Appendix C: GHG Reduction Technical Report

San Diego Regional
Priority Climate Action Plan (PCAP)

GHG Reduction Technical Report

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Prepared for

San Diego Association of Governments

SANDAG

Prepared by

Energy Policy Initiatives Center

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The Energy Policy Initiatives Center is a research center of the USD School of Law that studies energy policy issues affecting California and the San Diego region. Energy Policy Initiatives Center'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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1 INTRODUCTION

This report summarized the methods, models/tools, activity level assumptions, and data sources used to estimate GHG reductions for measures, programs, and projects included in the San Diego-Chula Vista-Carlsbad Metropolitan Statistical Area (San Diego Region) Priority Climate Action Plan (PCAP). For each program or projects, the following information is Included.[1]

- GHG Reduction Estimate Method
- Models/Tools Used
- Measure Implementation Assumptions
- GHG Reduction Estimate Assumptions
- Reference Case Scenario
- Measure Specific Activity Data

Section 2 summarizes common assumptions and methods that affect more than one PCAP measure or program. Sections 3 through 6 summarize the methods used to estimate GHG emission reductions. Not all programs included in the PCAP have quantified GHG reduction estimates. This document only includes those with estimated GHG reductions.

1.1 Summary of Results

Table 1 summarizes the estimated cumulative GHG reductions for 2025-203 and 2025-2050 for PCAP measures.

Table 1 Cumulative GHG Reductions by PCAP Measure

PCAP Measures	2025-2030 Cumulative GHG Reduction	2025-2050 Cumlative GHG Reduction
T-1 Increase Adoption of Zero Emission Vehicles	307,000	841,000
T-2 Increase Zero Emission Vehicle Charging Infrastructure	12,000	30,000
T-3 Expand Active Transportation Opportutnities	34,000	182,000
T-4 Increase Use of Public Transit	82,300	251,300
T-5 Improve Transportation System Efficiency	2,000	10,000
B-2 Electrify Buildings	44,000	171,000
CE-1 Increase Solar and Energy Storage	67,000	215,000
W. 1 Improve Water and Wastewater System Efficiency	15,000	77,000
Total	**563,300**	**1,777,300**

Table 2 summarizes the GHG reductions for PCAP measures and associated programs and projects.

[1] Based on guidance in the Phase II Notice of Funding Opportunity (NOFO) EPA-R-OAR-CPRGI-23-07.

Table 2 GHG Reduction Estimates for PCAP Measures, Programs, and Projects

PCAP Measure/Action*	2025-2030 Cumulative GHG Reduction (MT CO2e)	2025-2050 Cumulative GHG Reduction (MT CO2e)
T-1 Increase Adoption of Zero Emission Vehicles	**307,000**	**841,000**
T.1.1 Zero Emission Light-Duty Vehicle Incentive Program	238,000	615,000
T-1.2 Zero Emission Medium and Heavy-Duty Vehicle Incentive Program	29,000	76,000
T-1.4 Zero Emission Vehicles in Municipal Fleets	29,000	75,000
T-1.5 Zero Emission Rail	11,000	75,000
T-2 Increase Zero Emission Vehicle Charging Infrastructure	**12,000**	**30,000**
T-2.1 Public Light-Duty Zero-Emission Vehicle Charging Infrastructure Program	8,000	20,000
T-2.2 Zero-Emission Medium and Heavy-Duty Vehicle Charging Infrastructure Program	4,000	10,000
T-3 Expand Active Transportation Opportutnities	**34,000**	**182,000**
T-3.1 Active Transportation Program	34,000	182,000
T-4 Increase Use of Public Transit	**82,300**	**251,300**
T-4.1 Transit Incentive Programs	11,000	11,000
T-4.2 Bus Rapid Transit Projects	71,000	240,000
T-4.3 Flexible Fleets Program	300	300
T-5 Improve Transportation System Efficiency	**2,000**	**10,000**
T-5.1 Freight Signal Prioritization Project	2,000	10,000
B-2 Electrify Buildings	**44,000**	**171,000**
B-2.1 Municipal Building Electrification Program	13,000	49,000
B-2.2 Residential Building Electrification Program	31,000	122,000
CE-1 Increase Solar and Energy Storage	**67,000**	**215,000**
CE-1.2 Solar and Storage on Residential Buildings	67,000	215,000
W. 1 Improve Water and Wastewater System Efficiency	**15,000**	**77,000**
W-1.1 Wastewater and Energy Recovery Project	15,000	77,000
Total	**563,300**	**1,777,300**

*This table includes only measures, programs, and projects with estimated GHG reductions.

2 COMMON ASSUMPTIONS

This section provides a summary of methods used for more than one PCAP measure, including electric emissions rates, vehicle emission rates, and consideration of useful life. Further discussion of specific methods used to estimate GHG impacts is provided in the sections below.

2.1 Electric Emission Rates

For measures related to electricity, a key input in the analysis is the GHG emission rate of electric supply. For most of the electricity-related programs and projects s in the PCAP, we calculated GHG impacts annual average emission rates (AAER), which represent the total emissions divided by the total associated electricity. Table 3 shows the amount of electricity sales in 2021 and the annual GHG emissions intensity for retail electricity suppliers in the San Diego region.[2] The average weighted by retail sales is 472 lbs. CO_2e/MWh.

Table 3 GHG Emission Intensity for Retail Electricity Suppliers in the San Diego Region

Retail Suppliers	2021 Retail Sales (MWh)	2021 Annual Greenhouse Gas Emissions Intensity (lbs CO2e/MWh)
Clean Energy Alliance - Clean Impact Plus	419,723	238
Clean Energy Alliance - Clean Impact	5,723	472
Clean Energy Alliance - Green Impact	3,376	0
San Diego Community Power - PowerOn	1,918,834	378
San Diego Community Power - Power100	129,043	0
San Diego Gas & Electric Company	11,298,590	504
San Diego Gas & Electric Company - EcoChoice	43,107	0

This value is associated with a certain percentage of renewable supply. We assume that the ratio of GHG emissions intensity and percentage renewable remains constant as suppliers reach the statutory goal of 60% renewable electric supply by 2030 and 100% zero carbon by 2045. Table 4 shows data for the year 2021 (year of the most recent Power Source Disclosure data)[3], 2030 (interim year of renewable electricity content requirements), and 2045 (final year of requirements). For the analysis conducted for the PCAP, we interpolated between these values to get annual average emissions intensity rates.

Table 4 Forecast of Renewable/Zero Carbon Content and Annual Average Emission Rates

[2] Note that energy service providers that sell to customer under direct access are not listed here. Data is not available on the specific companies supplying customers or the amount supplied to customers in the San Diego region.
[3] California Energy Commission (CEC): Annual Power Content Labels for 2021. https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label/annual-power-1

Year	Renewable/ Zero Carbon Content	Annual Average Emissions Intensity (lbs CO2e/MWh)
2021	45%	472
2030	60%	340
2045	100%	-

2.1.1 Hourly Short-Run Marginal Emission Rates

There is one program related to solar and energy storage for which AAER were not sufficient to estimate GHG impacts. For this, we used hourly short-run marginal emission rates (SRMER) generated from the CPUC Avoided Cost Calculator[4] through 2050. Hourly SRMER assume only limited changes to the grid due to policy and other changes like additional electricity demand from electric vehicles and heat pumps for heating water and space heating and cooling. As a result, they are accurate in the short-term but can overestimate the level of emissions from the grid over time.

2.2 Vehicle Emission Rates

California Air Resources Board (CARB) EMFAC Model was used to derive vehicle miles driven per year, fuel/electricity use per vehicle, and emissions per vehicle mile (grams CO_2e/mile) of relevant vehicle classes to estimate GHG impacts for several PCAP programs and projects.[5] EMFAC is developed and used by CARB to assess emissions from on-road vehicles including cars, trucks, and buses in California, and to support CARB's regulatory and air quality planning efforts. US EPA approves EMFAC for use in State Implementation Plan and transportation conformity analyses. Table 5 provides an example of the emissions rates by vehicle class from the EMFAC model. Rates shown represent an average of all vehicle types across all vehicle model years within each vehicle class.

Table 5 Emission Rates by Vehicle Class in the San Diego Region (grams CO_2e/mile)[6]

Year	LDA	LDT	MDV	HDV	UBUS	SBUS
2030	266	329	397	1,353	884	1,045
2035	250	306	371	1,305	866	1,001
2040	243	293	357	1,274	842	971
2045	239	285	350	1,254	842	946
2050	239	282	347	1,239	842	924

[4] 2021 CPUC Avoided Cost Calculator. Available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm.

[5] California Air Resources Board, EMFAC Model. The most recent version is EMFAC2021 v1.0.2. Available at https://ww2.arb.ca.gov/our-work/programs/msei/on-road-emfac

[6] LDA is passenger cars, LDT is light-duty trucks, MDV is medium-duty vehicles, HDV is heavy-duty vehicles, UBUS is urban buses, and SBUS is school bus. The emission rates are specific to San Diego Region's vehicle mix based EMFAC2021 v1.0.2.

2.3 Useful Life and Replacement

GHG reduction estimates assume implementation activity occurs between 2025 and 2029. Reductions are assumed to occur during the useful life of the activity and no replacement is considered. For example, if the useful life of an electric vehicle is 10 years, reductions would be estimated for the 10 years a vehicle is assumed to be operational. In this case, the first vehicle would be put into operation in 2025 (and remain operational through 2034) and the last vehicle, put in operation in 2029, would still be operational in 2038. In this way, this measure would have GHG reductions from 2025 through 2038, a total of 13 years. Further, we do not assume that the vehicle would be replaced and continue to reduce emissions beyond this point. So, in this example, no emissions reductions for 2039-2050 would be included in the estimates presented here.

There are measures with longer useful lives, including bike lanes and solar that would continue to reduce emissions through the 2050 timeframe. For example, a rooftop solar system installed in 2025, would continue to be operational through 2049. And those installed in 2026 and beyond would continue to operate and reduce emissions through the 2050 timeframe. Emissions for these projects would be included in the cumulative GHG reduction estimate for 2025-2050.

3 TRANSPORTATION

The transportation section of the PCAP includes five measures.

- T.1. Increase Adoption of Zero-Emission Vehicles
- T.2. Increase Zero-Emission Vehicle Charging Infrastructure
- T.3 Expand Active Transportation Opportunities
- T.4. Increase Use of Public Transit
- T.5 Improve Transportation System Efficiency

3.1 T-1 Increase Adoption of Zero-Emission Vehicles

Measure T-1 comprises four programs and projects:

- T.1.1 Zero Emission Light-Duty Vehicle Incentive Program
- T-1.2 Zero Emission Medium and Heavy-Duty Vehicle Incentive Program
- T-1.4 Zero Emission Vehicles in Municipal Fleets
- T-1.5 Zero Emission Rail

The following sections summarize the methods used to estimate GHG reductions for these programs or projects.

3.1.1 Zero-Emission Light-Duty Vehicle Incentive Program

GHG reductions from the Zero-Emission Light-Duty Vehicle Incentive Program are estimated using the net impact of a reduction in fossil fuel usage and an increase in electricity use to charge electric vehicles. Emissions impacts are calculated using electricity emissions rates and carbon content of fossil fuels. Table 6 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 6 Methodology Summary for Light-Duty Zero Emission Vehicles

Models/Tools Used	We used one model to generate inputs for a custom calculation using standard methods for GHG quantification.[7] The California Air Resources Board EMFAC2021 v1.0.2 Model was used to derive emissions per vehicle (grams CO_2e/mile) of relevant vehicle classes.[8]
Measure Implementation Assumptions	The estimates presented here assume that vehicle purchases would occur equally over a five-year implementation period from 2025 to 2029.
GHG Reduction Estimate Assumptions	Key assumptions include: electric vehicles have a 10-year useful life;[9] and to estimate emissions from electricity use, a weighted average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[10] which includes calculated values for years with reported data and an

[7] GHG quantification is based on methods summarized in the Regional Climate Action Planning Framework. Technical Appendices. See San Diego Association of Governments. Regional Climate Action Planning Framework -- TECHNICAL APPENDIX II Methods to Calculate GHG Emissions Impacts of CAP Measures, VERSION 1.1. NOVEMBER 2020. Available at https://www.sandag.org/-/media/SANDAG/Documents/ZIP/projects-and-programs/recap-and-technical-appendices.zip

[8] California Air Resources Board, EMFAC2021 v1.0.2 Model. Available at https://ww2.arb.ca.gov/our-work/programs/msei/on-road-emfac

[9] Smith, K., Earleywine, M., Wood, E., Neubauer, J., & Pesaran, A. (2012). Comparison of Plug-In Hybrid Electric Vehicle Battery Life Across Geographies and Drive Cycles. National Renewable Energy Laboratory.

[10] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.

	interpolation between statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045.
Reference Case Scenario	The reference case is a typical light-duty passenger vehicle using fossil fuels. Emissions for a reference vehicle are derived using the CARB EMFAC model.
Measure Specific Activity Data	Assumed levels of vehicle purchases were derived from project data for San Diego County from the California Clean Vehicle Rebate Program.[11] During program years 2021-2023 an average of 5,000 incentives were provided each year. We assume this same level of participation would occur between 2025 and 2029.
2025-2030 Cumulative GHG Emissions Reduced	238,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	615,000 MT CO_2e

3.1.2 Zero Emission Medium- and Heavy-Duty Vehicle Incentive Program

GHG reductions from the Zero Emission Medium and Heavy-Duty Vehicle Incentive Program are estimated using the net impact of a reduction in fossil fuel usage and an increase in electricity use to charge electric vehicles. Emissions impacts are calculated using electricity emissions rate and carbon content of fossil fuels. Table 7 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 7 Methodology Summary for Medium- and Heavy-Duty Zero Emission Vehicles

Models/Tools Used	Same as LDV above.
Measure Implementation Assumptions	Same as LDV above.
GHG Reduction Estimate Assumptions	Same as LDV above.
Reference Case Scenario	Same as LDV above.
Measure Specific Activity Data	Assumed levels of vehicle purchases were derived from project data for San Diego County from the California Hybrid and Zero-emission Truck and Bus Voucher Incentive Project (HVIP).[12] During program years 2021-2023 an average of 100 incentives were provided. We assume 100 incentives per year would occur between 2025 and 2029.
2025-2030 Cumulative GHG Emissions Reduced	29,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	75,000 MT CO_2e

3.1.3 Zero Emission Vehicles in Municipal Fleets

GHG reductions from the Zero Emission Vehicles in Municipal Fleets Program are estimated using the net impact of a reduction in fossil fuel usage and an increase in electricity use to charge electric vehicles.

[11] California Clean Vehicle Rebate Program website. Available at https://cleanvehiclerebate.org/en
[12] California Hybrid and Zero-emission Truck and Bus Voucher Incentive Project (HVIP). Available at https://californiahvip.org/

Emissions impacts are calculated using electricity emissions rate and carbon content of fossil fuels. Table 8 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 8 Methodology Summary for Zero Emission Vehicles in Municipal Fleets

Models/Tools Used	Same as LDV above.
Measure Implementation Assumptions	Same as LDV above.
GHG Reduction Estimate Assumptions	Same as LDV above.
Reference Case Scenario	Same as LDV above.
Measure Specific Activity Data	Assumed levels of vehicle purchases were derived from project data provided by local jurisdictions and other public agencies in the San Diego region. The total number of vehicles provided is 2,062 LDV and 50 MDV. We assume a total of 2,500 vehicle purchases between 2025 and 2029 and assumed these would match the vehicle types and numbers reported.
2025-2030 Cumulative GHG Emissions Reduced	29,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	75,000 MT CO_2e

3.1.4 Zero-Emission Rail

GHG emissions reduction from electrifying North County Transit District's (NCTD) light rail SPRINTER line is estimated based on (1) the ultra-low-sulfur diesel (ULSD) avoided by switching to zero-emission multiple units (ZEMU), and (2) the ULSD emission factor. Table 9 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 9 Methodology Summary for Zero Emission Rail

Models/Tools Used	Data from the Argonne National Laboratory Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) 2022 was used to derive emission factors for ULSD.[13] These served as inputs to a custom calculation using the general method described above and NCTD's actual fuel use data.
Measure Implementation Assumptions	It is assumed that one ZEMU would be operational in 2027 and another ZEMU would be in 2028 (two total).
GHG Reduction Estimate Assumptions	Key assumptions include: ULSD savings were the diesel fuel used per year per vehicle replaced by a zero emissions vehicle; the fuel savings value (in gallons per year) was then multiplied by the following factors to get a value for GHG savings (in MT of CO_2e/year): 78,966 g/MMBtu and 0.129 MMBtu/gallon ULSD both from the GREET1 2022 Model;[14] 156,214 gallons of ULSD saved per year per ZEMU based on analysis of NCTD actual fuel use data; and GHG

[13] https://www.energy.gov/eere/greet
[14] Argonne National Laboratory. The Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model. Available at https://greet.anl.gov/

	reductions will occur from 2027 (when the first ZEMU enters into operation) through 2050.
Reference Case Scenario	The reference scenario is the business-as-usual diesel use from traditional vehicles; no ZEMU in operation.
Measure Specific Activity Data	300,000 gallons of ULSD avoided per year from 2 ZEMUs. NCTD determined that this is the level of activity for this project that is feasible during the 2025-2029 implementation period.
2025-2030 Cumulative GHG Emissions Reduced	11,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	75,000 MT CO_2e

3.2 T-2 Increase Zero Emission Vehicle Charging and Fueling Infrastructure

Measure T-2 comprises two programs:

- T-2.1 Public Light-Duty Zero-Emission Vehicle Charging Infrastructure Program
- T-2.2 Zero-Emission Medium and Heavy-Duty Vehicle Charging Infrastructure Program

The following sections summarize the methods used to estimate GHG reductions for these programs.

3.2.1 Public Light-Duty Zero-Emission Vehicle Charging Infrastructure Program

The overall approach to estimate GHG reduction associated with the installation of public light-duty electric vehicle chargers is to determine the VMT shift from gasoline to electricity per plug-in hybrid vehicle (PHEV) because of increased EV charging stations. Calculations followed the standard methods from the 2019 Final Sustainable Communities Strategy (SCS) Program and Evaluation Guidelines[15] and the Handbook for Analyzing GHG Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity.[16] Table 10 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 10 Methodology Summary for Public Light-Duty Zero-Emission Vehicle Chargers

Models/Tools Used	Several models were used to generate outputs for a customer calculating using standard calculation methods. California Air Resources Board EMFAC2021 v1.0.2 Model was used to derive the projected precent of PHEV miles in electric mode, VMTs per year, and the fuel and electricity consumption per PHEV.[17] NREL/CEC EVI Pro lite was used to evaluate the number of chargers and chargers per vehicle in the San Diego region.[18]

[15] California Air Resources Board (CARB). (2019, November). Final Sustainable Communities Strategy Program and Evaluation Guidelines Appendices. Retrieved from https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources.
[16] California Air Pollution Control Officers Association. (n.d.). Handbook for Analyzing GHG Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. Retrieved from https://www.caleemod.com/documents/handbook/ch_1/handbook_front.pdf.
[17] California Air Resources Board, EMFAC2021 v1.0.2 Model. Available at https://ww2.arb.ca.gov/our-work/programs/msei/on-road-emfac
[18] National Renewable Energy Laboratory and California Energy Commission. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite. Available at https://afdc.energy.gov/evi-pro-lite

Measure Implementation Assumptions	The estimates presented here assume that the installation of EV charging stations would occur equally over a five-year implementation period from 2025 to 2029.
GHG Reduction Estimate Assumptions	Key assumptions include: 80% of PHEV miles in electric mode with the measure[19]; annual GHG reductions are based on the equivalent of 2 vehicles per year per charger;[20] analysis is based on emissions from light-duty PHEVs; 10-year useful life of an electric vehicle;[21] and emissions from electricity were estimated using a weighted average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[22] which includes calculated values for years with reported data and an interpolation between statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045.
Reference Case Scenario	The reference case scenario is the projected emission of PHEVs before the measure of increased EV chargers (about 50% eVMT). Emissions for the reference vehicle were derived using data from the CARB EMFAC 2021 v1.0.2 model.
Measure Specific Activity Data	We assumed installation of 1,000 chargers during the implementation period 2025 to 2029.
2025-2030 Cumulative GHG Emissions Reduced	8,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	20,000 MT CO_2e

3.2.2 Medium and Heavy-Duty Electric Vehicle Charging Infrastructure Program

The overall approach to estimate GHG reduction associated with the installation of medium- and heavy-duty electric vehicle chargers is to determine the VMT shift from gasoline to electricity per plug-in hybrid vehicle (PHEV) because of increased EV charging stations. Calculations followed the standard methods from the 2019 Final Sustainable Communities Strategy (SCS) Program and Evaluation Guidelines[23] and the Handbook for Analyzing GHG Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity.[24] Table 11 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 11 Methodology Summary for Medium- and Heavy-Duty Electric Vehicle Chargers

Models/Tools Used	Same as LDV above.

[19] Smith, K., Earleywine, M., Wood, E., Neubauer, J., & Pesaran, A. (2012). Comparison of Plug-In Hybrid Electric Vehicle Battery Life Across Geographies and Drive Cycles. National Renewable Energy Laboratory.
[20] National Renewable Energy Laboratory and California Energy Commission. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite. Available at https://afdc.energy.gov/evi-pro-lite
[21] Smith, K., Earleywine, M., Wood, E., Neubauer, J., & Pesaran, A. (2012). Comparison of Plug-In Hybrid Electric Vehicle Battery Life Across Geographies and Drive Cycles. National Renewable Energy Laboratory.
[22] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.
[23] California Air Resources Board (CARB). (2019, November). Final Sustainable Communities Strategy Program and Evaluation Guidelines Appendices. Retrieved from https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources.
[24] California Air Pollution Control Officers Association. (n.d.). Handbook for Analyzing GHG Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. Retrieved from https://www.caleemod.com/documents/handbook/ch_1/handbook_front.pdf.

Measure Implementation Assumptions	Same as LDV above.
GHG Reduction Estimate Assumptions	Key assumptions include: 80% of PHEV miles in electric mode with the measure;[25] annual GHG reductions are based on the equivalent of 2 vehicles per year per charger;[26] analysis is based on emissions from medium-duty PHEVs, other medium- and heady-duty vehicles can be considered in future analysis; 10-year useful life of an electric vehicle;[27] and emissions from electricity were estimated using a weighted average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[28] which includes calculated values for years with reported data and an interpolation between statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045.
Reference Case Scenario	Same as LDV above.
Measure Specific Activity Data	We assumed installation of 500 chargers during the implementation period 2025 to 2029.
2025-2030 Cumulative GHG Emissions Reduced	4,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	8,000 MT CO_2e

3.3 T-3 Expand Active Transportation Opportunities

Measure T-3 comprises one program: T-3.1 Active Transportation Program. The following sections summarize the methods used to estimate GHG reductions for this program.

3.3.1 Active Transportation Program

GHG emissions reductions from active transportation program are estimated based on annual VMT reduction from changes in transportation mode share due to additional bike lanes and annual average vehicle emission rate. Table 12 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 12 Methodology Summary for Active Transportation Program

Models/Tools Used	Several models were used to generate inputs for a custom calculation using method described above, including CARB California Climate Investments Benefits Calculator Tools and Quantification Methodology, Active Transportation (December 15, 2022)[29] and SANDAG Transportation Forecast

[25] Smith, K., Earleywine, M., Wood, E., Neubauer, J., & Pesaran, A. (2012). Comparison of Plug-In Hybrid Electric Vehicle Battery Life Across Geographies and Drive Cycles. National Renewable Energy Laboratory.
[26] National Renewable Energy Laboratory and California Energy Commission. Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite. Available at https://afdc.energy.gov/evi-pro-lite
[27] Smith, K., Earleywine, M., Wood, E., Neubauer, J., & Pesaran, A. (2012). Comparison of Plug-In Hybrid Electric Vehicle Battery Life Across Geographies and Drive Cycles. National Renewable Energy Laboratory.
[28] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.
[29] CARB California Climate Investments Benefits Calculator Tools and Quantification Methodology, Active Transportation. Available at https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/sgc_ahsc_userguide_121522.pdf

	Information (ABM2+/2021 RP, Year 2025)[30] to determine VMT impact; and CARB EMFAC2021 v1.0.2[31] to determine vehicle emissions rates.
Measure Implementation Assumptions	Local jurisdictions and other public agencies have identified the new bicycle facilities that are ready for implementation in the 2025 to 2029 implementation period and are assumed to be constructed and operational by 2027.
GHG Reduction Estimate Assumptions	Key assumptions include: Annual VMT reduction: (1) new facility type (i.e., Class I bike path, Class II bike lane, and Class IV separated bikeway); (2) location of the facility (North San Diego County Coastal, San Diego South Bay, San Diego Urban Core); (3) first year facility will be open to user; (4) mileage of facility; (5) average daily traffic on road parallel to facility; (6) number of key destinations within 0.25 mile of facility; and (7) number of key destination within 0.5 mile of facility). Annual average vehicle emission rate is estimated based on (1) VMT distribution of light-duty vehicle by vehicle category and (2) emission rate of each light-duty vehicle category. GHG reductions will occur from 2027 (when the bicycle facilities are constructed and operational) through 2050 based on useful life. As the vehicle fleet gets cleaner (due to higher vehicle fuel efficiency and high penetration of ZEVs), the GHG reduction from miles avoided decreases.
Reference Case Scenario	No new bicycle facilities; trips are made by an average light-duty vehicle.
Measure Specific Activity Data	As noted above, local jurisdictions and public agencies have identified 77 miles of new bicycle facilities throughout the San Diego region.
2025-2030 Cumulative GHG Emissions Reduced	34,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	182,000 MT CO_2e

3.4 T-4 Increase Use of Public Transit

Measure T-4 comprises three programs:

- T-4.1 Transit Incentive Programs
- T-4.2 Bus Rapid Transit Projects
- T-4.3 Flexible Fleets Program

The following sections summarize the methods used to estimate GHG reductions for these programs.

3.4.1 Transit Incentive Programs

Transit incentives includes two programs to promote use of public transit: Youth Opportunity Pass (YOP)[32] and Try Transit.[33]

[30] CARB EMFAC Model. Available https://experience.arcgis.com/experience/81b2daca1827470ca8beeb4708139f79/page/Main/
[31] https://arb.ca.gov/emfac/emissions-inventory/dd07a6ca4ed10aa7ada49fc3daf62ef502a3afc7
[32] SANDAG Youth Opportunity Pass Program. Available at https://www.sandag.org/projects-and-programs/regional-initiatives/transit-equity-pilot/youth-opportunity-pass
[33] SANDAG Try Transit. Available at https://www.sandag.org/projects-and-programs/regional-initiatives/sustainable-transportation-services/transit-services

3.4.1.1 Youth Opportunity Pass

GHG emissions reduction from extending the YOP pilot program is estimated based on annual VMT reduction from transit trips replacing passenger vehicle trips and the annual average vehicle emission rate. Table 13 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 13 Methodology Summary for Youth Opportunity Pass

Models/Tools Used	Two models were used to generate inputs for the custom calculation using the general method described above: SANDAG Activity Based Model (ABM2+) to determine the VMT impact of the transit use and CARB EMFAC2021 v1.0.2[34] for vehicle emission rates.
Measure Implementation Assumptions	This existing program is assumed to be extended and funded from 2025 through 2029 at the same level of funding (adjusted with an inflation escalator) as in previous years.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2025 (when program is extended) through 2029; no GHG reduction after 2029 (i.e., no program impact after 2029); as the vehicle fleet gets cleaner (due to higher vehicle fuel efficiency and higher penetration of ZEVs), the GHG reductions from miles avoided will decrease; annual VMT reduction is estimated based on current FY2023 pilot program annual VMT reduction with an adjustment factor of 1/3 to account for new trips that would not have been made with a vehicle without the program;[35] FY2023 annual VMT reduction is based on (1) the difference between FY2023 and FY2019 boardings (with and without the program) and (2) estimated average trip distance for K-12 school trip purposes; annual average vehicle emission rate is estimated based on (1) VMT distribution of light-duty vehicle by vehicle category and (2) emission rate of each light-duty vehicle category.
Reference Case Scenario	No YOP program; trips are made by an average light duty vehicle.
Measure Specific Activity Data	Participation and VMT impact assumptions are based on actual program data: 2 million additional annual trips including Metropolitan Transit System (MTS) and NCTD buses and light rail trips, and 7 million vehicle miles avoided
2025-2030 Cumulative GHG Emissions Reduced	11,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	11,000 MT CO_2e

3.4.1.2 Try Transit

GHG emissions reductions from restarting Try Transit pilot program are estimated based on annual VMT reduction due to change in transportation mode share and annual average vehicle emission rate. Table 14 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

[34] https://arb.ca.gov/emfac/emissions-inventory/dd07a6ca4ed10aa7ada49fc3daf62ef502a3afc7

[35] The adjustment factor from SANDAG's Youth Opportunity Pass Pilot Program is used as a proxy. SANDAG: Youth Opportunity Pass Pilot Program: Comprehensive Program Report (December 2023). https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/regional-initiatives/transit-equity-pilot/youth-opportunity-pass/yop-comprehensive-program-report.pdf

Table 14 Methodology Summary for Try Transit

Models/Tools Used	One model was used to generate inputs for the custom calculation using method described above: CARB EMFAC2021 v1.0.2[36] for vehicle emission rates.
Measure Implementation Assumptions	This existing pilot program is assumed to be restarted and funded from 2025 through 2029 at the same level of funding as the previous program.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2025 (when program restarts) through 2030; 36% of program impacts will carryover for one year based on program evaluation data;[37] no GHG reductions occur after 2030 (i.e., no program impact after one year); as the vehicle fleet gets cleaner (due to higher vehicle fuel efficiency and high penetration of ZEVs), GHG reductions from miles avoided will decrease; annual VMT reduction is estimated based on (1) current pilot program (FY 2022 Q3 – FY 2023 Q4) annual VMT reduction,[38] (2) an adjustment factor of 1/3 to account for new trips that would not have been made with a vehicle without the program (similar to the YOP program)[39], and (3) a one year carryover factor to account for pilot participants continuing using transit after the pilot;[40] annual average vehicle emission rate is estimated based on (1) VMT distribution of light-duty vehicle by vehicle category and (2) emission rate of each light-duty vehicle category.
Reference Case Scenario	No Try Transit pilot program; trips are made by an average light duty vehicle.
Measure Specific Activity Data	Participation and VMT impact assumptions are based on actual program data: 338 participants per year on average, 222 Pronto Card (transit card) activated per year, and 90,000 vehicle miles avoided (not including adjustment factor).[41]
2025-2030 Cumulative GHG Emissions Reduced	120 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	120 MT CO_2e

3.4.2 Bus Rapid Transit Projects

GHG emissions reductions from implementing three new bus rapid transit (BRT) routes are estimated based on (1) emissions reduction from passenger vehicle miles avoided due to changes in mode share, and (2)

[36] California Air Resources Board, EMFAC Model. Available https://experience.arcgis.com/experience/81b2daca1827470ca8beeb4708139f79/page/Main/
[37] SANDAG. Try Transit Program: Summary Report Quarter 3 Fiscal Year 2022 – Quarter 4 Fiscal Year 2023.
[38] SANDAG: Try Transit Program: Summary Report, Quarter 3 Fiscal Year 2022 - Quarter 4 Fiscal Year 2023.
[39] The adjustment factor from SANDAG's Youth Opportunity Pass Pilot Program is used as a proxy. SANDAG: Youth Opportunity Pass Pilot Program: Comprehensive Program Report (December 2023). https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/regional-initiatives/transit-equity-pilot/youth-opportunity-pass/yop-comprehensive-program-report.pdf
[40] SANDAG: Try Transit Program: Summary Report, Quarter 3 Fiscal Year 2022 - Quarter 4 Fiscal Year 2023.
[41] *Ibid*.

emissions added due to new transit buses. Table 15 summarizes key aspects of the methodology used to estimate the GHG reductions from these projects.

Table 15 Methodology Summary for Bus Rapid Transit Projects

Models/Tools Used	Three models were used to generate inputs for a custom calculation using the general method described above: CARB Benefits Calculator Tool for the Transit and Intercity Rail Capital Program (October 18, 2019)[42] to estimate GHG impacts; SANDAG Activity Based Model (ABM2+) to estimate VMT impacts;[43] and CARB EMFAC2021 v1.0.2 for vehicle emission rates.[44]
Measure Implementation Assumptions	The new BRT routes analyzed here have already been identified by SANDAG and are assumed to be operational by 2027.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2027 (when BRT services are operational) and continue through 2041, based on the useful life of a transit bus; as the vehicle fleet gets cleaner (i.e., due to higher vehicle fuel efficiency and higher penetration of ZEVs), the GHG reduction from miles avoided will decrease; annual VMT avoided from passenger vehicle miles and added due to new transit buses is estimated based on (1) year 1 (2027) and year final (2041) annual ridership of the three routes and (2) length of average trip of the three routes; annual average passenger vehicle emission rates are estimated based on (1) VMT distribution of light-duty vehicle by vehicle category and (2) emission rate of each light-duty vehicle category; and annual transit bus emission rates are based on a model year 2027 transit bus during the useful life of the bus (15 years or 2027-2041).
Reference Case Scenario	No new BRT routes; trips are made by an average light duty vehicle.
Measure Specific Activity Data	SANDAG provided the following activity data based on output from their ABM: 7.9 million annual ridership (three routes), 9.2 million per year final annual ridership (three routes), and 2.7 million service miles (three routes).
2025-2030 Cumulative GHG Emissions Reduced	71,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	240,000 MT CO_2e

3.4.3 Flexible Fleets Program

GHG emissions reduction from extending four existing pilot flexible fleet routes or adding new similar routes similar is estimated based on annual passenger VMT reduction and annual average vehicle emission rate. Table 16 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 16 Methodology Summary for Flexible Fleets Program

Models/Tools Used	Two models were used to generate inputs for this custom calculation using the general method described above: CARB California Climate Investments

[42] https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/calsta_tircp_finalqm_cycle4.pdf
[43] https://www.sandag.org/data-and-research/transportation-modeling
[44] https://arb.ca.gov/emfac/emissions-inventory/dd07a6ca4ed10aa7ada49fc3daf62ef502a3afc7

	Benefits Calculator Tools and Quantification Methodology, Shared Mobility – Innovative Transit (December 15, 2022)[45] to estimate GHG impacts and CARB EMFAC2021 v1.0.2 for vehicle emission rates.[46]
Measure Implementation Assumptions	The existing pilot programs will be extended or a new similar programs will be funded from 2025 through 2029, at the same level of funding as the previous program.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2025 (i.e., when program is extended) through 2029; no GHG reduction after 2029 (i.e., no program impact after 2029); annual passenger VMT reductions are estimated based on (1) current pilot programs' average monthly trips, ridership, and VMT; annual average vehicle emission rates are estimated based on (1) VMT distribution of light-duty vehicle by vehicle category and (2) emission rate of each light-duty vehicle category; and, as vehicles fleet gets cleaner (i.e., due to higher vehicle fuel efficiency and high penetration of ZEVs), the GHG reduction from miles avoided will decrease.
Reference Case Scenario	No on-demand shared mobility services; trips are made by the average light duty vehicle.
Measure Specific Activity Data	Ridership and VMT impact data is based on existing program data provided by SANDAG and other similar programs operational in the San Diego region: 11,000 average monthly ridership (four routes), 210,000 passenger miles avoided (four routes).
2025-2030 Cumulative GHG Emissions Reduced	300 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	300 MT CO_2e

3.5 T-5 Improve Transportation System Efficiency

Measure T-5 comprises one program: T-5.1 Freight Signal Prioritization Project. The following sections summarize the methods used to estimate GHG reductions for this program.

3.5.1 Freight Signal Prioritization Project

GHG emissions reduction from implementing the Harbor Drive Freight Signal Prioritization (FSP) is estimated based on (1) annual moving and idling emissions from heavy-duty trucks serving the Port of San Diego's marine cargo terminals,[47] and (2) average moving and idling emissions reduction from the FSP field testing.[48] Table 17 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

[45] https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/sgc_ahsc_userguide_121522.pdf
[46] https://arb.ca.gov/emfac/emissions-inventory/dd07a6ca4ed10aa7ada49fc3daf62ef502a3afc7
[47] Port of San Diego Maritime Clean Air Strategy (October 2021) https://pantheonstorage.blob.core.windows.net/environment/20211214-Final-MCAS.pdf
[48] https://www.ite.org/ITEORG/assets/File/Awards/2022/TSMO_MORE_STC%20Traffic_stripped.pdf

Table 17 Methodology Summary Freight Signal Prioritization Project

Models/Tools Used	One model is used to generate inputs for a custom calculation using the general method described above: CARB EMFAC2021 v1.0.2 for vehicle emission rates.[49] In addition, results from field tests are used to estimate emissions impacts.
Measure Implementation Assumptions	The projects are assumed to be operational by 2027.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2027 through 2045, assuming all trucks will be zero emission trucks on and after 2045 due to California's Advanced Clean Trucks requirement; the SANDAG Advancing Border (US – Mexico border) Connectivity Project is under design, so the emissions reduction from the Harbor Drive FSP is used as a conservative proxy.
Reference Case Scenario	No FSP projects; heavy-duty truck trips are made without signal prioritization.
Measure Specific Activity Data	Assumed activity levels for this measure is based on the following data on the Harbor Drive FSP provided by SANDAG: average travel time decreased by 9.5%; average stops decreased by 21.7%; and average speed increased by 13.9%
2025-2030 Cumulative GHG Emissions Reduced	2,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	10,000 MT CO_2e

[49] https://arb.ca.gov/emfac/emissions-inventory/dd07a6ca4ed10aa7ada49fc3daf62ef502a3afc7

4 BUILDING ENERGY USE

The building energy section of the PCAP includes one measure: B.2 Electrify Buildings.

4.1 B-2 Electrify Buildings

Measure B-2 comprises two programs:

- B-2.1 Municipal Building Electrification Program
- B-2.2 Residential Building Electrification Program

The following sections summarize the methods used to estimate GHG reductions for these programs.

4.1.1 Municipal Building Electrification Program

GHG reductions from Municipal Building Electrification projects is estimated using the energy impacts of switching from natural gas water heaters, natural gas space heating, traditional electric space cooling technology to heat pump technologies. GHG estimates are estimated using changes in energy use, electricity emissions rates, and carbon content of natural gas. Table 18 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 18 Methodology Summary for Municipal Building Electrification

Models/Tools Used	No models or tools were used. Custom calculations using standard methods for GHG quantification were used.[50]
Measure Implementation Assumptions	The estimates presented here assume that the total number of heat pump equipment installations and associated energy reductions would occur equally over a five-year implementation period from 2025 to 2029. Equipment to be replaced with heat pump technologies includes traditional water heaters, boilers, space heating and cooling equipment.
GHG Reduction Estimate Assumptions	Key general assumptions include: a 15-year useful life for heat pump technologies based on information from the California electronic Technical Reference Manual (eTRM);[51] three quarters of the local jurisdictions receive service from a 100% renewable/carbon free service option; the other quarter receive service at the weighted average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[52] which includes calculated values for years with reported data and an interpolation to statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045; as a consequence of this only 25% of the electricity increase is assumed to cause an emissions increase; carbon content of methane is 0.0054 MT CO_2e/therm;[53] regional GHG reduction potential is based in part on detailed analysis the City of San Diego's energy services performance contract (ESPC) provider to assess decarbonization

[50] GHG quantification is based on methods summarized in the Regional Climate Action Planning Framework. Technical Appendices. See San Diego Association of Governments. Regional Climate Action Planning Framework -- TECHNICAL APPENDIX II Methods to Calculate GHG Emissions Impacts of CAP Measures, VERSION 1.1. NOVEMBER 2020. Available at https://www.sandag.org/-/media/SANDAG/Documents/ZIP/projects-and-programs/recap-and-technical-appendices.zip
[51] The California electronic Technical Reference Manual (eTRM)is available online at https://www.caltf.org/etrm-overview
[52] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.
[53] The Climate Registry 2021 Default Emission Factors and Emissions Factors for Greenhouse Gas Inventories, U.S EPA April 2022.

	opportunities at a select group of City of San Diego buildings, representing 55 buildings, totaling approximately 497,650 square feet; baseline annual natural gas use was taken from monthly utility bill data for 46 of the 55 candidate sites; domestic water heating is assumed to be approximately 60% of the total annual gas load; swimming pools are assumed to have an estimated annual average natural gas use of 35,000 therms per year; to determine savings from electrification, an average gas heating efficiency of 78% was assumed for space and domestic water heating, as well as pool heating; an average annual coefficient of performance (COP) for new heat pumps was assumed to be 4.0; and, a conversion factor of 5.7 kWh/therm was used to estimate future electricity use post-electrification.
Reference Case Scenario	The reference scenario is the business-as-usual use of traditional technologies for water heaters, boilers, space heating and cooling equipment. As described above, the baseline consumption was derived using energy billing data.
Measure Specific Activity Data	The level of activity assumed for GHG reduction estimates are based on detailed analysis completed by the City of San Diego to implement their building electrification plan (assumptions described above). These projects are a mix of heat pump water heaters (HPWH), heat pump HVAC (HPHVAC), and pool heaters. This mix is assumed to be representative of project needs of other jurisdictions in the region based on additional data collected from local jurisdictions. The City of San Diego represents about 43% of the region's population. Results for the City of San Diego's analysis were extrapolated to the regional population.
2025-2030 Cumulative GHG Emissions Reduced	13,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	49,000 MT CO_2e

4.1.2 Residential Building Electrification Program

GHG reductions from Residential Building Electrification projects is estimated using the energy impacts of switching from natural gas water heaters, natural gas space heating, and traditional electric space cooling technology to heat pump technologies. GHG estimates are estimated using changes in energy use and electricity emissions rate and carbon content of natural gas. Table 19 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 19 Methodology Summary for Residential Building Electrification

Models/Tools Used	No models or tools are used. Custom calculations using standard methods for GHG quantification were used.[54]

[54] GHG quantification is based on methods summarized in the Regional Climate Action Planning Framework. Technical Appendices. See San Diego Association of Governments. Regional Climate Action Planning Framework -- TECHNICAL APPENDIX II Methods to Calculate GHG Emissions Impacts of CAP Measures, VERSION 1.1. NOVEMBER 2020. Available at https://www.sandag.org/-/media/SANDAG/Documents/ZIP/projects-and-programs/recap-and-technical-appendices.zip

Measure Implementation Assumptions	The estimates presented here assume that heat pump equipment installations and associated energy reductions would occur equally over a five-year implementation period from 2025 to 2029.
GHG Reduction Estimate Assumptions	Key assumptions include: a 15-year useful life for heat pump technology based on information from the California electronic Technical Reference Manual (eTRM);[55] an annual electricity increase of 1,507 kWh and a natural gas reduction of 195 therms for HPWHs and 1,303 kWh and 220 therms for HPHVAC; all baseline water and space heating technologies were assumed to be fueled by natural gas;[56] emissions impacts of electricity were estimated using a weighted average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[57] which includes calculated values for years with reported data and an interpolation to statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045; carbon content of methane is 0.0054 MT CO_2e/therm.[58]
Reference Case Scenario	Reference case is business as usual, assuming energy consumption associated with existing equipment. For heat pump water heaters (HPWH) the baseline technology is natural gas and for heat pump HVAC (HPHVAC) the base line is natural gas for heating and electricity for cooling.
Measure Specific Activity Data	The level of activity is based on actual project Tech Clean California data for incentives provided in the San Diego region.[59] It is assumed that 150 HPWHs and 1,500 HPHVACs will be installed annually, for a total of 750 and 7,500, respectively, over the five-year implementation period of 2025-2029.
2025-2030 Cumulative GHG Emissions Reduced	31,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	122,000 MT CO_2e

[55] The California electronic Technical Reference Manual (eTRM)is available online at https://www.caltf.org/etrm-overview
[56] Based on project data from the Tech Clean California program. Data available at https://techcleanca.com/public-data/download-data/
[57] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.
[58] The Climate Registry 2021 Default Emission Factors and Emissions Factors for Greenhouse Gas Inventories, U.S EPA April 2022.
[59] Based on project data from the Tech Clean California program. Data available at https://techcleanca.com/public-data/download-data/

5 INCREASE SUPPLY OF CLEAN ENERGY

The clean energy supply section of the PCAP includes one measure: CE.1 Increase Solar and Energy Storage.

5.1 CE-1 Increase Solar and Energy Storage

Measure CE-1 comprises one program: CE-1.1 Solar and Storage on Residential Buildings. The following sections summarize information on the methods used to estimate GHG reductions for this program.

5.1.1 Solar and Energy Storage on Residential Buildings

GHG reductions from solar and energy projects are estimated by (1) determining the amount of solar and battery energy used to serve building load, the amount solar and battery energy exported to the grid, and the amount energy imported from the grid, and (2) determining the emissions impacts using electric emissions rates. To account for different project configurations, we calculated emissions impacts two ways to create a range. For the solar only scenario, we used an annual average emission rate (AAER) to represent the low end of estimate. For the solar plus energy storage, we used hourly short run marginal emission rates (SRMER). Values reported here represent the midpoint of this range, this reflects a potential mix of 50% solar only and 50% solar plus storage projects. Table 20 summarizes key aspects of the methodology used to estimate the GHG reductions from this program.

Table 20 Methodology Summary for Residential Solar and Energy Storage

Models/Tools Used	Several tools were used to generate inputs for a custom calculation using generally accepted methods. Building energy load shapes were derived using the California Energy Commission's (CEC) California Building Energy Code Compliance (CBECC) model.[60] Hourly short-run marginal emission rates (SRMER) are from the CPUC Avoided Cost Calculator.[61] PV production estimates are from the CBECC model and validated using the National Renewable Energy Laboratory (NREL) PVWatts calculator.[62]
Measure Implementation Assumptions	The estimates presented here assume that solar and energy storage equipment installations and associated energy reductions would occur equally over a five-year implementation period from 2025 to 2029.
GHG Reduction Estimate Assumptions	Key assumptions include: PV performance declines by 1.4% per year[63] and batteries by 0.01% per cycle;[64] hourly building energy load shapes and hourly data on PV generation and battery behavior are used to determine import, export, and self-consumption of PV and battery energy; because GHG emissions impacts of energy storage are based on the differences in emission rates when charging and discharging, hourly analysis is used to estimate the emissions impact of adding energy storage to a PV project; GHG reduction estimates for the solar plus storage scenario are calculated using hourly short-run marginal emission rates (SRMER) from the CPUC Avoided Cost

[60] California Energy Commission. 2022 Energy Code Compliance Software. Available at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency-1.
[61] 2021 CPUC Avoided Cost Calculator. Available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm.
[62] National Renewable Energy Laboratory PV Watts Calculator. Available at https://pvwatts.nrel.gov/
[63] PV degradation rate: NEM 2_Lookback_Study 2021, p. 63.
[64] Degradation rate provided by Unigrid battery company.

	Calculator - this represents the high end of the range;[65] a 25-year useful life for PV and 13-year-life for battery storage;[66] and, for the low end of the range, we use a weighted annual average electric emission rate using reported emissions from all retail suppliers in the San Diego region,[67] which includes calculated values for years with reported data and an interpolation to statutory targets of 60% renewable electricity by 2030 and 100% carbon-free electricity in 2045.
Reference Case Scenario	The reference scenario is business-as-usual energy consumption from the grid with no solar and energy storage. In the solar-only scenario, AAER is used to determine reference emissions (low end of range). For the solar-plus-energy storage scenario, SRMER is used (high end of range).
Measure Specific Activity Data	We assumed 1,000 projects per year with an average PV system size of 8 kW and average storage size of 10 kWh.
2025-2030 Cumulative GHG Emissions Reduced	67,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	215,000 MT CO_2e

[65] 2021 CPUC Avoided Cost Calculator. Available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm.
[66] Verdant. (2021, January). Net-Energy Metering 2.0 Lookback Study. Retrieved from https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/net-energy-metering-nem/nemrevisit/nem-2_lookback_study.pdf.
[67] California Energy Commission. Power Source Disclosure Program Power Content Label. Available at https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-content-label.

6 DECARBONIZE THE WATER SUPPLY

The Water section of the PCAP includes one measure: W-1 Improve Energy Efficiency of Water System.

6.1 W-1 Improve Water and Wastewater System Efficiency

Measure W-1 comprises one project: W-1.1 Wastewater and Energy Recovery Project. The following sections summarize information on the methods used to estimate GHG reductions for this project.

6.1.1 Wastewater and Energy Recovery Project

GHG emissions reduction from the East County Advanced Water Purification (AWP) project is estimated based on (1) the emissions associated with treating water locally to reduce imported water, and (2) the emissions reduction from using electricity and heat generated an on-site combined heat and power (CHP) plant instead of grid purchase. The CHP uses biogas generated at AWP's anaerobic digester.

Emissions associated with treating water locally is estimated based on (1) energy used to supply, treat, and distribute imported water to Southern California; (2) energy used to treat water beyond tertiary level to achieve potable water quality and to convey treated water to surface water reservoir; and (3) San Diego regional electricity emission factor in Table 4.

Emissions reduction associated with CHP plant is estimated based on (1) emissions avoided from diverting organic waste from the landfill, (2) emissions avoided from running the boiler, (3) emissions avoided from grid electricity purchase, and (4) emissions added due to CHP plant operation using biogas. Table 21 summarizes key aspects of the methodology used to estimate the GHG reductions from this project.

Table 21 Methodology Summary for Wastewater and Energy Recovery Project

Models/Tools Used	Custom calculation using facility and plant engineering and design specifications provided by facility staff.
Measure Implementation Assumptions	The advanced water treatment and CHP plant are both assumed to be constructed and operational by 2027.
GHG Reduction Estimate Assumptions	Key assumptions include: GHG reductions will occur from 2027 (when the facilities are constructed and operational) through 2050; and as the grid electricity get cleaner (due to California's Renewable Portfolio Standards), the GHG reduction from grid electricity avoided will decrease.
Reference Case Scenario (GHG Emissions/ Activity Level)	San Diego East County continues to receive imported water; and organic waste (food waste) continues to be disposed at landfills.
Measure Specific Activity Data	To estimate energy and GHG impacts of this project, we assume that 11.5 million gallons of potable water are produced per day (12,880 acre feet per year) and 75 wet short tons of food waste diverted from landfill to digester per day.
2025-2030 Cumulative GHG Emissions Reduced	15,000 MT CO_2e
2025-2050 Cumulative GHG Emissions Reduced	77,000 MT CO_2e