percent of pool owners who purchase a reel | *50%* | - |
| GHGs reduced ($MT\ CO_2e$/pool/yr) | *0.013* | CAP Appendix B |
| Useful life (yrs) | *7* | MWD, 2003 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## City Action WE-1.2 Require Weather-Based Irrigation Systems

City Action WE-1.2 is a continuation of current requirements for all non-residential projects submitting landscape plans to the City to install weather-based irrigation controllers (WBICs). While GHG reductions in the CAP includes that from activity in 2018, this analysis only includes those projects beginning in 2019 through 2030 and their associated GHG reductions in 2030 (159 MT $CO_2e$).[40]

Participants include non-residential property owners who develop new landscape plans (over 500 square feet) and landscape rehabilitation plans (over 2,500 square feet).[41] Upfront costs include the purchase (retail price plus sales tax) and installation of WBICs to attach to a landscape irrigation system. Participants are able to receive an upfront cost reduction through the SoCal WaterSmart rebate program for each WBIC purchased. Ongoing costs include monthly service fees to connect to a weather monitoring program that last the entirety of the WBIC's useful life (15 years). Many devices include a free subscription for a set amount of time; this analysis assumes service fees are waived for the first year. Benefits are received as reduced water bills; WBICs reduce annual water demand for landscape irrigation. Helix Water District's commercial water rate is used to calculate bill reductions.

Non-participant costs include the cost to fund the WBIC rebate program through SoCal WaterSmart program. It does not, however, include overhead costs associated with operating the WaterSmart program.

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

An extended set of cost-effectiveness results for City Action WE-1.2 are provided in Table B40.

**Table B40. Cost-Effectiveness for City Action WE-1.2 Perspectives in 2030**

| WE-1.2: Require Weather-Based Irrigation Systems | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced (MT $CO_2e$) | 159 | | | | |
| $/MT $CO_2e$ | 3% | $2,429 | ($6) | $2,423 | $2,462 |
| | 5% | $1,955 | ($5) | $1,950 | $1,981 |
| | 7% | $1,597 | ($5) | $1,592 | $1,617 |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action WE-1.2 are documented in Table B41. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B41. Data Inputs and Assumptions for City Action WE-1.2**

| WE-1.2: Require Weather-Based Irrigation Systems |
|---|

[40] The CAP estimates GHG reductions to be 179 MT $CO_2e$ in 2030 (13 MT $CO_2e$ from projects implemented in 2018 and 159 MT $CO_2e$ from projects implemented between 2019 and 2030)

[41] It is assumed that pool covers are accessory products purchased by the homeowner and not the developer in the case of new single-family residential construction with a pool.

| Description | Input[1] | Source |
|---|---|---|
| **Direct Costs** | | |
| WBIC cost ($/WBIC) | *($260)* | Review of online retailers |
| WBIC installation ($/WBIC) | *($150)* | Review of online retailers |
| WaterSmart rebate ($/WBIC) | *$35* | SoCal WaterSmart, 2019 |
| Service fee ($/WBIC/yr) | *($420)* | Review of subscription costs |
| **Direct Benefits** | | |
| Water bill savings ($/HCF) | *$5.53* | Helix Water District, 2018 |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2019* | CAP Appendix B |
| Number of landscape projects (projects/yr) | *10* | CAP Appendix B |
| Number of WBICs installed (WBICs/project) | *4* | Helix Water District rebate program data |
| Water savings (AFY/project) | *2.6* | CAP Appendix B |
| GHGs reduced (MT $CO_2$e/project/yr) | *1.3* | CAP Appendix B |
| Useful life (yrs) | *15* | U.S. EPA 2011 |

[1]All dollar values are in 2019$ Energy Policy Initiatives Center, USD

## Measure SW-1: Reduce Solid Waste and Increase Recycling

This section includes discussion on the following City action:

- SW-1.1: Implement Solid Waste Reduction and Recycling Targets

For the City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon. Other externalities associated with this City action, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Improved public health;
- Enhanced community character;
- Increased local green jobs; and
- Improved resiliency to climate change impacts.

### City Action SW-1.1: Implement Solid Waste Reduction and Recycling Targets

City Action SW-1.1 is continuation of current efforts throughout the City to increase solid waste diversion and recycling and attain a 75% diversion rate by 2020. This analysis looks at efforts to divert solid waste between 2020 and target year 2030, with an estimated 32,245 tons of solid waste diverted in 2030 and 7,832 MT $CO_2e$ reduced.

Specific recycling and diversion activities to achieve the CAP goals have not yet been identified. As such, the benefits and costs analyzed here cannot be attributed to an individual participant group. They may be experienced by the City, the waste hauler, or passed through to waste customers in the form of rate increases. The cost per ton for waste diversion used in this analysis was estimated using currently available program data for waste diversion activities funded by State Cap-and-Trade dollars. Programs included in estimating costs include the following types of activity: organics recycling and food recovery; food waste prevention and rescue; paper, plastic, and glass recycling; organics and fiber recycling. Recycling facilities may also achieve benefits as revenue from the sale of processed material, but those benefits are not included here.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action SW-1.1 are provided in Table B42.

**Table B42. Cost-Effectiveness for City Action SW-1.1 Perspectives in 2030**

| SW-1.1: Implement Solid Waste Reduction and Recycling targets | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 7,832 | | | | |
| $\$/MT\ CO_2e$ | 3% | ($310) | - | ($310) | ($268) |
| | 5% | ($280) | - | ($280) | ($242) |
| | 7% | ($255) | - | ($255) | ($221) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action SW-1.1 are documented in Table B43. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B43. Data Inputs and Assumptions for City Action SW-1.1**

| SW-1.1: Implement Solid Waste Reduction and Recycling targets | | |
|---|---|---|
| Description | Input[1] | Source |
| **Direct Costs** | | |
| Waste diversion program cost ($/ton) | *($74)* | CARB, 2019 |
| **Direct Benefits** | | |
| NA | - | - |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2019* | CAP Appendix B |
| Solid waste diverted (short ton/yr) | *Varies by year* | CAP Appendix B |
| GHGs reduced ($MT\ CO_2e/ton/yr$) | *Varies by year* | CAP Appendix B |
| Useful life (yrs) | *NA* | *Reductions are accounted for same year as activity |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## Measure CS-1: Increase Urban Tree Planting

This section includes discussion on the following City actions:

- CS-1.1: Increase Shaded Landscape Area
- CS-1.2: Increase Tree Shade in Surface Parking Lots
- CS-1.3: Increase Street Trees

For each City action included under this measure, the externalities incorporated into calculations include the EPA's social cost of carbon, the value of avoided criteria pollutants, and reduced water treatment costs associated with rain interception. Other externalities associated with these City actions, including those identified in the CAP document, but not incorporated into the quantitative analysis include:

- Improved air quality;
- Increased natural habitat;
- Improved public health;
- Improved water quality;
- Reduced urban heat island effects;
- Enhanced community character;
- Increased local green jobs;
- Improved resiliency to climate change impacts;
- Enhanced aesthetic value;
- Reduced energy use in tree-adjacent buildings; and
- Increased property values.

### City Action CS-1.1: Increase Shaded Landscape Area

City Action CS-1.1 is a continuation of current requirements for new development projects to plant one tree per 600 square feet of qualified landscape area. While carbon sequestration included in the CAP includes that from trees planted in 2018, this analysis only includes those planted starting in 2019 through 2030 and their associated carbon sequestration in 2030 (42 MT $CO_2e$).[42]

Participants include two types of development projects – multi-family residential and non-residential. Initial costs include the purchase and planting of landscape trees. It is assumed that individual trees are purchased in 15 gallon containers. Additional costs include the cost of watering during the first three years (establishment period) and ongoing pruning and maintenance (every seven years). Watering costs differ by development type; multi-family projects pay the multi-family water rate and non-residential projects pay the commercial rate offered through Helix Water District. There are no direct monetary benefits received by participants.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

[42] The CAP estimates carbon sequestered to be 46 MT $CO_2e$ in 2030 (4 MT $CO_2e$ from trees planted in 2018 and 42 MT $CO_2e$ from trees planted between 2019 and 2030)

An extended set of cost-effectiveness results for City Action CS-1.1 are provided in Table B44.

**Table B44. Cost-Effectiveness for City Action CS-1.1 Perspectives in 2030**

| CS-1.1: Increase Shaded Landscape Area | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced ($MT\ CO_2e$) | 42 | | | | |
| $\$/MT\ CO_2e$ | 3% | (\$734) | - | (\$734) | (\$458) |
| | 5% | (\$498) | - | (\$498) | (\$340) |
| | 7% | (\$353) | - | (\$353) | (\$256) |

All dollar values are in 2019\$ Energy Policy Initiatives Center, USD

General data inputs for City Action CS-1.1 are documented in Table B45. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B45. Data Inputs and Assumptions for City Action CS-1.1**

| CS-1.1: Increase Shaded Landscape Area | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Purchase and planting (\$/tree) | *(\$55)* | Review of local nursery prices |
| Tree maintenance (\$/tree) | *(\$284)* | Review of local contractor estimates |
| Water bill increase – multi-family projects (\$/HCF) | *(\$5.47)* | Helix Water District, 2018 |
| Water bill increase – non-residential projects (\$/HCF) | *(\$5.53)* | Helix Water District, 2018 |
| **Direct Benefits** | | |
| NA | - | - |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $O_3$ (\$/lb) | *\$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $NO_2$ (\$/lb) | *\$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ (\$/lb) | *\$1.53* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ (\$/lb) | *\$0.91* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC (\$/lb) | *\$1.77* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC (\$/lb) | *\$1.77* | McPherson et al., 2000 |
| Rain interception benefits (\$/gal) | *\$0.01* | McPherson et al., 2000 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2019* | CAP Appendix B |
| Trees planted annually | *200* | CAP Appendix B |

| | | |
|---|---|---|
| Percent of trees from multi-family projects | *36%* | Based on historic project data provided by City |
| Percent of trees from non-residential projects | *64%* | Based on historic project data provided by City |
| Water demand (gal/tree/yr) | *570* | City of Santa Monica, 2015 |
| Years of watering (establishment, yrs) | *3* | City of San Diego, 2015 |
| Frequency of maintenance (e.g., pruning, yrs) | *5* | Consistent with City best practices |
| Avoided criteria pollutants – $O_3$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $NO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Rain intercepted (gal/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| GHGs sequestered (MT $CO_2$e/tree/yr) | *0.0354* | CAP Appendix B |
| Useful life (yrs) | *40* | McPherson et al. 2006 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## City Action CS-1.2: Increase Tree Shade in Surface Parking Lots

City Action CS-1.2 requires the City to update the landscape ordinance to require a minimum of one tree per five parking spaces in new surface parking lots. This analysis assumes the ordinance goes into effect in January 2021 and continues through the 2030 CAP target year, sequestering an estimated 14 MT $CO_2$e in 2030 with 400 trees planted.

Participants include non-residential development projects. Initial costs include the purchase and planting of landscape trees. It is assumed that individual trees are purchased in 15 gallon containers. Additional costs include the cost of watering during the first three years (establishment period) and ongoing pruning and maintenance (every seven years). Watering costs are estimated using Helix Water District's commercial rate. There are no direct monetary benefits received by participants.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action CS-1.2 are provided in Table B46.

**Table B46. Cost-Effectiveness for City Action CS-1.2 Perspectives in 2030**

| CS-1.2: Increase Tree Shade in Surface Parking Lots | | | | | |
|---|---|---|---|---|---|
| | Discount Rate | Participant | Non-Participant | Measure | Society |
| GHGs Reduced ($MT\ CO_2e$) | 14 | | | | |
| $\$/MT\ CO_2e$ | 3% | ($841) | - | ($841) | ($410) |
| | 5% | ($612) | - | ($612) | ($370) |
| | 7% | ($456) | - | ($456) | ($309) |

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for City Action CS-1.2 are documented in Table B47. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B47. Data Inputs and Assumptions for City Action CS-1.2**

| CS-1.2: Increase Tree Shade in Surface Parking Lots | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Purchase and planting ($/tree) | *($55)* | Review of local nursery prices |
| Tree maintenance ($/tree) | *($284)* | Review of local contractor estimates |
| Water bill increase – non-residential projects ($/HCF) | *($5.53)* | Helix Water District, 2018 |
| **Direct Benefits** | | |
| NA | - | - |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $O_3$ ($/lb) | *$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $NO_2$ ($/lb) | *$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ ($/lb) | *$1.53* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ ($/lb) | *$0.91* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC ($/lb) | *$1.77* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC ($/lb) | *$1.77* | McPherson et al., 2000 |
| Rain interception benefits ($/gal) | *$0.01* | McPherson et al., 2000 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Trees planted annually | *40* | CAP Appendix B |
| Water demand (gal/tree/yr) | *570* | City of Santa Monica, 2015 |
| Years of watering (establishment, yrs) | *3* | City of San Diego, 2015 |
| Frequency of maintenance (e.g., pruning, yrs) | *5* | Consistent with City best practices |
| Avoided criteria pollutants – $O_3$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |

| | | |
|---|---|---|
| Avoided criteria pollutants – $NO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Rain intercepted (gal/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| GHGs sequestered (MT $CO_2$e/tree/yr) | *0.0354* | CAP Appendix B |
| Useful life (yrs) | *24* | Roman and Scatena, 2011 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

## City Action CS-1.3: Increase Street Trees

City Action CS-1.3 requires the City to update the landscape ordinance to require a minimum of one tree per 30 linear feet of street frontage at new residential and non-residential developments. This analysis assumes the ordinance goes into effect in January 2021 and continues through the 2030 CAP target year, sequestering an estimated 39 MT $CO_2$e in 2030, with 1,100 trees planted.

Participants include three types of development projects – single-family residential, multi-family residential, and non-residential. Initial costs include the purchase and planting of landscape trees. It is assumed that individual trees are purchased in 15 gallon containers. Additional costs include the cost of watering during the first three years (establishment period) and ongoing pruning and maintenance (every seven years). Watering costs differ by development type. Single-family residential water utility customers can pay one of three rates (tier 1, tier 2, or tier 3) according to their monthly demand. It is unclear what the average monthly water demand is for residential units, thus this analysis applies the lowest (tier 1) rate consistent with other measure calculations.[43] Multi-family projects pay the multi-family water rate and non-residential projects pay the commercial rate offered through Helix Water District. There are no direct monetary benefits received by participants.

No non-participant costs were identified for this action and costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting).

Costs to the City to administer and implement this City action (administrator perspective) are not included (e.g., CAP monitoring and reporting). Additionally, no non-participant costs were identified.

An extended set of cost-effectiveness results for City Action CS-1.3 are provided in Table B48.

**Table B48. Cost-Effectiveness for City Action CS-1.3 Perspectives in 2030**

| **CS-1.3: Increase Street Trees** | | | | | |
|---|---|---|---|---|---|
| | **Discount Rate** | **Participant** | **Non-Participant** | **Measure** | **Society** |
| GHGs Reduced (MT $CO_2$e) | 39 | | | | |
| $/MT $CO_2$e | 3% | ($841) | - | ($841) | ($409) |
| | 5% | ($612) | - | ($612) | ($370) |
| | 7% | ($455) | - | ($455) | ($309) |

[43] Use of a higher tier rate would increase the costs incurred and, consequently, decrease the action's cost-effectiveness.

All dollar values are in 2019$ Energy Policy Initiatives Center, USD

General data inputs for measure CS-1.1 are documented in Table B49. Assumptions and emissions reduction calculations for action activity were aligned with methodologies identified in CAP Appendix B (emissions reduction technical document).

**Table B49. Data Inputs and Assumptions for City Action CS-1.3**

| CS-1.3: Increase Street Trees | | |
|---|---|---|
| **Description** | **Input[1]** | **Source** |
| **Direct Costs** | | |
| Purchase and planting ($/tree) | *($55)* | Review of local nursery prices |
| Tree maintenance ($/tree) | *($284)* | Review of local contractor estimates |
| Water bill increase – single-family projects ($/HCF) | *($4.82)* | Helix Water District, 2018 |
| Water bill increase – multi-family projects ($/HCF) | *($5.47)* | Helix Water District, 2018 |
| Water bill increase – non-residential projects ($/HCF) | *($5.53)* | Helix Water District, 2018 |
| **Direct Benefits** | | |
| NA | - | - |
| **Externalities Included** | | |
| Social cost of carbon | *Varies by year* | U.S. EPA, 2016 |
| Avoided criteria pollutants – $O_3$ ($/lb) | *$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $NO_2$ ($/lb) | *$1.24* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ ($/lb) | *$1.53* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ ($/lb) | *$0.91* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC ($/lb) | *$1.77* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC ($/lb) | *$1.77* | McPherson et al., 2000 |
| Rain interception benefits ($/gal) | *$0.01* | McPherson et al., 2000 |
| **Other Inputs and Assumptions** | | |
| Start year of activity | *2021* | CAP Appendix B |
| Trees planted annually | *200* | CAP Appendix B |
| Percent of trees from single-family projects | *46%* | Based on historic project data provided by City |
| Percent of trees from multi-family projects | *13%* | Based on historic project data provided by City |
| Percent of trees from non-residential projects | *41%* | Based on historic project data provided by City |
| Water demand (gal/tree/yr) | *570* | City of Santa Monica, 2015 |
| Years of watering (establishment, yrs) | *3* | City of San Diego, 2015 |
| Frequency of maintenance (e.g., pruning, yrs) | *5* | Consistent with City best practices |
| Avoided criteria pollutants – $O_3$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $NO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $SO_2$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – $PM_{10}$ (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – VOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| Avoided criteria pollutants – BVOC (lb/tree/yr) | *Varies by age* | McPherson et al., 2000 |

| | | |
|---|---|---|
| Rain intercepted (gal/tree/yr) | *Varies by age* | McPherson et al., 2000 |
| GHGs sequestered (MT $CO_2$e/tree/yr) | *0.0354* | CAP Appendix B |
| Useful life (yrs) | *24* | Roman and Scatena, 2011 |

[1]All dollar values are in 2018$ Energy Policy Initiatives Center, USD

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