City of Bakersfield

Climate Pollution Reduction Grant

Greenhouse Gas Reduction Assumptions Technical Appendix

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March 2024

*Disclaimer: This project has been funded wholly or in part by the United States Environmental Protection Agency (EPA) under assistance agreement 98T74201 to the City of Bakersfield. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.*

# Executive Summary

This technical appendix describes the analysis underlying the cost and greenhouse gas (GHG) reductions of the near-term projects in the City of Bakersfield (City) that will be funded from the Climate Pollution Reduction Grant (CPRG). Table 1 below summarizes the results of this analysis. In total, the projects will cumulatively reduce 11,049 metric tons of carbon dioxide equivalent (MT CO2e) by 2030, and 60,823 MT CO2e by 2050. All references to CO2e in this document include the global warming effects of carbon dioxide, methane, and nitrous oxide. These gases are assumed to have global warming potentials of 1, 27.9, and 273, respectively, which were the values used in the City’s Climate Action Plan (City of Bakersfield 2023: 10).

Table 1 Summary of Requested CPRG Funding and GHG Reductions from City of Bakersfield

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Project Number | Project Name | Budget | Average Annual Reductions  (MT CO2e / year) | | Cumulative  Reductions  (MT CO2e / year) | |  |
| 2025 - 2030 | 2025 - 2050 | 2025 - 2030 | 2025 - 2050 | $ per MT CO2e Reduced (2025-2030) |
| 1 | MLK Community Center: energy efficiency | $15,000,000 | 94 | 143 | 565 | 3,718 | $26,548 |
| 2 | Solar on low-income housing | $460,800 | 8 | 7 | 47 | 189 | $9,748 |
| 3 | Weatherization for low-income Residents | $2,975,175 | 40 | 47 | 243 | 1,230 | $12,246 |
| 4 | Citywide solar PV System | $25,650,000 | 639 | 421 | 3,835 | 10,962 | $6,689 |
| 5 | Low-income energy efficiency program | $6,859,868 | 54 | 39 | 324 | 1,013 | $21,177 |
| 6 | EV charging and Vehicles | $40,950,000 | 719 | 1,347 | 4,317 | 35,046 | $9,487 |
| 7 | Project E-Bike | $5,000,000 | 211 | 234 | 1,266 | 6,079 | $3,949 |
| 8 | Complete Streets | $61,330,130 | 6 | 11 | 35 | 283 | $1,728,912 |
| 9 | Enhanced Street Trees | $665,000 | 4 | 5 | 24 | 127 | $28,148 |
| 10 | Tree plantings and sod for undeveloped parks | $18,483,500 | 11 | 14 | 69 | 368 | $269,632 |
| 11 | Median xeriscaping | $500,000 | 1 | 0 | 6 | 12 | $90,119 |
| 12 | Organic material processing equipment and vehicles | $3,085,000 | 49 | 64 | 295 | 1,660 | $10,443 |
| 13 | Recyclables processing equipment | $7,050,000 | 4 | 5 | 24 | 135 | $293,259 |
| **Total** | | **$188,009,473** | **1,842** | **2,338** | **11,049** | **60,823** | **$17,016\*** |

Notes: CPRG = Climate Pollution Reduction Grant; GHG = greenhouse gases, MT CO2e = metric tons of carbon dioxide equivalent.

\*This value is an average cost per metric ton of carbon dioxide equivalent reduced.

Totals may not sum exactly due to independent rounding.

Source: Prepared by Ascent in 2024.

The following text documents the specific methods and assumptions for each project. The full Excel workbook with calculations is provided as an attachment.

# PROJECT CARBON REDUCTION QUANTIFICATION

##### Project 1: Martin Luther King, Jr Community Center

It was assumed that without the funding requested, the Community Center would obtain a certification level pursuant to the US Green Building Council’s Leadership in Energy and Environmental Design (LEED) program; with the funding, it was assumed to achieve a LEED Silver rating. Silver-rated buildings have a lower carbon intensity per square foot than a Certified-rated building. Table 2 below shows the resulting emissions reduction from this lower carbon intensity. Estimates of emissions intensity per square foot were derived from Green Business Certification, Incorporated (2024), and new square footage for this building was derived from the City of Bakersfield’s public materials describing the new community center (2022).

The new community center would be fully constructed in June 2027; thus, its annual emissions reductions were prorated for both the 2025-2030 period and the 2025-2050 period accordingly. This proration approach applies for all other projects in this memorandum.

Table 2 GHG Emissions Reduction from LEED Silver Certification for the MLK Community Center

|  |  |
| --- | --- |
| Item | Quantity |
| Building square footage | 78,775 |
| LEED Certified MT CO2e per square foot per year | 0.009 |
| LEED Silver MT CO2e per square foot per year | 0.007 |
| MT CO2e reduction (per square foot per year) | 0.002 |
| Assumed construction completion date | 6/1/2027 |
| MT CO2e reduction (per year) | 158 |
| 2025-2030 average annual emissions reductions (prorated) MT CO2e | 94 |
| 2025-2050 average annual emissions reductions (prorated) MT CO2e | 143 |

Notes: GHG = greenhouse gas; LEED = Leadership in Energy and Environmental Design; MLK = Martin Luther King, Jr.; MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

##### Projects 2, 4, and 5 (Solar Photovoltaic Projects)

For these projects (Project 2, Solar on low-income housing; Project 4, citywide solar photovoltaic; and Project 5, low-income energy efficiency), photovoltaic (PV) array size in kilowatts (kW), online date, and cost were provided by the City. The City also provided annual kilowatt-hour (kWh) generation for the citywide solar PV facilities and the low-income energy efficiency projects (City of Bakersfield, pers. comm., 2024). For the low-income housing project, its generation was estimated assuming a capacity factor of 19 percent,[[1]](#footnote-2) which is the same as the capacity factor of Project 5 (both projects are rooftop solar and thus expected to have similar capacity factors).

Annual energy generation was assumed to offset grid power at the emissions factors from the Bakersfield Climate Action Plan (City of Bakersfield 2023: 122). Table 3 below summarizes the results of this calculation. The declining average annual GHG reductions are due to emissions factors which decrease over time due to low-carbon energy mandates in California (such as the Renewables Portfolio Standard and the state’s carbon neutrality target by 2045 [Assembly Bill 1279]). Emissions factors in interim years between those modeled in that plan were linearly interpolated.

Table 3 GHG Emissions Reduction from Solar Photovoltaic Projects

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Project 2: Solar on Low-Income housing | Project 4: Citywide Solar PV Facilities | Project 5: Low-Income Energy Efficiency |
| Photovoltaic array size (AC kW) | 144 | 5,000 | 705 |
| Cost ($) | $460,800 | $25,650,000 | $6,859,868 |
| Capacity factor | 19% | 27% | 19% |
| Annual kWh savings | 236,384 | 11,970,000 | 1,157,298 |
| Monthly kWh savings | 19,699 | 997,500 | 96,442 |
| Assumed online date | 6/1/2028 | 12/2/2026 | 6/2/2027 |
| Months until end of 2030 | 31 | 50 | 44 |
| Months until end of 2050 | 275 | 293 | 287 |
| Average emissions factors until end of 2030 (MT CO2e / MWh) | 0.076 | 0.077 | 0.077 |
| Average emissions factors until end of 2050 (MT CO2e / MWh) | 0.035 | 0.037 | 0.037 |
| 2025-2030 cumulative emissions reductions (MT CO2e) | 47 | 3,835 | 324 |
| 2025-2050 cumulative emissions reductions (MT CO2e) | 189 | 10,962 | 1,013 |
| 2025-2030 average annual emissions reductions (prorated) MT CO2e | 7.88 | 639.13 | 53.99 |
| 2025-2050 average annual emissions reductions (prorated) MT CO2e | 7.26 | 421.40 | 38.94 |

Notes: AC kW = alternating current kilowatts; kWh = kilowatt-hours; MW = megawatt-hours; MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

##### Project 3: Weatherization for Low-Income Residents

Data from the California Air Resources Board (CARB) (2023: 15) was used to estimate the effects of weatherization on energy savings, assuming that this project is implemented in single-family homes. The per-home values shown in Table 4 below were then multiplied by the number of homes weatherized (on average, 20 homes per year between 2025 and 2029).

Table 4 Emissions Calculations for Weatherization for Low-Income Residents

|  |  |
| --- | --- |
| Item | Quantity |
| Reduction per home per year from weatherization (therms) | 74 |
| Reduction per home per year from weatherization (MWh) | 2.43 |
| Average emissions factors until end of 2030 (MT CO2e / MWh) | 0.079 |
| Average emissions factors until end of 2050 (MT CO2e / MWh) | 0.041 |
| Natural gas emissions factor, MT CO2e per therm | 0.00532 |

Notes: MWh = megawatt-hour, MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

##### Project 6: EV Charging and Vehicles

The City provided a list of internal combustion engine vehicles from its fleet that it would replace with electric vehicles using CPRG funding. It also provided the projected cost of these vehicle replacements and the current average annual fuel usage per vehicle, in gallons per year per vehicle (Flores, pers. comm., 2024). These data were matched with emissions type per gallon of fuel from CARB’s EMissions FACtor model (2024) to calculate emissions. This calculation is summarized in Table 5 below, which shows total emissions reductions from complete electrification.

Table 5 City of Bakersfield Vehicles Eligible for Electrification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Vehicle Type | Fuel | Fuel Consumption (gallon/vehicle/year) | Emissions Factor  (lb CO2e / gallon) | Vehicles Electrified | Vehicle Purchase Cost | Emissions Reduction from Electrification  (MT CO2e/year) |
| Solid Waste Collection Vehicles | CNG | 8,253 | 18.84 | 7 | $7,000,000 | 497 |
| CAT Loaders | Diesel | 6,466 | 23.35 | 4 | $3,500,000 | 274 |
| Excavators | Diesel | 350 | 23.35 | 2 | $1,600,000 | 7 |
| Dump Truck | Diesel | 1,700 | 23.35 | 4 | $2,400,000 | 72 |
| Fire Engine | Diesel | 2,888 | 23.35 | 1 | $2,500,000 | 31 |
| Police SUV Interceptor | Gasoline | 1,108 | 19.32 | 30 | $2,400,000 | 289 |
| Compact Vehicle | Gasoline | 238 | 19.32 | 35 | $1,750,000 | 72 |
| Pickup Truck | Gasoline | 711 | 19.32 | 28 | $2,200,000 | 173 |
| Utility Truck | Gasoline | 980 | 19.32 | 12 | $2,600,000 | 102 |
| Bucket Truck | Gasoline | 2,043 | 19.32 | 1 | $500,000 | 18 |
| **Total** |  | | | **124** | **$26,450,000** | **1,535** |

Notes: CNG = compressed natural gas, lb CO2e = pounds of carbon dioxide equivalent; MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

It was assumed that this electrification takes place over four years, starting at the beginning of 2025. The amount of vehicles electrified in a given year was calculated based on that year’s prorated share of program expenditures: $10 million, $6.5 million, $5 million, and $5 million in Years 1, 2, 3, and 4, respectively. Thus, emissions reductions in those years are 579 MT CO2e, 956 MT CO2e, 1,246 MT CO2e, and 1,535 MT CO2e, respectively.

##### Project 7: Project E-Bike

It was assumed that e-bikes substitute for vehicle trips (i.e., displace vehicle miles traveled [VMT], and thus reduce vehicle emissions) using the assumptions in Table 6 below. The City provided data on the number of residents receiving an e-bike voucher and the total cost of issuing vouchers (City of Bakersfield, pers. comm., 2024). It was assumed that the average one-way bike trip length[[2]](#footnote-3) was 1.7 miles (California Air Pollution Control Officers 2021: C-2), riders used their bikes 0.18 times per day (calculated assuming a median trip frequency of 5 trips per 28 days—see Fitch, Mohiuddin, and Handy [2021]), and there were 347 travel days per year (California Air Resources Board 2018: 238).

Table 6 Project E-Bike Emissions Reductions Calculation Assumptions

|  |  |
| --- | --- |
| Item | Quantity |
| Number of residents receiving e-bike voucher | 4,614 |
| Dollars per voucher (includes overhead) | $1,084 |
| Total cost ($) | $5,000,000 |
| Average one-way bike trip length (miles) | 1.7 |
| Average round-trip length (miles) | 4.2 |
| Uses of E-bike per day | 0.18 |
| Uses of E-bike per year | 62 |
| Displaced VMT per person per year | 260 |

Notes: VMT = Vehicle miles traveled.

Source: Prepared by Ascent in 2024.

This displaced VMT was then applied to grams per VMT emissions factors from the Bakersfield Climate Action Plan (2023: 136) to calculate CO2e savings, as shown in Table 7 below.

Table 7 GHG Reductions from E-Bike Adoption

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 2025 | 2030 | 2040 | 2045 | 2050 |
| g CO2e per VMT | 300 | 285 | 243 | 236 | 215 |
| Total MT CO2e savings | 292 | 277 | 237 | 229 | 209 |

Notes: g CO2e per VMT = grams of carbon dioxide equivalent per vehicle mile traveled; MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

##### Project 8: Complete Streets

Complete streets projects were assumed to add bike lanes and trees (which reduce emissions by reducing VMT and sequestering carbon via photosynthesis, respectively) in the quantities and cost in Table 8 below.

Table 8 Bike Lanes and Trees Added by Complete Streets Projects

|  |  |  |  |
| --- | --- | --- | --- |
| Project | Miles of Bike Lane | Trees | Cost |
| 18th/19th Street | 2.4 | 65 | $26,000,000 |
| 34th Street | 1.6 | 60 | $11,700,000 |
| Niles and Monterey | 5.25 | 150 | $23,630,130 |
| **Total** | **9.25** | **275** | **$61,330,130** |

Source: Data provided by City of Bakersfield (2024a); Prepared by Ascent in 2024.

The increased miles of bike lane were inputted into the California Air Pollution Control Officers’ (CAPCOA’s) Formula T.20: Expand Bikeway Network, assuming 260 miles of bike lanes before the implementation of complete streets (City of Bakersfield 2017: 4), and 269.25 afterward. Table 9 below shows the inputs to this formula.

Table 9 Inputs to CAPCOA Formula T.20: Expand Bikeway Network

|  |  |
| --- | --- |
| Item | Quantity |
| Existing bikeway miles in plan/community | 260 |
| Bikeway miles in plan/community with measure | 269.25 |
| Bicycle mode share in plan/community | 0.18% |
| Vehicle mode share in plan/community | 94.19% |
| Average one-way bicycle trip length in plan/community | 1.7 |
| Average one-way vehicle trip length in plan/community | 9.7 |
| Elasticity of bike commuters with respect to bikeway miles per 10,000 population | 0.25 |

Notes: CAPCOA = California Air Pollution Control Officers.

Source: Prepared by Ascent in 2024.

This resulted in a VMT reduction of approximately 0.0003 percent of citywide annual passenger VMT in Bakersfield. This value was then applied to VMT values from the Bakersfield CAP (2023: 136) to calculate emissions reductions.

Table 10 GHG Emissions Reduction from Bike Lanes in Complete Streets Projects

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Item | 2025 | 2030 | 2040 | 2045 | 2050 |
| Citywide Annual Passenger VMT | 2,304,797,776 | 2,461,505,091 | 2,844,970,206 | 2,954,977,196 | 3,146,709,754 |
| Annual VMT reductions | 6,866 | 7,333 | 8,475 | 8,803 | 9,374 |
| Grams CO2e per mile | 300 | 284.95 | 243.36 | 235.99 | 215 |
| **MT CO2e reduction** | **2** | **2** | **2** | **2** | **2** |

Notes: MT CO2e = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Prepared by Ascent in 2024.

In addition to the reductions from bike lanes above, carbon reductions from the new street trees in Table 8 (Bike Lanes and Trees Added by Complete Street Projects) were added to the values in the table above, assuming each tree sequesters 0.0354 MT CO2e per year, and that tree are fully grown after 20 years and cease to sequester carbon thereafter (California Air Pollution Control Officers 2010: 402). This resulted in 9.7 MT CO2e per year, which was added to the values in Table 10 to get approximately 12 MT CO2e per year.

##### Projects 9: (Enhanced Street Trees) and 10 (Parks)

For these projects, the City provided tree counts (City of Bakersfield 2024a), which were multiplied by the 0.0354 MT CO2e per year sequestration value shown above. For park projects, an exact tree count was not available, so parks were assumed to have 10 trees per acre (Villa, pers. comm., 2024). Table 11 shows this calculation.

Table 11 GHG Reductions from Enhanced Street Trees and Parks

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Project Number | Project Type | Project Name | Acres | Total Cost ($) | Number of Trees | MT CO2e per year Reduction (2025 – 2030) | MT CO2e per year Reduction (2025 – 2050) |
| 9 | Street Trees | Truxtun Avenue, Millcreek and Central Park | NA | $665,000 | 182 | 6.4 | 5.2 |
| 10 | Park | South Oswell | 7.49 | $2,621,500 | 75 | 2.7 | 2.1 |
| 10 | Park | Antonio Giovanni | 16.5 | $5,775,000 | 165 | 5.8 | 4.7 |
| 10 | Park | Buena Vista Ranch | 7.3 | $2,555,000 | 73 | 2.6 | 2.1 |
| 10 | Park | Hershel Moore | 12.02 | $4,207,000 | 120 | 4.3 | 3.4 |
| 10 | Park | Berkshire Park | 3.2 | $1,120,000 | 32 | 1.1 | 0.9 |
| 10 | Park | Coffee and Etchart | 6.3 | $2,205,000 | 63 | 2.2 | 1.8 |
| **Total** | **NA** | **NA** | **52.8** | **$19,148,500** | **710** | **25.1** | **20.1** |

Notes: MT CO2e = metric tons of carbon dioxide equivalent; NA = not applicable.

Totals may not sum exactly due to independent rounding.

Source: Prepared by Ascent in 2024.

The total MT CO2e reduction values in Table 11 were then prorated for the amount of time these trees were planted between 2025 and 2030, as well as 2025 and 2050. This resulted in prorated average 2025-2030 and 2025-2050 average annual MT CO2e reductions of approximately 15 and 19 MT CO2e, respectively, for these projects.

##### Project 11: Median Xeriscaping

The City estimated water savings from xeriscaping of 3,520,000 gallons per year (City of Bakersfield 2024), resulting in a reduction in electricity usage used to extract, convey, and treat that water. This reduction in electricity usage, in turn, resulted in the reductions shown in Table 12 below.

Table 12 Calculations of GHG Reduction from Xeriscaping

|  |  |
| --- | --- |
| Item | Quantity |
| Estimated annual water savings (gallons per year) | 3,520,000 |
| Estimated annual water savings (acre-feet per year) | 10.8 |
| Energy intensity for City-owned water supply (kWh per acre-foot) | 1,086 |
| Energy savings from water savings (kWh per year) | 11,727 |
| Average emissions factors until end of 2030 (MT CO2e / MWh) | 0.0788 |
| Average emissions factors until end of 2050 (MT CO2e / MWh) | 0.0408 |
| 2025-2030 annual reductions (MT CO2e) | 0.92 |
| 2025-2050 annual reductions (MT CO2e) | 0.48 |

Notes: kWh = kilowatt=hour; MT CO2e = metric tons of carbon dioxide equivalent; MWh = megawatt-hour.

Source: Prepared by Ascent in 2024.

##### Projects 12 and 13: Organic Materials and Recyclables Processing

The City provided tons of organic waste that could avoid landfilling due to the new equipment in Projects 11 and 12 in 2023 and 2029 (City of Bakersfield 2024). Table 13 below summaries those quantities, which increase from 2023 to 2029 due to more efficient equipment. At the end of the phase-in of this equipment in 2029, the City would avoid landfilling 191,198 more tons of waste per year relative to 2023 levels.

Table 13 Tons of Waste Per Year Avoiding Landfill in the City of Bakersfield

|  |  |  |  |
| --- | --- | --- | --- |
| Facility | 2023 tons per year | 2029 tons per year | Additional tons per year avoiding landfill in 2029,  relative to 2023 |
| Mt. Vernon Organics Facility | 235,745 | 412,554 | 176,809 |
| City Materials Recovery Facility | 15,146 | 29,535 | 14,389 |
| **Total** | **250,891** | **442,089** | **191,198** |

Source: Prepared by Ascent in 2024.

This implies that every year from 2023 to 2029, the ability of the City to remove waste from landfills increases by 31,866 tons. Avoided tonnage was calculated year-over-year for each year from 2023 to 2050 and multiplied by a factor of 0.85 pounds of CO2e per ton of landfilled waste avoided (Strakaluse, pers. comm., 2024) to calculate emissions reductions. Table 14 below shows the results of this calculation.

Table 14 Calculations of Emissions Reductions Due to Increased Landfill Avoidance

|  |  |  |
| --- | --- | --- |
| Year | Additional waste avoiding landfill every year due to new equipment | Reduced MT CO2e per year |
| 2024 | 31,866 | 12.29 |
| 2025 | 63,733 | 24.57 |
| 2026 | 95,599 | 36.86 |
| 2027 | 127,465 | 49.14 |
| 2028 | 159,332 | 61.43 |
| Each year 2029 – 2050 | 191,198 | 73.72 |

Notes: MT CO2e = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

Based on these data, average annual MT CO2e reductions were calculated from 2025 – 2030 and 2025 – 2050, which yielded the results in Table 1.

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1. Capacity factor is defined as the actual output of a generator (such as a solar PV array), divided by what that output would be if the generator ran at its maximum capacity for every hour of every day over a given period of time. It is generally expressed as a percentage. Utility-scale solar generally has a higher capacity factor than rooftop solar, due to economies of scale and being sited in areas with better solar conditions. [↑](#footnote-ref-2)
2. Average bike trip length was unavailable for Bakersfield specifically, so the Los Angeles-Long Beach-Anaheim Core-Based Statistical Area’s value of 1.7 was used as a proxy. [↑](#footnote-ref-3)