Appendix E:

Technical Methodology for the Roadmap Implementation Scenario

Contents

1 Introduction

The Implementation Scenario is intended to illustrate what levels of greenhouse gas (GHG) reductions could be achieved if the San Diego Regional Climate Action Roadmap (Roadmap) measures were implemented alongside other regional and state actions. It represents an ambitious vision, rather than a prescriptive plan for how specific measures could be implemented. These values are not site-specific and should be interpreted as one pathway to show what could be achieved; it is not a forecast. Each category of emission reductions (numbered below) is modeled using different approaches and assumptions. The categories of Roadmap measures and California Scoping Plan (Scoping Plan) goals represent illustrative pathways of what could be achieved under certain assumptions. The modeling of the Draft 2025 Regional Plan category reflects SANDAG's detailed travel demand model and draft plan assumptions. Taken together, these categories provide one possible scenario for how regional emissions could change, but actual future outcomes will depend on policy decisions, funding, technology, and market adoption. The University of San Diego School of Law's Energy Policy Initiatives Center (USD EPIC) estimated the GHG emissions reduction potential from the following implementation categories:

1. **2025 Draft Regional Plan Category** showing the impact of implementing SANDAG's Draft 2025 Regional Plan.[1]
2. **Roadmap Measures Category** showing the impact of implementing all GHG reduction measures outlined in this Roadmap.
3. **California Scoping Plan Goals Category** showing state identified programs to reach the statewide emissions reduction goals that have not yet been legislatively adopted and whose implementing authority is unclear or lies outside of regional actors.

1.1 Overview of this Appendix

This appendix includes the following sections:

- **Background** provides common background information on selection of projection categories.
- **Implementation Scenario Results** provides the results of the Implementation Scenario by category for the goal years 2035 and 2045.
- **Method to Calculate the Implementation Scenario** includes subsections by category which cover methods used to develop each by emissions category. Only sectors which impact each emissions category are included. For each measure, underlying assumptions included in the Legislatively-Adjusted business-as-usual (BAU) scenario, as described in **Appendix D**, are included for comparison purposes.

2 Background

2.1 Annual Activity Data and Emissions Results

Unless stated otherwise, all activity data, GHG emissions, and GHG emissions reductions reported in this Appendix are annual values for the calendar year, and all emission factors reported in this document are annual average values for the calendar year.

[1] The Regional Plan is SANDAG's Regional Transportation Plan and Sustainable Communities Strategy.

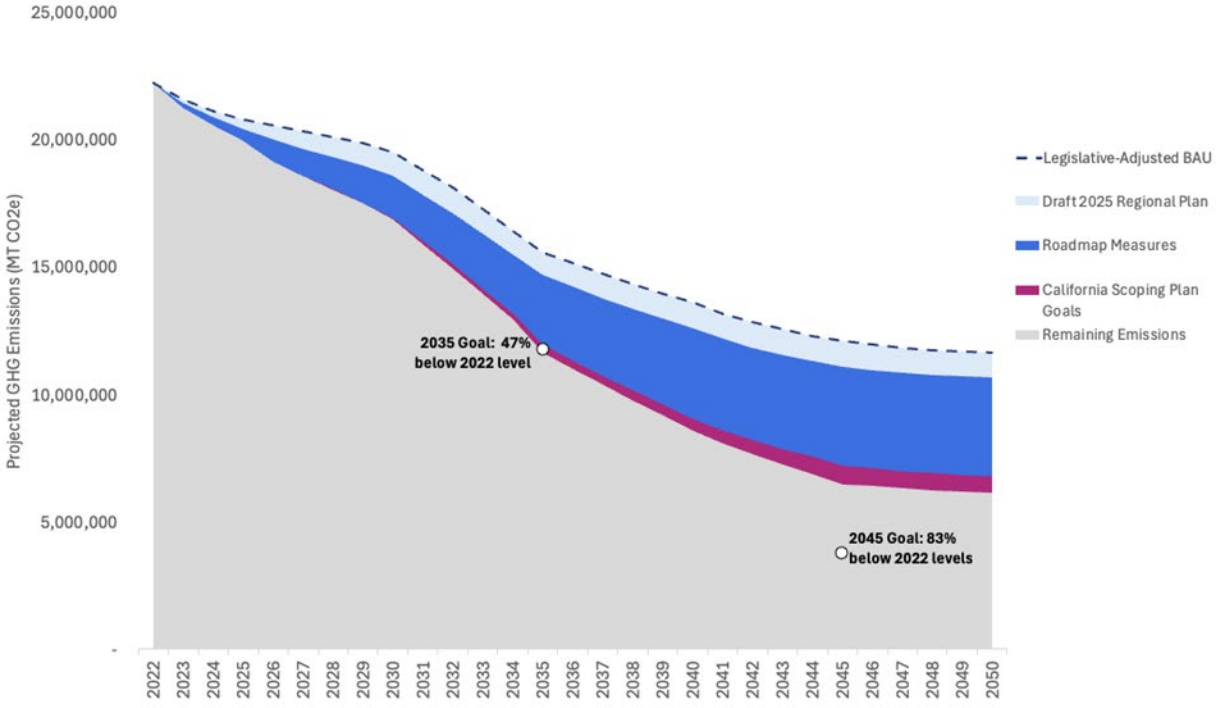
2.2 Rounding of Values in Tables and Figures

Rounding is used only for the final GHG values within the tables and figures throughout the document. Values are rounded to the nearest integer. Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values summed in any table or figure.

3 Summary of the Implementation Scenario and Results

Figure E.1 shows the annual GHG reduction potential of the Implementation Scenario by category compared with the Legislatively-Adjusted BAU projection.

Figure E.1: GHG Emissions Reduction Potential by Category



Source: USD EPIC, 2025

4 Method to Calculate the Regional Plan Category

The Regional Plan category shows the emissions reduction difference between the Draft 2025 Regional Plan "Build" and "No Build" scenarios. The Regional Plan "No Build" scenario, which is included in the Legislatively-Adjusted BAU, only provides emissions reduction projections for projects included in the Draft 2025 Regional Plan which are recently completed or in progress and fully funded through construction. The "Build" scenario incorporates all projects outlined in the Draft 2025 Regional Plan, which is financially constrained, meaning the projects and investments included in the plan can be reasonably funded with a mix of federal, state, and local sources. The difference between the "Build" and "No Build" scenarios is included in the Roadmap as the "Draft 2025 Regional Plan" category to show the reduction potential from the fully realized Regional Plan. Additional information on the Regional Plan modeling assumptions can be found in SANDAG's **Draft 2025 Regional Plan**.

5 Method to Calculate the Roadmap Measures Category

The Roadmap Measure category illustrates the potential reductions from the measures included in the Roadmap, which are covered in more detail in Chapter 6 of the Roadmap. These estimates were developed using a top-down, regional modeling approach. The reductions outlined in this section are not forecasts of what will occur, but rather one vision for what could be achieved. The Roadmap Measures category is not financially constrained and should be interpreted as an illustrative analysis of potential reductions. Actual future reductions will depend on factors outside the scope of this analysis, including local implementation choices, funding availability, technology development, market adoption, and other factors.

5.1 Transportation

T-1 Reduce Vehicle Miles Traveled (VMT) through Increased Public Transit Use

Objectives for Measure T-1 are as follows:

- T-1.1: Increase transit ridership
- T-1.2: Add Bus Rapid Transit (BRT) service
- T-1.3: Increase frequency and span of service of existing routes
- T-1.4: Expand trolley/light rail service

Table E.1: Method for Calculating Measure T-1

Method for Calculating Measure T-1	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection includes the following mode share from SANDAG's Transportation Demand Model for resident trips attributed to public transit[2]: • % of work trips during peak period: 1.4% in 2022 to 1.3% in 2050 • % of work trips all day: 1.0% in 2022 to 1.0% in 2050 • % of all trips: 1.3% in 2022 to 1.2% in 2050

[2] Draft Regional Plan 2050 No Build Scenario, Appendix N, Table N.4.2

2025 Draft Regional Plan Assumptions	The 2025 Draft Regional Plan category includes the following mode share from SANDAG's Transportation Demand Model for resident trips attributed to public transit[3]: • % of work trips during peak period: 1.4% in 2022 to 2.9% in 2050 • % of work trips all day: 1.0% in 2022 to 2.2% in 2050 • % of all trips: 1.3% in 2022 to 2.6% in 2050
GHG Reduction Estimate Assumptions	The measure assumes public transit use for all trip types regionwide would increase above 2025 Draft Regional Plan levels by an additional 2.5 percentage points (2.5%pt) by 2035 and 5.0%pt by 2045. All trip types include residents, visitors, airport connections, and border crossing trips. This measure also assumes vehicle trips are avoided with these additional transit trips, rather than other non-motorized trips.
Models/Tools Used for GHG Reductions	Average vehicle emission rates in San Diego Region: adjusted EMFAC2025 v2.0.0 results after accounting for state and regional electric vehicle policies and programs Total number of daily transit trips (2022, 2035, and 2050) and average transit trip distance (2022, 2035, and 2050): ABM15.2.1
Measure Specific Activity Data	Average vehicle trip distance avoided by using transit: 9.5 miles in 2035, 9.6 miles in 2045 Additional daily transit trips: 297,000 in 2035, 595,000 in 2045
2035 GHG Emissions Reduced	193,400 MT CO_2e
2045 GHG Emissions Reduced	153,600 MT CO_2e

T-2 Reduce VMT through Active Transportation

Objectives for Measure T-2 are as follows:

- T-2.1: Build and/or improve bikeways to expand safe and accessible routes
- T-2.2: Build and/or improve sidewalks to expand safe and accessible routes

Table E.2: Method for Calculating Measure T-2

Method for Calculating Measure T-2	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection includes the following mode share attributed to active transportation (including both biking and walking modes)[4]: • % of work trips during peak period: 5.2% in 2022 to 6.2% in 2050

[3] Draft Regional Plan 2050 Build Scenario, Appendix N, Table N.4.2
[4] Draft Regional Plan 2050 No Build Scenario, Appendix N, Table N.4.2

	• % of work trips all day: 12.5% in 2022 to 14.1% in 2050 • % of all trips: 16.2% in 2022 to 18.3% in 2050
2025 Draft Regional Plan Assumptions	The 2025 Draft Regional Plan category includes the following mode share attributed to active transportation (including both biking and walking modes)[5]: • % of work trips during peak period: 5.2% in 2022 to 7.1% in 2050 • % of work trips all day: 12.5% in 2022 to 15.1% in 2050 • % of all trips: 16.2% in 2022 to 19.9% in 2050
GHG Reduction Estimate Assumptions	This measure assumes biking as a mode share of all trip types regionwide would increase above 2025 Draft Regional Plan levels by an additional 4.2%pt by 2035 and 5.0%pt by 2045. It also assumes walking as a mode share of all trip types regionwide would match projected BAU levels. All trips include residents, visitors, and border crossing trips. This measure also assumes vehicle trips are avoided with these additional biking trips, rather than trips with other modes (e.g., transit, micromobility).
Models/Tools Used for GHG Reductions	Average vehicle emission rates in San Diego Region: adjusted EMFAC2025 v2.0.0 results after accounting for state and regional electric vehicle policies and programs. Total number of daily trips (2022, 2035, and 2050) and average biking and walking trip distance (2022, 2035, and 2050): ABM15.2.1.
Measure Specific Activity Data	Average vehicle trip distance avoided by walking: 0.9 miles in 2035 and 2045 Average trip distance avoided by biking: 3.9 miles in 2035 and 4.2 miles in 2045 Additional daily biking trips: 464,000 in 2035, and 553,000 in 2045
2035 GHG Emissions Reduced	124,300 MT CO_2e
2045 GHG Emissions Reduced	64,600 MT CO_2e

T-3 Reduce VMT through Flexible Fleets

Objectives for Measure T-3 are as follows:

- T-3.1: Increase micromobility, such as electric scooters, bikeshare, and e-bikes
- T-3.2: Increase microtransit, including neighborhood electric vehicles (NEVs)
- T-3.3: Increase on-demand carshare and vanpool

[5] Draft Regional Plan 2050 Build Scenario, Appendix N, Table N.4.2

Table E.3: Method for Calculating Measure T-3

Method for Calculating Measure T-3	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection includes the following mode share attributed to flexible fleets[6]: • % of work trips during peak period: 1.0% in 2022 to 1.2% in 2050 • % of work trips all day: 0.8% in 2022 to 1.0% in 2050 • % of all trips: 0.9% in 2022 to 0.9% in 2050
2025 Draft Regional Plan Assumptions	The 2025 Draft Regional Plan category includes the following mode share attributed to flexible fleets[7]: • % of work trips during peak period: 1.0% in 2022 to 1.1% in 2050 • % of work trips all day: 0.8% in 2022 to 0.9% in 2050 • % of all trips: 0.9% in 2022 to 0.9% in 2050
GHG Reduction Estimate Assumptions	The measure assumes the percentage of all trips using micromobility (e-bikes and e-scooters) as a mode share regionwide would increase above 2025 Draft Regional Plan levels by an additional 4.5%pt by both 2035 and 2045. VMT reduction through other flexible fleet modes (e.g., microtransit, NEVs, and on-demand rideshares) is not quantified due to limited mode choice information from the ABM and the Draft 2025 Regional Plan but would be covered under this measure and the additional percentage points. All trips include resident's trips only. This measure also assumes vehicle trips are avoided with these additional micromobility trips, rather than trips with other modes (e.g., transit, biking).
Models/Tools Used for GHG Reductions	Average vehicle emission rates in San Diego Region: adjusted EMFAC2025 v2.0.0 results after accounting for state and regional electric vehicle policies and programs. Total number of daily trips (2022, 2035, and 2050) and average micromobility trip distance (2022, 2035, and 2050): ABM15.2.1
Measure Specific Activity Data	Average trip distance avoided by using micromobility: 4.0 miles in 2035 and in 2045 Additional daily micromobility trips: 498,000 in 2035, and in 2045[8]

[6] Regional Plan 2050 No Build Scenario, Appendix N, Table N.4.2, "Other" mode includes TNC (transportation network companies) and taxi besides micromobility.

[7] Regional Plan 2050 Build Scenario, Appendix N, Table N.4.2, "Other" mode includes TNC (transportation network companies) and taxi besides micromobility.

[8] Average trip distance avoided by using micromobility were used in calculating miles and GHG avoided, however, the trips can be made through other flexible fleet modes (e.g., microtransit, NEVs, and on-demand rideshares), not limited to micromobility trips.

2035 GHG Emissions Reduced	136,400 MT CO_2e
2045 GHG Emissions Reduced	53,300 MT CO_2e

T-4 Reduce VMT through Transportation Demand Management (TDM)

Objectives for Measure T-4 are as follows:

- T-4.1: Reduce single-occupancy vehicle commuter trips through TDM strategies

Table E.4: Method for Calculating Measure T-4

Method for Calculating Measure T-4	
2025 Draft Regional Plan Assumptions	The 2025 Draft Regional Plan category includes the following percentage of employees that can telework[9]: • % Telework Primarily: 18.6% in 2022 to 19.45% in 2050 • % Telework Occasionally: 15.6% in 2022 to 15.6% in 2050 • % Telework Total: 34.2% in 2022 to 35.1% in 2050
GHG Reduction Estimate Assumptions	The measure assumes the regionwide telecommute policy (applicable to telecommutable jobs/industries that are more likely to telecommute more - finance, real estate, and professional and business service industry), can telework one additional day per week by 2035, and two additional days per week by 2045 above 2025 Draft Regional Plan assumptions.
Models/Tools Used for GHG Reductions	Average vehicle emission rates in San Diego Region: adjusted EMFAC2025 v2.0.0 outputs Average work trip distance during peak period (2022, 2035, and 2050): ABM15.2.1
Measure Specific Activity Data	Average work trip distance avoided: 11 miles (one-way) in 2035 and 2045 Percent of employees who telecommute taking midday trips: 80% Mid-day trip distance if telework: 9.4 miles (round trip) Miles avoided per telecommutable job per year due to telecommute policy: 772 miles in 2035 and 1,522 miles in 2045
2035 GHG Emissions Reduced	59,200 MT CO_2e
2045 GHG Emissions Reduced	47,500 MT CO_2e

T-5 Increase the Adoption of Zero-Emission Vehicles (ZEVs)

Objectives for Measure T-5 are as follows:

- T-5.1: Increase the light-duty ZEV population
- T-5.2: Increase medium- and heavy-duty ZEV population

[9] Regional Plan 2050 No Build Scenario, Appendix M, Table M.15

- T-5.3: Install charging and refueling infrastructure for light-duty ZEVs
- T-5.4: Install charging and refueling infrastructure for medium- and heavy-duty ZEVs
- T-5.5: Convert passenger rail cars to zero-emission

Table E.5: Method for Calculating Measure T-5

Method for Calculating Measure T-5	
Legislatively-Adjusted BAU Projection	The vehicle breakdown in the Legislatively-Adjusted BAU projection follows EMFAC 2025's projected EV adoption rate (49% of total VMT are e-VMT by 2035 and 82% are e-VMT by 2045).
GHG Reduction Estimate Assumptions	The measure assumes that EV adoption and EV infrastructure resulting from regional programs are already captured in the regional EV adoption rate in EMFAC2025, which also accounts for statewide EV regulations and programs. A portion of the GHG reduction from achieving the EMFAC 2025 EV adoption rate is subtracted from the total and allocated to this measure based on the number of EVs funded through the regional programs. Two regional programs are included: • SDG&E's Transportation Electrification Programs, mainly Power Your Drive for Fleets (PYDFF) program assisting a minimum of 300 sites supporting the electrification of 3,100 medium-duty and heavy-duty (MDHD) vehicles, and • San Diego County Air Pollution Control District's (SDAPCD) Clean Air for All Programs, including Carl Moyer Memorial Air Quality Standards Attainment Program and Community Air Protection Program
Models/Tools Used for GHG Reductions	Average vehicle emission rates, e-VMT, and kWh EV load in San Diego Region: adjusted EMFAC2025 v2.0.0 outputs Regional EV programs implementation and evaluation reports
Measure Specific Activity Data	3,100 electric MDHD vehicles supported through PYDFF Program by 2035 260 electric MDHD vehicles supported through Clean Air for All Programs by 2035 (assuming program implementation level is similar to 2023 and 2024 levels)
2035 GHG Emissions Reduced	142,600 MT CO_2e
2045 GHG Emissions Reduced	177,300 MT CO_2e

T-6 Reduce Fuel Use from Idling

Objectives for Measure T-6 are as follows:

- T-6.1: Install traffic calming measures, like roundabouts and/or traffic circles, where appropriate and consistent with local conditions

- T-6.2: Optimize traffic signals to facilitate traffic flow and improve safety
- T-6.3: Implement curb management strategies to reduce idling and enable efficient and safe traffic flow

Table E.6: Method for Calculating Measure T-6

Method for Calculating Measure T-6	
Legislatively-Adjusted BAU Projection	No traffic calming measures included in the Legislatively-Adjusted BAU scenario
GHG Reduction Estimate Assumptions	The measure assumes that 42 roundabouts will be installed by 2035 and an additional 37 (76 total) roundabouts by 2045 regionwide. It also assumes that traffic signals at 176 intersections will be retimed by 2035 and an additional 60 (236 total) by 2045 regionwide. The effect of traffic signal synchronization and roundabouts on fuel reduction depends on the traffic volume and size of the intersections on the arterials. Based on study of traffic signal synchronization projects at cities similar to cities in the San Diego Region, the annual fuel savings per intersection is around 2,400 gallons.[10] Similarly, the annual fuel savings per roundabout is around 19,000 gallons.[11] The measure assumes 2,400 gallons per intersection and 19,000 gallons per roundabout of annual fuel savings could be realized in the base year 2022, with vehicles getting more efficient and the number of ZEVs increasing, the fuel savings per roundabout and per intersection will decrease. The fuel saving in 2035 and 2045 are calculated based on the increase in vehicle fuel efficiency.
Models/Tools Used for GHG Reductions	Percent increase in vehicle fuel efficiency compared with base year 2022 in San Diego Region: adjusted EMFAC2025 v2.0.0 results after accounting for state and regional electric vehicle policies and programs.
Measure Specific Activity Data	Equivalent fuel savings per intersection from roundabouts: 10,000 gallons per year in 2035 and 4,000 gallons per year in 2045 Equivalent fuel savings per intersection from signal retiming: 1,200 gallons per year in 2035 and 500 gallons per year in 2045
2035 GHG Emissions Reduced	5,700 MT CO_2e
2045 GHG Emissions Reduced	3,700 MT CO_2e

[10] Sunkari: The Benefits of Retiming Traffic Signals (2004). The Jacksonville traffic signal retiming project at a 25-intersection section resulted in estimated annual fuel savings of 65,000 gallons.

[11] Varhelyi: The Effects of Small Roundabouts on Emission and Fuel Consumption: A Case Study (2002). The study estimated the traffic volume of the intersection and the fuel consumption before and after the roundabout. The traffic volume is 23,500 vehicles per day and the fuel savings are approximately 144 kg per day after the roundabout installation.

5.2 Electricity

E-1 Decarbonize the Regional Electric Grid

Objectives for Measure E-1 are the following:

- E-1.1 Increase distributed renewable energy generation
- E-1.2 Increase regional participation in fully renewable electricity options ahead of state mandates

Table E.7: Methods for Calculating Measure E-1

Methods for Calculating Measure E-1	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection includes efforts underway by the region's Community Choice Aggregation (CCA) energy providers to accelerate the decarbonization of the electric grid ahead of Renewable Portfolio Standards (RPS). This includes both Clean Energy Alliance and San Diego Community Power's goals of achieving 100% renewable energy for all of their customers by 2035. CCAs are forecasted to supply 53% of the total electricity load by 2035. The remaining electricity load, served by SDG&E and direct access contracts, are assumed to follow the Renewable Portfolio Standard and achieve 90% renewable energy by 2035 and 100% by 2045.
GHG Reduction Estimate Assumptions	E-1.1: Distributed energy resources assumed to generate 20% of regionwide electricity demand by 2045, with a straight-line projection starting in 2023. E-1.2: As the BAU projection assumes the existing CCA programs already accelerate the renewable procurement timeline ahead of RPS, no additional acceleration was assumed.
Models/Tools Used for GHG Reductions	Adjusted California Energy Commission (CEC) Integrated Energy Policy Report (IEPR) demand forecast
Measure Specific Activity Data	Equivalent electricity served by distributed resources: 2,100 GWh in 2035 and 3,600 GWh in 2045
2035 GHG Emissions Reduced	47,700 MT CO_2e
2045 GHG Emissions Reduced	0 MT CO_2e

5.3 Buildings

B-1 Increase Energy Efficiency of Buildings and B-2 Increase Electrification of Buildings

Objectives for Measures B-1 and B-2 are as follows:

- B-1.1-1.3: Increase energy efficiency of municipal, residential, and non-residential buildings
- B-2.1-2.3: Electrify municipal, residential, and non-residential buildings

Because emissions projections between the two measures are interrelated, the calculation for both measures was combined.

Table E.8: Methods for Calculating Measures B-1 and B-2

Methods for Calculating Measures B-1 and B-2	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection includes energy efficiency upgrades anticipated by the CEC through building code updates.
GHG Reduction Estimate Assumptions	To estimate the energy and GHG emissions impact from ComStock measures for non-residential buildings, we used the following measures: • Electric Cooking Equipment • Package 1 - Wall and Roof Insulation and New Windows • Package 5 - Heat pump roof top unit + Air source heat pump (ASHP) Boiler + Demand Control Ventilation + Heat/Energy Recovery + Economizers Because ComStock only represents about 64% of the building stock, a significant portion of buildings were missing from this analysis. To compensate for this omission, the results were scaled up to include all commercial and industrial buildings in the region. To do this, the 14 ComStock building types were assumed to represent 75% of building inventory (instead of 64%). To estimate the energy and GHG emissions impact from ResStock measures for residential buildings, we used the following measures: • Package 15.03- ASHP replaces Natural Gas + Heat Pump Water Heating + Envelope, Light Touch • Dryer, Electric, Replaces Non-Electric • Cooking, Electric, Induction, Replaces Non-Electric • Pool Heaters, Electric, Replaces Natural Gas • Spa Heaters, Electric, Replaces Natural Gas • ASHP, EnergySTAR Ducted, Electric Backup, if Existing Propane Heating • Mini-split heat pump, EnergySTAR Ductless, Electric Backup, if Existing Propane Heating ResStock building stock data was validated using the San Diego Association of Government's Series 15 regional demographic projections by comparing the total number and distribution of residential buildings ComStock building stock data was validated using the building analysis in the Cost Effectiveness Explorer tool.

	GHG emissions were estimated using standard emission factors for natural gas, oil, and propane. The electricity emissions rate assumes all load serving entities reach statewide targets for renewable and zero carbon electricity through 2045.
Models/Tools Used for GHG Reductions	National Renewable Energy Laboratory's ComStock and ResStock models were used to estimate the baseline energy use and the impact of building efficiency and electrification measures for all available building types.
Measure Specific Activity Data	Measures considered changes in electricity, natural gas, and propane consumption due to the listed measures. Equivalent activity data includes: Electricity: 918 GWh increase in 2035 and 1,624 GWh increase in 2045 from electrification efforts Natural gas: 218 million therms saved in 2035 and 385 million therms saved in 2045 Propane: 378,000 MMBtu saved in 2035 and 670,000 MMBtu in 2045
2035 GHG Emissions Reduced	1,548,800 MT CO_2e
2045 GHG Emissions Reduced	2,180,400 MT CO_2e

5.4 Industry

IND-1 Reduce Short-Lived Climate Pollutant (SLCP) Emissions

Objectives for Measure IND-1 are as follows:

- IND-1 Reduce high global warming potential (GWP) refrigerant use

Table E.9: Methods for Calculating Measure IND-1

Methods for Calculating Measure IND-1	
Legislatively-Adjusted BAU Projection	No high-GWP gas reduction included in the Legislatively-Adjusted BAU scenario
GHG Reduction Estimate Assumptions	It is assumed that 75% of all commercial, industrial, and transportation refrigerants are replaced with low-GWP refrigerants by 2045; 42% by 2035. It is assumed that these refrigerants will be replaced with refrigerants that have 0 GWP (such as Ammonium).
Models/Tools Used for GHG Reductions	No models used
Measure Specific Activity Data	Scaled category-wide emissions down by 75% as data is not available by refrigerant type.
2035 GHG Emissions Reduced	284,700 MT CO_2e

2045 GHG Emissions Reduced	940,200 MT CO_2e

IND-2 Reduce Energy Intensity of Industrial Facilities

Objectives for Measure IND-2 are as follows:

- IND-2.1: Increase industrial energy efficiency
- IND-2.2: Increase the use of distributed energy resources (renewable or alternative fuel use) in industrial facilities

The impacts of Measure IND-2 are captured in part in the calculations for Measures B-1, B-2, and E-1.2. Data is not available at the granularity required to calculate the GHG emissions impacts separately.

5.5 Solid Waste and Materials Management

SW-1 Divert Waste from Landfills

Objectives of Measure WMM-1 are as follows:

- SW-1.1: Increase diversion of organic waste from landfills
- SW-1.2: Increase edible food recovery
- SW-1.3: Increase diversion of C&D waste from landfills

Table E.10: Methods for Calculating Measure SW-1

Methods for Calculating Measure SW-1	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection assumes the goal from California's SB 1383 of reaching 75% organics diversion to landfill is met by 2035.
GHG Reduction Estimate Assumptions	It is assumed that 88% of organic waste would be diverted from landfill by 2035 and 100% of organic waste would be diverted from landfill by 2045.
Models/Tools Used for GHG Reductions	EPA WARM Model v 15
Measure Specific Activity Data	Total organic waste to landfill reduced above Legislatively-Adjusted BAU levels equates to 127,000 tons in 2035 and 254,000 tons in 2045.
2035 GHG Emissions Reduced	5,800 MT CO_2e
2045 GHG Emissions Reduced	11,700 MT CO_2e

SW-2 Reduce Waste Emissions through Increased Methane Capture

Objectives for Measure SW-2 are as follows:

- SW-2.1: Expand and implement methane capture at waste facilities

Table E.11: Methods for Calculating Measure SW-2

Methods for Calculating Measure SW-2	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection assumes that 85% of methane is captured from landfills by 2035 in line with SDAPCD assumptions.[12]
GHG Reduction Estimate Assumptions	It is assumed that 95% of methane is captured from landfills by 2045.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Methane capture rate, and additional 10%pt from the Legislatively-Adjusted BAU by 2045
2035 GHG Emissions Reduced	0 MT CO_2e
2045 GHG Emissions Reduced	55,700 MT CO_2e

5.6 Water and Wastewater

WW-1 Reduce Demand for Potable Water and WW-2 Optimize Energy Use in Water and Wastewater Systems

Objectives for Measure WW-1 and WW-2 are as follows:

- WW-1.1 Reduce municipal water use
- WW-1.2 Reduce residential water use
- WW-1.3 Reduce commercial and industrial water use
- WW-2.1 Improve energy efficiency of water and wastewater systems
- WW-2.2 Increase use of distributed energy resources (DER) in water and wastewater operations
- WW-2.3 Expand water reuse

Because emissions projections between the two measures are interrelated, the calculation for both measures was combined.

[12] Assumption based on San Diego Air Pollution Control District assumptions, https://www.sdapcd.org/content/dam/sdapcd/documents/permits/emissions-calculation/instructions/Landfill-Operations.pdf

Table E.12: Methods for Calculating Measures WW-1 and WW-2

Methods for Calculating Measures WW-1 and WW-2	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection assumes the addition of water recycling plants (Pure Water and East County Advanced Water Purification Facilities) are built out to the scale projected by the respective facilities. The BAU further uses the San Diego County Water Authority water source projection through 2045 to allocate water emissions to the associated source. They project stable water imports, with increased water demand fulfilled using the recycled water. Energy associated with water recycling and desalination follows RPS renewables trajectory.
GHG Reduction Estimate Assumptions	It is assumed that the renewable energy transition is accelerated from the RPS timeline to the respective local CCA timeline for local traditional water treatment, desalination, and potable reuse facilities.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Quantity of water treated and energy consumption by treatment facility and energy intensity of grid electricity Acre feet (AF) of water treated by facility type in 2035: Potable Reuse: 112,600 AF Desalination: 6,000 AF Recycled: 45,600 AF Traditional Treatment – Local: 76,200 AF Remaining Imported: 358,100 AF AF of water treated by facility type in 2045: Potable Reuse: 112,600 AF Desalination: 6,000 AF Recycled: 45,700 AF Traditional Treatment – Local: 72,700 AF Remaining Imported: 393,696 AF
2035 GHG Emissions Reduced	21,700 MT CO_2e
2045 GHG Emissions Reduced	0 MT CO_2e

WW-3 Reduce Methane Emissions from Wastewater Systems

Objectives for Measure WW-3 are as follows:

- WW-3.1: Increase efficiency of methane capture and utilization systems at wastewater treatment facilities
- WW-3.2: Reduce methane emissions from wastewater and septic systems

Table E.13: Methods for Calculating Measure WW-3

Methods for Calculating Measure WW-3	
Legislatively-Adjusted BAU Projection	Current wastewater treatment plant (WWTP) emissions remain stable in the Legislatively-Adjusted BAU projection fluctuating only with population changes.
GHG Reduction Estimate Assumptions	It is assumed that the current levels of WWTP methane emissions are reduced to 48% and 85% of the 2022 levels of methane emitted by 2035 and 2045 respectively.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Reported methane process emissions by facility, see Appendix B for reported values by WWTP and Appendix D for projection methodology.
2035 GHG Emissions Reduced	4,200 MT CO_2e
2045 GHG Emissions Reduced	7,400 MT CO_2e

5.7 Agriculture

AG-1 Reduce Emissions from Agriculture Operations

Objectives for Measure AG-1 are as follows:

- AG-1.1: Transition agricultural operations to cleaner fuels and energy sources
- AG-1.2: Increase energy efficiency of agricultural machinery and farm equipment

Table E.14: Methods for Calculating Measure AG-1

Methods for Calculating Measure AG-1	
Legislatively-Adjusted BAU Projection	The Legislatively-Adjusted BAU projection assumes the region reaches California's aim to reduce GHG emissions from agricultural equipment by 40% below 1990 levels by 2030, and achieve carbon neutrality by 2045, with programs like the Funding Agricultural Replacement Measures for Emission Reductions (FARMER) program supporting this goal.
GHG Reduction Estimate Assumptions	It is assumed that agricultural offroad equipment transitions to 42% and 75% electric by 2035 and 2045, respectively.
Models/Tools Used for GHG Reductions	CARB OFFROAD2021
Measure Specific Activity Data	Emissions by equipment fuel type . Tons per year (tpy) of carbon dioxide avoided in 2035: Diesel equipment: 8,600 tpy CO2 Gasoline equipment: 1,500 tpy

	Tons per day (tpy) of carbon dioxide avoided in 2045: Diesel equipment: 16,000 tpy CO2 Gasoline equipment: 2,400 tpy CO2
2035 GHG Emissions Reduced	11,000 MT CO_2e
2045 GHG Emissions Reduced	20,000 MT CO_2e

AG-2 Expand Urban Agriculture in the Region

No emissions reductions were calculated for this measure to be consistent with the State inventory, which only quantifies anthropogenic emissions.

AG-3 Increase Agricultural Practices to Sequester Carbon

No emissions reductions were calculated for this measure to be consistent with the State inventory, which only quantifies anthropogenic emissions. However, sequestration estimates from the County of San Diego's 2024 Climate Action Plan (CAP)[13] Measure A-4.1 are listed as an informational item to show the current work being done within the region. The figures listed describe only the County's estimate and are not scaled up to represent goals for the entire Region as described in this Roadmap.

- *2035 GHG Emissions Sequestered – Informational Only: 47,700* MT CO_2e
- *2045 GHG Emissions Sequestered – Informational Only: 121,600* MT CO_2e

AG-4 Conserve Agricultural Land

No emissions reductions were calculated for this measure to be consistent with the State inventory, which only quantifies anthropogenic emissions. However, sequestration estimates from the County of San Diego's 2024 CAP Measure A-3.1 are listed as an informational item to show the current work being done within the region. The figures listed describe only the County's estimate and are not scaled up to represent goals for the entire Region as described in this Roadmap.

- *2035 GHG Emissions Sequestered – Informational Only: 12,200* MT CO_2e
- *2045 GHG Emissions Sequestered – Informational Only: 17,300* MT CO_2e

5.8 Natural and Working Lands

NWL-1 Conserve Coastal and Wetland Ecosystems and NWL-2 Conserve Forest, Shrubland, and Chaparral ecosystems

No emissions reductions were calculated for this measure to be consistent with the State inventory, which only quantifies anthropogenic emissions. However, sequestration estimates from the County of San Diego's 2024 CAP Measure A-1.1 and A-1.2 are listed as an informational item to show the current work being done within the region. The figures listed describe only the County's estimate and are not scaled up to represent goals for the entire Region as described in this Roadmap.

[13] County of San Diego 2024 Climate Action Plan. **Appendix 7**.

- *2035 GHG Emissions Sequestered – Informational Only: 72,400* MT CO_2e
- *2045 GHG Emissions Sequestered – Informational Only: 92,400* MT CO_2e

NWL-3 Increase Urban Greening

No emissions reductions were calculated for this measure to be consistent with the State inventory, which only quantifies anthropogenic emissions. However, sequestration estimates from the County of San Diego's 2024 CAP Measure A-2.1 and A-2.2 are listed as an informational item to show the current work being done within the region. The figures listed describe only the County's estimate and are not scaled up to represent goals for the entire Region as described in this Roadmap.

- *2035 GHG Emissions Sequestered – Informational Only: 4,300* MT CO_2e
- *2045 GHG Emissions Sequestered – Informational Only: 6,800* MT CO_2e

6 Method to Calculate the California Scoping Plan Goals Category

The following measures have been selected from the 2022 California Scoping Plan[14] to show how regional emissions would be impacted by the achievement of Scoping Plan goals. Scoping Plan Goals are distinct from the Legislatively-Adjusted BAU scenario described in **Appendix D** as the Scoping Plan Goals do not have corresponding legislative or regulatory mandates but are identified by the State as visionary pathways to achieving carbon neutrality by 2045. Furthermore, the selected Scoping Plan Goals shown below in Tables E.15 - E.20 were included in the California Scoping Plan Goals category, but not included in the Roadmap Measures category because the implementing authority for these actions does not lie within the region or is unclear. Specific Scoping Plan goals have been selected for inclusion in the Roadmap Implementation Scenario based on their applicability to the region and data availability, as further detailed in **Table E.21**. Additionally, measures and goals published in the Scoping Plan have been numbered in this document differently and summarized for clarity.

6.1 Electricity & Natural Gas

Table E.15: Scoping Plan Goal 1

Scoping Plan Goal 1: Retire combined heat and power (CHP) facilities by 2040	
GHG Reduction Estimate Assumptions	The measure assumes all CHP facilities in the San Diego region would be retired by 2040. Assumes facility shutdowns would result in linear emissions reductions starting from zero in 2026 to full reductions by 2040
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Total natural gas reduced by 2040: 7,182,000 therms Emissions from electricity changed by 2040: negligible given RPS requirements

[14] California Air Resources Board. 2022 Scoping Plan for Achieving Carbon Neutrality. Table 2-1.

2035 GHG Emissions Reduced	11,200 MT CO_2e
2045 GHG Emissions Reduced	39,200 MT CO_2e

Table E.16: Scoping Plan Goal 2

Scoping Plan Goal 2: 0% energy demand from "Other Industrial Manufacturing" electrified by 2030 and 50% by 2045	
GHG Reduction Estimate Assumptions	The measure assumes 50% of the Industrial customer class natural gas consumption would be electrified by 2045.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Total natural gas reduced by 2045: 26,947,000 therms Emissions from electricity changed by 2045: negligible given RPS requirements
2035 GHG Emissions Reduced	49,000 MT CO_2e
2045 GHG Emissions Reduced	147,000 MT CO_2e

6.2 Industrial

Table E.17: Scoping Plan Goal 3 – High-GWP Potential Emissions

Scoping Plan Goal 3 - High-GWP Potential Emissions: Low-GWP refrigerants introduced as building electrification increases, mitigating HFC (hydrofluorocarbon) emissions	
GHG Reduction Estimate Assumptions	The measure assumes 75% of residential high-GWP refrigerants are replaced with low-GWP refrigerants (90% GWP emission reduction) by 2045.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Percent of households with low-GWP refrigerant: 42% in 2035 and 75% in 2045. Reduction in emissions profile of refrigerants (can be up to 100% if using Ammonium as a refrigerant): 51% in 2035 and 90% in 2045.
2035 GHG Emissions Reduced	67,200 MT CO_2e
2045 GHG Emissions Reduced	228,200 MT CO_2e

6.3 Other Fuels

Table E.18: Scoping Plan Goal 4 – Stone, Clay, Glass, and Cement

Scoping Plan Goal 4 – Stone, Clay, Glass, and Cement: Carbon capture and storage (CCS) on 40% of all Stone, Clay, Glass, and Cement operations by 2035 and on all facilities by 2045.	
GHG Reduction Estimate Assumptions	The measure assumes 40% of all operations equals the same emissions reduction as 40% of all facilities (as data is not available at the facility level). The measure also assumes that process emissions are reduced by 40%, such that all non-energy consumption emissions (CO_2, CH_4, N_2O) from Stone, Clay, Glass, and Cement operations are reduced 40% by 2045. Assumed CCS programs start in 2030 and reach 40% goal by 2035.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Total process emissions from California Stone, Clay, Glass, and Cement facilities attributed to the San Diego region via manufacturing jobs in 2022: 220,000 MT CO_2e. Total process emissions from California Stone, Clay, Glass, and Cement facilities projected in 2035 using manufacturing sector projected jobs growth: 233,000 MT CO_2e. Total process emissions from California Stone, Clay, Glass, and Cement facilities projected in 2045 using manufacturing sector projected jobs growth: 279,000 MT CO_2e.
2035 GHG Emissions Reduced	93,200 MT CO_2e
2045 GHG Emissions Reduced	111,600 MT CO_2e

6.4 Off-Road

Table E.19: Scoping Plan Goal 5

Scoping Plan Goal 5: 25% of energy demand from construction equipment electrified by 2030 and 75% electrified by 2045	
GHG Reduction Estimate Assumptions	The measure assumes that 25% of total offroad construction and mining equipment emissions are electrified by 2030 and 75% by 2045. It is assumed that efforts to reduce begin in 2030 and scale linearly until goals are met.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Total pre-measure tons CO_2 per day (tpd CO_2) from construction and mining equipment in the San Diego region is estimated and projected as follows: 2022: 468 tpd CO_2 2035: 469 tpd CO_2 2045: 472 tpd CO_2
2035 GHG Emissions Reduced	64,700 MT CO_2e
2045 GHG Emissions Reduced	117,300 MT CO_2e

6.5 Aviation

Table E.20 Scoping Plan Goal 6

Scoping Plan Goal 6: 20% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045.	
GHG Reduction Estimate Assumptions	The measure assumes 20% of all aviation fuel demand attributed to the San Diego Region (in the Take Off-Landing Cycle) is met by electricity or hydrogen with zero-emission production. All San Diego airports are included in this analysis (municipal, military operating from County-owned airports, and San Diego International). This measure assumes reduction programs start in 2040 and reach 20% reduction by 2045.
Models/Tools Used for GHG Reductions	None
Measure Specific Activity Data	Total MT CO_2e from all airports in 2045: 453,000
2035 GHG Emissions Reduced	0 MT CO_2e
2045 GHG Emissions Reduced	90,700 MT CO_2e

7 Approach to Incorporating the 2022 California Scoping Plan in the Roadmap

The Roadmap's Legislatively-Adjusted BAU, Draft 2025 Regional Plan category, and California Scoping Plan Goals category in the Roadmap Implementation Scenario include different subsets of the goals and actions from the 2022 California Scoping Plan. Table E.21 shows how the California 2022 Scoping Plan was accounted for in the Roadmap GHG reduction quantifications. It describes whether California Scoping Plan goals and actions were:

- Included in the California Scoping Plan Goals category of Roadmap Implementation Scenario (because it is not tied to adopted legislation or regulation but instead reflects the state's vision for reducing emissions by 2045),
- Counted in the Roadmap Legislatively Adjusted BAU projection (because it has been adopted through state law or regulation),
- Reflected in the Draft 2025 Regional Plan category (if covered by SANDAG's 2025 Regional Plan actions), or
- Excluded because the goal was not relevant to the San Diego region or lacked sufficient data for analysis.

Table E.21 2022 California Scoping Plan and Roadmap Comparison

California 2022 Scoping Plan Sector	California 2022 Scoping Plan Goal or Action	How it is Addressed in the Roadmap
Smart Growth / Vehicle Miles Traveled (VMT)	VMT per capita reduced 25% below 2019 levels by 2030, and 30% below 2019 levels by 2045.	Partially met through smart growth and VMT reductions incorporated in the 2025 Draft Regional Plan category as described in section 4.
Light-duty Vehicle (LDV) Zero Emission Vehicles (ZEVs)	100% of LDV sales are ZEV by 2035.	Partially included in Legislatively-Adjusted BAU and Roadmap Measure T-5, as described in Table E.5. Includes 82% of total VMT (LDV+HDV) to come from ZEVs by 2045 from the combined measures.
Truck ZEVs	100% of medium-duty (MDV)/ heavy-duty vehicle (HDV) sales are ZEV by 2040 (AB 74 University of California Institute of Transportation Studies [ITS] report).	Partially included in Legislatively-Adjusted BAU and Roadmap Measure T-5, as described in Table E.5. Includes 11% of MDV/HDV population to come from the combined measures.

Aviation	20% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045. Sustainable aviation fuel meets most or the rest of the aviation fuel demand that has not already transitioned to hydrogen or batteries.	Included as Scoping Plan Goal 6, as described in Table E.20
Ocean Going Vessels (OGVs)	2020 OGV At-Berth regulation fully implemented, with most OGVs utilizing shore power by 2027. 25% of OGVs utilize hydrogen fuel cell electric technology by 2045.	Not included. At-Berth OGV emissions not separated from total OGV emissions. Data on hydrogen technology is not available.
Port Operations	100% of cargo handling equipment is zero-emission by 2037. 100% of drayage trucks are zero emission by 2035.	Not included. Data on drayage trucks not available.
Freight and Passenger Rail	100% of passenger and other locomotive sales are ZEV by 2030. 100% of line haul locomotive sales are ZEV by 2035. Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others primarily utilize electricity.	Included in Legislatively-Adjusted BAU projection for Rail as described in Appendix D in line with CARB's 2023 In-Use Locomotive Regulation[15]
Oil and Gas Extraction	Reduce oil and gas extraction operations in line with petroleum demand by 2045.	Not included, not applicable to the San Diego Region
Petroleum Refining	CCS on majority of operations by 2030, beginning in 2028 Production reduced in line with petroleum demand.	Not included, not applicable to the San Diego Region
Electricity Generation	Sector GHG target of 38 million metric tons of carbon dioxide equivalent (MMT CO2e) in 2030 and 30 MMT CO2e in 2035. Retail sales load coverage.20 gigawatts (GW) of offshore wind by 2045. Meet increased demand for electrification without new fossil gas-fired resources.	Included in Legislatively-Adjusted BAU, as described in Appendix D.

[15] CARB's **In-Use Locomotive Regulation** was approved April 2023 and repealed in June 2025 as it did not get authorization from the EPA to enforce the regulation. This was included in the Legislatively-Adjusted BAU as during the analysis was conducted before the regulation was repealed.

New Residential and Commercial Buildings	All electric appliances beginning 2026 (residential) and 2029 (commercial), contributing to 6 million heat pumps installed statewide by 2030.	Significant electric transition incorporated into Legislatively-Adjusted BAU and Roadmap Measures B-1 and B-2, as described in Table E.8. Further measures not included as CARB has delayed its zero-emissions appliance rulemaking process.
Existing Residential Buildings	80% of appliance sales are electric by 2030 and 100% of appliance sales are electric by 2035. Appliances are replaced at end of life, such that by 2030 there are 3 million all-electric and electric-ready homes—and by 2035, 7 million homes—as well as contributing to 6 million heat pumps installed statewide by 2030.	Significant electric transition incorporated into Legislatively-Adjusted BAU and Roadmap Measures B-1 and B-2, as described in Table E.8. Further measures not included as CARB has delayed its zero-emissions appliance rulemaking process.
Existing Commercial Buildings	80% of appliance sales are electric by 2030, and 100% of appliance sales are electric by 2045. Appliances are replaced at end of life, contributing to 6 million heat pumps installed statewide by 2030.	Significant electric transition incorporated into Legislatively-Adjusted BAU and Roadmap Measure B-1 and B-2, as described in Table E.8.
Food Products	7.5% of energy demand electrified directly and/or indirectly by 2030; 75% by 2045.	Not included, not applicable to the San Diego Region
Construction Equipment	25% of energy demand electrified by 2030 and 75% electrified by 2045.	Included as Scoping Plan Goal 5, as described in Table E.19
Chemicals and Allied Products; Pulp and Paper	Electrify 0% of boilers by 2030 and 100% of boilers by 2045. Hydrogen for 25% of process heat by 2035 and 100% by 2045 Electrify 100% of other energy demand by 2045.	Not included, not applicable to the San Diego Region
Stone, Clay, Glass, and Cement	CCS on 40% of operations by 2035 and on all facilities by 2045. Process emissions reduced through alternative materials and CCS.	Included as Scoping Plan Goal 4, as described in Table E.18
Other Industrial Manufacturing	0% energy demand electrified by 2030 and 50% by 2045.	Included as Scoping Plan Goal 2, as described in Table E.16
Combined Heat and Power	Facilities retire by 2040.	Included as Scoping Plan Goal 1, as described in Table E.15

Agricultural Energy Use	25% energy demand electrified by 2030 and 75% by 2045.	Included in Roadmap Measure AG-1, as described in Table E.14
Low Carbon Fuels for Transportation	Biomass supply is used to produce conventional and advanced biofuels, as well as hydrogen.	Not included, not applicable to the San Diego Region
Low Carbon Fuels for Buildings and Industry	In 2030s, biomethan blended in pipeline. Renewable hydrogen blended in fossil gas pipeline at 7% energy (~20% by volume), ramping up between 2030 and 2040. In 2030s, dedicated hydrogen pipelines constructed to serve certain industrial clusters.	Not included, not applicable to the San Diego Region
Non-combustion Methane Emissions	Increase landfill and dairy digester methane capture. Some alternative manure management deployed for smaller dairies. Moderate adoption of enteric strategies by 2030. Divert 75% of organic waste from landfills by 2025. Oil and gas fugitive methane emissions reduced 50% by 2030 and further reductions as infrastructure components retire in line with reduced fossil gas demand.	Not included, not applicable to San Diego Region
High GWP Potential Emissions	Low GWP refrigerants introduced as building electrification increases, mitigating HFC emissions.	Included as Scoping Plan Goal 3, as described in Table E.17