TECHNICAL APPENDIX

Assumptions and Methodology for Estimating GHG Emissions Reductions

As a complement to this Technical Appendix, we have included three custom built Excel-based spreadsheet tools that were used to calculate GHG reductions for each of the three proposed measures. In addition, we have included a fourth custom built Excel spreadsheet to model the financing capacity of the revolving loan fund (RLF) for municipal building decarbonization.

Municipal Building Decarbonization

GHG Reduction Estimate Method

Overview

We used an Excel-based, custom-built **GHG reduction tool** to estimate impacts from municipal building decarbonization projects across the MSA from 2025 to 2050. A primary input to this tool was the number and rollout schedule of projects on an annual basis; these values were generated by a second custom-built, Excel-based **financing capacity model** of the RLF used for up-front financing of the projects. The financing capacity model determined the sustainable number of loans that could be issued from the RLF, given an initial funding of $100.5M, and considering the costs and payback terms of each of three types of municipal decarbonization projects:

- **Type 1 projects** (10% of budget) represent municipal facilities that want to save money on energy bills while decarbonizing (for example - office buildings).
- **Type 2 projects** (45% of budget) represent municipal facilities that provide essential services to the community (for example - police stations, court houses, post offices). Retrofitting these facilities would allow them to continue to operate to serve the public during a grid outage or other emergency. These projects have larger solar PV and battery storage systems compared to type 1 projects.
- **Type 3 projects** (45% of budget) represent municipal facilities that can offer shelter and emergency-related services to the public during an outage or other emergency, beyond their normal services (for example - libraries, community centers). Type 3 projects have the same size solar PV and battery systems as type 2 projects, and also include additional resilience program funding to support emergency-related services for communities.

Representative project costs were developed for each project type, as shown in the GHG spreadsheet. **Note that, although we will be leveraging all available local, federal, state, and ratepayer rebate and incentive programs for the municipal decarbonization projects, our GHG calculations assumed no outside funding in order to represent only those reductions associated with CPRG monies**.

All three project types incorporate energy efficiency (EE) upgrades, heat pump water heater (HPWH) installation, heat pump HVAC installation, and solar PV and battery storage installation, and assume the replacement of existing gas-fueled water and space heating equipment. To calculate the average annual GHG reductions by project type, the kWh and therm savings for each measure were converted to metric tons (MT) of CO_2e using conversion factors from Southern California Edison (SCE). We assumed a constant natural gas (therms) emission factor from 2025-2050 but scaled the average SCE kWh electricity emission factor from 2020-2022 out to 2050 according to statewide RPS standards.

To estimate the total GHG emission reductions, the GHG equivalents of kWh and therm savings for each project type were then multiplied by the assumed number of projects reached under the project budget.

The RLF is designed to maximize projects completed in the initial 5-year grant period. Loans will be interest-free with no fees or pre-payment penalties. There will also be a principal forgiveness incentive that will convert a portion of the loan to a grant for projects that are completed within the initial 5-year period (up to 25% for type 1 projects and up to 50% for type 2 projects). Loans will be structured with fixed repayments for ease of agency budgeting and loan terms will be capped at 15 years.

Models/Tools Used

Our analysis used an excel-based custom built tool to calculate GHG emissions reductions. Feeding into that tool was a financing capacity model that allowed us to determine a feasible number of projects to assume in the GHG reductions calculations. Both workbooks are included as application attachments.

Measure Implementation Assumptions

We assume that projects are implemented starting in 2025, with a staggered rollout rate through 2029 as follows:

- Year 1: 10%
- Year 2: 25%
- Year 3: 30%
- Year 4: 25%
- Year 5: 10%

We assume that the installed equipment is replaced in kind when it reaches the end of its effective useful life, and therefore GHG savings for each project continues to accrue through 2050.

Furthermore, because the project rollout assumptions have been shown by the RLF financing capacity model to be sustainable through 2050 and beyond, we assume that additional projects will continue to be implemented beyond the 5-year grant term, extending the effective life of the original pool of CPRG funds. Therefore, these additional projects also accrue GHG savings through 2050.

GHG Reduction Estimate Assumptions

Additional key assumptions in the municipal building decarbonization analysis include the following:

- We assumed a constant natural gas emission factor from 2025-2050 but scale the average of SCE's carbon intensity factors per kWh from 2020-2022 out to 2050 according to statewide RPS standards of 60% renewable energy by 2030, 90% by 2035, 95% by 2040, and 100% by 2045. As such, there are no GHG savings associated with reduced electricity consumption after 2045, as the reference scenario yields zero GHG emissions from all grid electricity consumption. There are still GHG savings associated with reduced natural gas consumption.
- We assumed a representative solar PV size of 725 kW with 305 kWh battery storage capacity for project type 1. For project types 2 and 3, we assume a solar PV size of 1,014 kW with 3,714 kWh battery capacity.
- Implementation costs per measure were estimated using quotes from contractors and incorporate the full installed costs of the measures including markup, profit, installation labor, etc.
- To calculate GHG reductions we've determined that 6 Type 1 projects, 10 Type 2 projects, and 10 Type 3 projects can be completed in the initial 5-year grant period, given the funding allocation and assuming no external project funding to buy down the loan. To determine this, we utilized a

financing capacity model that takes into account the recycling of loan funds from repayments in the first five years and the potential for partial loan forgiveness.

- Using the same financing capacity model, we've determined that an additional 5 Type 1 projects, 7 Type 2 projects, and 7 Type 3 projects can be completed after the initial 5-year period utilizing the RLF as it recycles based on loan repayments.

Reference Case Scenario

We used an activity-level reference scenario approach. Reference case electricity and natural gas emission factors from SCE were used to calculate the GHG emissions avoided through decarbonization measures that affect building electricity and natural gas consumption.

Measure Specific Activity Data

Building Decarbonization Measure	Project Types	kWh Savings	Therm Savings
HPWH	All	-13,000	1,400
Heat Pump HVAC	All	30,406.	234
EE Upgrades	All	60,813	N/A
725 kW Solar PV with 305 kWh battery capacity	Project type 1	422,432	N/A
1,014 kW Solar PV with 3,614 kWh battery capacity	Project types 2 and 3	528,189	N/A

GHG Emissions Reduced

Annual average and cumulative emissions reductions for each timeframe are shown below. Specific yearly reductions are shown in the GHG reduction spreadsheet.

Calculated Impacts	Units	Value
Average Annual Reductions[4]	MTCO2e	1,088
2025-2030 Cumulative Reductions	MTCO2e	11,323
2025-2050 Cumulative Reductions	MTCO2e	28,287

GHG Reduction Uncertainties

Uncertainties with potential to impact the estimated GHG emission reduction estimates include:

- Equipment assumptions, including:
    - Efficiency for both existing and replacement equipment
    - Solar PV production
    - Equipment useful life
- Overall building energy demand

[4] The average annual reduction is calculated by summing the total from 2025-2050 divided by 26 years.

- Cost assumptions for equipment and contractor labor
- Schedule assumptions, including interest by agencies, time to completion for any individual project, and overall rollout timeline over the 5-year grant term. *Schedule assumptions were discussed in the Narrative, under section 1a (Underlying Assumptions, Risks, and Impacts).*

Equipment assumptions are based on data from dozens of recently completed projects in Southern California, many of which include before and after metered data of energy consumption, as well as from highly accurate solar potential mapping conducted by national laboratories, and manufacturer's equipment specifications. While there is a risk that the performance of any given piece of equipment or individual project might be lower than assumed, we anticipate that there will also be cases of higher performance that, on balance, will keep the average of all projects within a few percentage points of our assumptions. This should not have a significant impact on the overall anticipated GHG reductions from these projects.

Overall building energy demand might increase over time, based on factors such as expanded hours, increased plug loads, or increased need for cooling as temperatures rise. The incorporation of solar and storage elements in the measure design will allow for this increased demand to be met by clean energy generated on site and stored for use during peak grid hours. We therefore do not anticipate risks from increased energy demand to have a significant impact on GHG emission reductions.

Cost assumptions for equipment and contractor labor are based on data from similar recent projects. The risk of prices increasing over time has been addressed in the budget by a built-in escalation over the five year grant term to reflect expected cost trends. If prices rise faster than expected, there is a risk that projects may not be able to include all desired components, or that fewer projects can be completed during the project term. We engaged PFM Advisors to create a financing capacity model, which is included with the optional GHG calculation spreadsheets. This model was developed with highly conservative inputs beyond actual expectations to test the fund's durability, including a heavily front-loaded rollout rate and assuming each project will take out the maximum available loan.

Residential Building Decarbonization

GHG Reduction Estimate Method

Overview

We used an Excel-based, custom built **GHG reduction tool** to estimate impacts from residential building decarbonization projects from 2025 to 2050. The residential sector decarbonization measures were identified based on the upcoming California Energy Commission (CEC) Equitable Building Decarbonization (EBD) Direct Install Program and complemented by regional stakeholder input on additional measures appropriate for the region including solar PV and storage.

Representative project costs were developed for each residential building type (single family, multi-family, and manufactured), and assumed leveraging of all available local, federal, state, and ratepayer rebate and incentive programs. It was assumed that 85% of funds would be allocated to single-family homes, 10% to multi-family homes, and 5% to manufactured homes, based on assessor's parcel data on building type for the MSA region.

The GHG reduction tool contains a detailed list of the appliances and equipment assumed to be included in a typical project by building type. The EE or fuel switching measures' kWh or therm savings were obtained from the California Electronic Technical Reference Manual (CAeTRM). To calculate the GHG emission reductions of the solar and battery storage installations, we assumed a representative solar project size of 4.2 kW and used the NREL PV Watts calculator tool[5] to estimate a typical annual kWh production for the region. We assumed an AC-coupled battery storage system with a capacity of 26.4 kWh and 1 battery cycle per day to estimate the annual kWh in energy avoided from the grid.

To calculate the GHG emission reductions for a typical single family, multi-family, and manufactured home, the kWh and therm savings for each measure were converted to metric tons (MT) of CO_2e using conversion factors from SCE. We assumed a constant natural gas (therms) emission factor from 2025-2050 but scaled the average SCE kWh electricity emission factor from 2020-2022 out to 2050 according to statewide RPS standards.

To estimate the average annual GHG reductions by home type, the GHG equivalents of kWh and therm savings were multiplied by the typical home quantities of the unit of each decarbonization measure. Subsequently, the GHG reduction estimate per home was multiplied by the assumed number of homes and/or units reached under the project budget. Lastly, to only account for the GHG emissions that are covered from potential CPRG funds, we applied a ratio for each home type of the amount of CPRG funds needed divided by the total cost of the program.

Models/Tools Used

Our analysis used an excel-based custom built tool that incorporated annual solar production data obtained from the NREL PV Watts calculator tool.

Measure Implementation Assumptions

We assume that the program is implemented starting in 2025, with a staggered rollout rate through 2029 as follows:

- Year 1: 10%
- Year 2: 25%
- Year 3: 30%
- Year 4: 25%
- Year 5: 10%

We assume that the installed appliances and equipment are replaced in kind when they reach the end of their effective useful life, and therefore GHG savings for each project continues to accrue through 2050.

GHG Reduction Estimate Assumptions

Additional key assumptions in the residential building decarbonization analysis include the following:

- We assume a constant natural gas emission factor from 2025-2050 but scale the average of SCE's carbon intensity factors per kWh from 2020-2022 out to 2050 according to statewide RPS standards of 60% renewable energy by 2030, 90% by 2035, 95% by 2040, and 100% by 2045. As such, there are no GHG savings associated with reduced electricity consumption after 2045, as the reference scenario yields zero GHG emissions from all grid electricity consumption. There are still GHG savings associated with reduced natural gas consumption.
- Solar and battery storage installations were only included for single-family homes.
- We assume a representative 4.2 kW solar installation and 26.4 kWh battery storage capacity for each single-family home.

[5] National Renewable Energy Laboratory. "NREL's PVWatts Calculator." NREL. https://pvwatts.nrel.gov/index.php.

- 85% of the budget is allocated to single family homes, 10% to multi-family homes, and 5% to manufactured homes.
- Implementation costs per measure were estimated using quotes from contractors and incorporate the full installed costs of the measures including markup, profit, installation labor, etc.
- **To avoid claiming GHG reductions from portions of the projects that are covered by other funding sources, we applied a ratio for each home type of the amount of CPRG funds needed divided by the total cost of the program. These ratios were approximately 56% for single family homes, 68% for multi-family homes, and 63% for manufactured homes.**

Reference Case Scenario

We used an activity-level reference scenario approach. Reference case electricity and natural gas emission factors were used from SCE to calculate the GHG emissions avoided through decarbonization measures that affect building electricity and natural gas consumption.

Measure Specific Activity Data

We used kWh and therm savings from CAeTRM to calculate GHG savings for the building decarbonization measures. We used the NREL PV Watts calculator tool[6] to estimate an annual kWh production from the representative 4.2 kW residential solar project.

GHG Emissions Reduced

Annual average and cumulative emissions reductions for each timeframe are shown below. Specific yearly reductions are shown in the GHG reduction spreadsheet.

Calculated Impacts	Units	Value
Average Annual Reductions[7]	MTCO2e	783
2025-2030 Cumulative Reductions	MTCO2e	4,953
2025-2050 Cumulative Reductions	MTCO2e	20,424

GHG Reduction Uncertainties

Uncertainties with potential to impact the estimated GHG emission reduction estimates include:

- Appliance and equipment assumptions, including:
  - Efficiency for both existing and replacement appliances
  - Solar PV production
  - Equipment useful life
- Overall household energy demand
- Cost assumptions for equipment and contractor labor
- Schedule assumptions, including time to completion for any individual project and overall rollout timeline over the 5-year grant term. *Schedule assumptions were discussed in the Narrative, under section 1a (Underlying Assumptions, Risks, and Impacts).*

[6] National Renewable Energy Laboratory. “NREL’s PVWatts Calculator.” NREL. https://pvwatts.nrel.gov/index.php.
[7] The average annual reduction is calculated by summing the total from 2025-2050 divided by 26 years

Equipment assumptions are based on data from hundreds of recently completed projects in Southern California, many of which include before and after metered data of energy consumption, as well as from highly accurate solar potential mapping conducted by national laboratories, and manufacturer's appliance specifications. While there is a risk that the performance of any given appliance or piece of equipment or individual home project might be lower than assumed, we anticipate that there will also be cases of higher performance that, on balance, will keep the average of all projects within a few percentage points of our assumptions. This should not have a significant impact on the overall anticipated GHG reductions from these projects.

Overall household energy demand might increase over time, based on factors such as baseline insufficiency (e.g., not cooling a home to a safe temperature to avoid high energy bills), increased plug loads, or increased need for cooling as temperatures rise. The incorporation of solar and storage elements in the measure design will allow for this increased demand to be met by clean energy generated on site and stored for use during peak grid hours. We therefore do not anticipate risks from increased energy demand to have significant impacts on GHG emission reductions.

Cost assumptions for equipment and contractor labor are based on data from similar recently completed projects. The risk of prices increasing over time has been addressed in the budget by a built-in 2.5% escalation over the 5-year grant term to reflect expected cost trends. If prices rise faster than expected, there is a risk that projects may not be able to include all desired components or that fewer projects can be completed during the project term. In addition to changes in cost, the program anticipates that incentive and rebate program offerings will fluctuate throughout the course of the project. To mitigate any impacts to the project, The Energy Coalition (subconsultant) will utilize its expertise in navigating and leveraging incentive programs to apply to all eligible federal, state, and other offerings to maximize cost-effectiveness of the CPRG funds throughout the duration of the project period.

Light Duty Electric Vehicle (EV) Infrastructure

GHG Reduction Estimate Method

Overview

Emissions reductions resulting from the expansion of electric vehicle (EV) charging infrastructure are estimated using the following methods and assumptions for Level 2 (7.5 KW) and DC Fast Chargers (DCFC; 150 KW). To estimate electricity usage from EV chargers, the following formula was used:

(# of chargers operational per year X # of charging sessions per day)/(Grid Loss Factor) X days per year)

Where:

- # of chargers operational per year = variable
- # of charging sessions per day = 0.4 for Level 2, 12.0 for DCFC
- Grid Loss Factor = 0.9
- Days per year = 365

Charging session assumptions were developed using data from Electrify America's Quarterly Reports submitted to the California Air Resources Board (CARB).[8] These reports include actual data on statewide chargers, including the sessions per charger per day. The calculation uses the average sessions per day for Statewide Level 2 Chargers and DCFC. The sum of Level 2 and DCFC electricity was then multiplied by the carbon intensity of electricity (expressed in pounds CO2e per MWh) based on the chargers' operational year, and converted to metric tons.

[8] CARB, 2023. Electrify America Reports. Available at: https://ww2.arb.ca.gov/resources/documents/electrifyamerica-reports

After estimating electricity usage, the amount of displaced vehicle miles traveled (VMT) was calculated by dividing the total electricity usage by the fuel efficiency of an EV (expressed in kWh per mile).[9] The resultant VMT represents the number of miles traveled by EVs that would have otherwise been traveled by internal combustion engine (ICE) vehicles. The VMT was then multiplied by an annual weighted average emission factor (expressed in grams CO2e per mile) derived from EMFAC2021 and converted to metric tons.[10] [11] EMFAC2021 is a preferred model for California emissions calculations, as it is based on CA county-specific data. The net emissions reductions were then calculated as the difference between the emissions generated from charger electricity consumption and the emissions reductions from displacing ICE vehicles with EVs for each year that EV chargers are active.

Models/Tools Used

A spreadsheet model was developed. EMFAC2021, an on-road emissions model that provides emissions data for criteria pollutants and GHGs, was used to derive the average emissions rate (in grams per mile) of CO2e for a gasoline light-duty vehicle operating in San Bernardino and Riverside Counties in year 2023. Emissions from electricity usage by EV chargers were estimated by forecasting emission factors for year 2025 from EPA's eGRID tool, which provides grid average regional emission factors through 2022.

Measure Implementation Assumptions

We assume that the program is implemented starting in 2025, with a staggered rollout rate through 2029 as follows:

- Year 1: 8%
- Year 2: 25.5%
- Year 3: 31%
- Year 4: 25.5%
- Year 5: 10%

The EV scenario analyzed includes implementation of 500 Level 2 chargers and 285 DCFCs in 2025. For purposes of evaluating emissions from 2025-2030 and 2025-2050, chargers were assumed to be operational through 2050. We assume that chargers are replaced when they reach the end of their effective useful life.

GHG Reduction Estimate Assumptions

The carbon intensity value uses historical data from EPA's Emissions & Generation Resource Integrated Database (eGRID) Tool to project future year emission factors considering the State's Renewables Portfolio Standard (RPS) requirements for utilities to procure 60 percent renewable energy by 2030 and 100 percent renewable energy by 2045.[12] For example, electricity generated by EV chargers in the year 2045 or later is assumed to produce zero emissions as the electrical grid is anticipated to be carbon-free.

No external funding was assumed for this measure, and therefore all GHG reductions are associated with CPRG grant funds.

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[9] The fuel efficiency of EVs were calculated by running EMFAC2021 in Emissions Inventory mode and dividing the energy consumption of passenger EVs by their total VMT. EMFAC2021 assumes that the fuel efficiency of passenger EVs does not increase over time.

[10] CARB, EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory

[11] The emission factors include all passenger vehicles (EMFAC vehicle types LDA, LDT1, LDT2, MCY, and MDV) within San Bernardino and Riverside Counties for each year from 2020 through 2045. EMFAC2021's latest project year is 2045, therefore emission factors for years after 2045 are assumed to be the same as 2045.

[12] CARB, Renewables Portfolio Standard. Available at: https://ww2.arb.ca.gov/our-work/programs/renewablesportfolio-standard

Reference Case Scenario

This analysis represents a business-as-usual (BAU) scenario in which the regulations in place at the time of analysis are assumed to be carried forward for future years. In other words, the analysis does not account for planned state regulations (e.g. Pavley Vehicle Standards and Renewables Portfolio Standard) that would increase the efficiency of on-road vehicles and further decarbonize the electricity grid by the year 2030.

Measure-Specific Activity Data

Cost estimates were based on the following per-unit values in year 2030:[13]

- Level 2 EVCS, upfront capital costs and costs per year of full operation:
    - $25,000 capital cost per charger (equipment and infrastructure costs)
    - $720 maintenance cost per charger
    - $300 network cost per charger
- DCFC EVCS, upfront capital costs and costs per year of full operation
    - $130,000 capital cost per charger (equipment and infrastructure costs)
    - $1,400 maintenance cost per charger
    - $300 network cost per charger

GHG Emissions Reduced

Calculated Impacts	Units	Value
Average Annual Reductions[14]	MTCO2e	28,052
2025-2030 Cumulative Reductions	MTCO2e	115,573
2025-2050 Cumulative Reductions	MTCO2e	729,352

GHG Reduction Uncertainties

Uncertainties with potential to impact the estimated GHG emission reduction estimates include:

- Customer utilization
- Cost assumptions for equipment and contractor labor
- Schedule assumptions, including utility interconnection, equipment shipping delays, and overall rollout timeline over the 5-year grant term. *Schedule assumptions were discussed in the Narrative, under section 1a (Underlying Assumptions, Risks, and Impacts).*

Customer utilization assumptions are based on data from hundreds of monitored charger installations throughout California. While there is a risk that customer utilization at any given charger location might be lower than assumed, we anticipate there will also be cases of higher utilization that, on balance, will keep the average across all installed chargers within a few percentage points of our assumptions. We have also incorporated the following elements to support a high level of utilization: (1) funding is included for community outreach to inform the location of charging stations; (2) the selected contractor(s) will be required to meet requirements for providing real-time operational metrics and achieving a 97% up-time standard. Finally, given the state's EV targets, and the new federal rules requiring the majority of new car sales be electric or hybrid by 2032, we have good reason to anticipate

[13] Estimates include costs from equipment and infrastructure, electricity usage, maintenance, operations, and network.

[14] The average annual reduction is calculated by summing the total from 2025-2050 divided by 26 years.

increasing levels of utilization over time as the availability of charges supports the communities' increased adoption of EVs. We believe there is a low risk of significant impact from utilization rate assumptions on the overall anticipated GHG reductions from this measure.

If prices increase more than expected, there is a risk that projects may not be able to include all desired components, or that fewer projects can be completed during the project term. To address this risk, cost assumptions for equipment and contractor labor are conservative – based on data from similar recently completed projects and expected cost trends.