
Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity

*Designed for Local Governments, Communities,
and Project Developers*

Final Draft

December 2021



Acknowledgements

This Handbook benefited from the hard work and creative insights of many people. The California Air Pollution Control Officers Association (CAPCOA) appreciates the efforts of all who contributed their time and energy to the project. In particular, CAPCOA thanks the following organizations and agencies.

Project Management and Coordination

Sacramento Metropolitan Air Quality Management District

Authors

ICF with contributions from Fehr & Peers, Sacramento Metropolitan Air Quality Management District, and STI

Technical Advisory Committee

Bay Area Air Quality Management District

California Polytechnic State University

California Strategic Growth Council

California Air Resources Board

California Department of Public Health

California Department of Transportation

City of Los Angeles

City of Mt. Shasta

City of Roseville

City of Sacramento

City of Watsonville

County of Sacramento

County of Santa Barbara

EcoAdapt

Governor's Office of Planning and Research

ICLEI – Local Governments for Sustainability

Metropolitan Transportation Commission

Placer County

Placer County Air Pollution Control District

Sacramento Area Council of Governments

Sacramento Tree Foundation

Sacramento Water Forum

Santa Clara Valley Water District

San Diego Association of Governments

San Diego Regional Climate Collaborative

San Joaquin Valley Air Pollution Control District

Santa Barbara County Air Pollution Control District

San Luis Obispo Air Pollution Control District

South Coast Air Quality Management District

The Climate Registry

University of California, Davis

Special Thanks

Many people have generously provided guidance, insights, and expertise to our project. We would like to warmly thank staff at the California Environmental Justice Alliance; the Center on Race, Poverty & the Environment; City of Bakersfield; California Energy Commission; California Department of Water Resources; California State Water Resources Control Board; and many others for their time and assistance.

Funding Partners

California Department of Transportation (via Senate Bill 1 Adaptation Planning Grants)

Bay Area Air Quality Management District

Sacramento Metropolitan Air Quality Management District

California Department of Public Health's Office of Health Equity, and Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (HHS) as part of a financial assistance award totaling \$147,000 with 100 percent funded by CDC/HHS. The contents are those of the authors and do not necessarily represent the official views of, nor an endorsement, by CDC/HHS, or the U.S. Government.

Dedication

This Handbook is intended to provide tools and methods to people who are doing the hard work on the ground. The hard work of reducing our impact on climate change, making communities more resilient to the effects of climate change, and promoting health and equity among communities that bear disproportionate environmental burdens. The hard work to include everyone in what Dr. Martin Luther King Jr. referred to as “an inescapable network of mutuality” in his 1967 *Christmas Sermon on Peace*.

What we do today will either remedy or perpetuate past environmental injustices. What we do today will shape our climate tomorrow. Our communities are being changed by climate and will change more.

When we understand the tons of carbon emitted, the feet of sea level rise, and the degrees of temperature change, we will know better the consequences of our actions. When we listen, respect, engage, involve, and empower all people affected by our actions, we will know better the diverse concerns, needs, and hopes of all our communities.

With this understanding, we can and must take action to reduce our contributions to climate change, to make our communities more resilient, and to implement solutions that are informed by and responsive to the people most affected by new plans, projects, and programs. We need to do this with and for the people left out too often in the past to mold a better future for this generation and the generations to come. We need to do this for a state, a country, and a planet that is changing rapidly due our actions and inactions.

This Handbook is dedicated to all Californians—whose health, wellbeing, and safety are at the heart of all our efforts. We build and design communities for people, yet often the human perspective is lost amidst discussions around emissions, thresholds of significance, vehicle miles traveled, and site plans. We aim to re-center people in this conversation—especially the people whose voices have been marginalized and excluded from participating in the planning that shapes all our lives. At its core, the Handbook is designed and developed by people, for people, and for the sake of creating livable, prosperous, resilient communities in which all can thrive, now and into the future.

An Important Consideration

CAPCOA prepared this Handbook to provide a common platform of information and tools for evaluating greenhouse gas reduction measures, climate vulnerabilities and promoting equity to support sustainable, resilient, and equitable land use planning and project design. It was prepared in collaboration with academia, agencies, community organizations and leaders, local governments, nongovernmental organizations, and technical experts. The quantification methods, tools, and recommendations provided in this Handbook were developed based on the latest science and literature available at the time of publication.

Our understanding of climate science and accepted practice for how equity and environmental justice can and should be addressed in land use planning continues to evolve. Regulations, policies, and government programs to reduce greenhouse gas emissions are likewise dynamic. Future legislation, litigation, public opinion, and scientific research may influence how climate change, emissions reduction, and health and equity are reviewed and addressed in our community.

In light of these considerations, this Handbook should be viewed as a *planning resource*. It provides strategies, tools, and analytical methods to facilitate integrated and resilient decision making, despite potential future planning uncertainty. The Handbook should not be used to dictate public policy or provide legal advice.

Table of Contents

| | |
|--|-----|
| Acronyms and Abbreviations | vi |
| Chapter 1: Introduction | 1 |
| Chapter 2: Integrated and Resilient Planning | 7 |
| Chapter 3: Measures to Reduce GHG Emissions..... | 29 |
| Transportation | 62 |
| Energy..... | 210 |
| Water | 305 |
| Lawn and Landscaping | 332 |
| Solid Waste | 336 |
| Natural and Working Lands | 346 |
| Construction | 361 |
| Refrigerants | 375 |
| Miscellaneous | 397 |
| Chapter 4: Assessing Climate Exposures and Measures to Reduce Vulnerabilities | 404 |
| Chapter 5: Measures for Advancing Health and Equity | 450 |
| Chapter 6: Resources to Support Resilient and Equitable Emission Reduction Planning..... | 592 |
| Appendix A: Key Terms and Definitions | A-1 |
| Appendix B: Federal and State Planning Framework..... | B-1 |
| Appendix C: Emission Factors and Data Tables..... | C-i |
| Appendix D: Climate Vulnerability Worksheets | D-1 |
| Appendix E: Measure Index..... | E-1 |

Acronyms and Abbreviations

| | |
|--------------|---|
| °F | degrees Fahrenheit |
| A/C | air conditioning |
| AADT | annual average daily traffic |
| AB | Assembly Bill |
| ACS | American Community Survey |
| ACT | Advanced Clean Truck |
| AF | acre-feet |
| AFUE | annual fuel utilization efficiency |
| AMMP tool | CARB's Benefits Calculator Tool for the Alternative Manure Management Program |
| APEN | Asian Pacific Environmental Network |
| APG | California Adaptation Planning Guide |
| AQI | air quality index |
| ARCCA | Alliance of Regional Collaboratives for Climate Adaptation |
| Bayview CBTP | Bayview Community Based Transportation Plan |
| BCZ | building climate zones (as defined by the CEC) |
| BEV | battery electric vehicle |
| BIPOC | Black, Indigenous, and People of Color |
| BMR | below market rate |
| BRACE | Building Resilience Against Climate Effects |
| BRT | bus rapid transit |
| Btu | British Thermal Unit |
| C.F.R. | Code of Federal Regulations |
| CA Code | California Plumbing Code |
| CAA | Clean Air Act |
| CAFE | Corporate Average Fuel Economy |
| CalBRACE | California Building Resilience Against Climate Effects |
| CalEEMod | California Emissions Estimator Model |
| CalEPA | California Environmental Protection Agency |
| CALFIRE | California Department of Forestry and Fire Protection |

| | |
|---------------------|--|
| CALGreen | 2019 California Green Building Standards |
| Caltrans | California Department of Transportation |
| CAPCOA | California Air Pollution Control Officers Association |
| CAPP | Community Air Protection Program |
| CARB | California Air Resources Board |
| CAS | Climate Adaptation Strategy |
| CBO | community-based organization |
| CBSA | core-based statistical area |
| CBSC | California Building Standards Commission |
| CBTP | community-based travel planning |
| CCA | Community Choice Aggregation |
| CCR | California Code of Regulations |
| CDC | U.S. Centers for Disease Control and Prevention |
| CDPH | California Department of Public Health |
| CE | combustion efficiency |
| CEC | California Energy Commission |
| CEQ | Council on Environmental Quality |
| CEQA | California Environmental Quality Act |
| CEUS | California Commercial End-Use Survey |
| CH ₄ | methane |
| CHP Tool | Combined Heat and Power Energy and Emission Calculator |
| CHP | combined heat and power |
| CLT | community land trust |
| CNG | compressed natural gas |
| CNRA | California Natural Resources Agency |
| CO | carbon monoxide |
| CO ₂ | carbon dioxide |
| CO ₂ e | carbon dioxide equivalent |
| COMET | COMET-Planner Tool |
| Commercial Forecast | Uncalibrated Commercial Sector Forecast |
| CoSMoS | Coastal Storm Modeling System |
| CPUC | California Public Utilities Commission |

| | |
|--------------------|--|
| CSTDM | California Statewide Travel Demand Model |
| CTR | commute trip reduction |
| DBE | disadvantaged business enterprise |
| DGS | Department of General Services |
| DOC | dissolved organic carbon |
| DR | demand response |
| Du | dwelling units |
| DVBE | disabled veteran-owned business enterprise |
| DWR | California Department of Water Resources |
| EA | environmental assessment |
| EBT | Electronic Benefit Transfer |
| ECAP | Equitable Climate Action Plan |
| EDFZ | Electricity Demand Forecast Zone |
| EDG | Community Resilience Economic Decision Guide and Online Tool |
| EER | energy efficiency ratio |
| EGC | Enterprise Green Communities |
| EIR | environmental impact report |
| EIS | environmental impact statement |
| ESP | energy service provider |
| ETWU per the MWELO | estimated total water use |
| eVMT | electric mode vehicle miles traveled |
| Explorer | Cool Surface Savings Explorer |
| FCEV | fuel cell electric vehicle |
| FCZ | Forecast Climate Zone (as defined by the CEC) |
| FEMA | Federal Emergency Management Agency |
| FHWA | Federal Highway Administration |
| FVS | Forest Vegetation Simulator |
| g | grams |
| gal | gallon |
| GHCN-Daily | Global Historical Climatology Network–Daily |
| GHG | greenhouse gas |

| | |
|--------------------|--|
| GMP | gross metropolitan product |
| GSP | groundwater sustainability plan |
| GWP | global warming potential |
| ha | hectare |
| HDPE | high-density polyethylene |
| HERS | Home Energy Rating System |
| HFCs | hydrofluorocarbons |
| HPI | The California Healthy Places Index |
| HUD | U.S. Department of Housing and Urban Development |
| HVAC | heating ventilation and air conditioning |
| IBHS | Insurance Institute for Business & Home Safety |
| ICARP | Integrated Climate Adaptation and Resiliency Program |
| ICT | Innovative Clean Transit |
| LDA | light-duty automobiles |
| LDT1 | light-duty truck class 1 |
| LDT2 | light-duty truck class 2 |
| ILSR | Institute for Local Self-Reliance |
| IOUs | investor-owned utilities |
| IPCC | Intergovernmental Panel on Climate Change |
| ITE | Institute of Transportation Engineers |
| ITHIM | Integrated Transport and Health Impact Model |
| KSF | 1,000 gross square feet |
| kWh | kilowatt-hours |
| lb | pound |
| LBNL | Lawrence Berkeley National Laboratory |
| LCFS | Low Carbon Fuel Standard |
| LED | light-emitting diode |
| LFG | landfill gas |
| LGBTBE | LGBTQIA+-owned business enterprise |
| LHC | Little Hoover Commission |
| LOS | level of service |
| MAWA per the MWELO | maximum allowable water use |

| | |
|------------------|--|
| MBE | minority-owned business enterprise |
| MCHX | microchannel heat exchanger |
| MHSA | Mental Health Services Act |
| MJ | megajoule |
| MMBtu | 1 million British thermal units |
| mpg | miles per gallon |
| MPO | metropolitan planning organization |
| MSW | municipal solid waste |
| MT | metric ton |
| MTC | Metropolitan Transportation Commission |
| MTV | maximum transfer value |
| MWELO | Model Water Efficient Landscape Ordinance |
| MWh | megawatt-hour |
| N ₂ O | nitrous oxide |
| NAACP | National Association for the Advancement of Colored People |
| NAAQS | national ambient air quality standards |
| NDC | Nationally Determined Contribution |
| NEPA | National Environmental Policy Act |
| NGO | non-governmental organization |
| NH ₃ | ammonia |
| NHTSA | National Highway Traffic and Safety Administration |
| NO ₂ | nitrogen dioxide |
| NOAA | National Oceanic and Atmospheric Administration |
| NO _x | nitrogen oxides |
| NREL | National Renewable Energy Laboratory |
| NWL | natural and working lands |
| NYLSRJP | New York Law School Racial Justice Project |
| ODS | ozone-depleting substances |
| OEHHA | Office of Environmental Health Hazard Assessment |
| OPC | Ocean Protection Council |
| OPR | California Office of Planning and Research |
| PBID | property business improvement district |

| | |
|--------------------------------------|--|
| PBOT | Portland Bureau of Transportation |
| PFCs | perfluorinated carbons |
| PHEV | plug-in hybrid electric vehicle |
| PM _{2.5} , PM ₁₀ | particulate matter |
| PV | photovoltaic |
| PVC | polyvinyl chloride |
| RAD | Responsible Appliance Disposal |
| RASS | Residential Appliance Saturation Study |
| REC | renewable energy credit |
| REIA | Racial Equity Impact Assessment and Implementation Guide |
| Reporting Rule | Greenhouse Gas Reporting Rule |
| ROG | reactive organic gases |
| RPS | Renewable Portfolio Standard |
| RSM | Regional Sediment Management |
| RTP | regional transportation plan |
| SAF | solar availability factor |
| SAFE | Safer Affordable Fuel-Efficient |
| SAJE | Strategic Actions for a Just Economy |
| SANDAG | San Diego Association of Governments |
| SB | Senate Bill |
| SCAQMD | South Coast Air Quality Management District |
| scf | standard cubic foot |
| sf | square feet |
| SF ₆ | sulfur hexafluoride |
| SFMTA | San Francisco Municipal Transportation Agency |
| SFPD | San Francisco Planning Department |
| SHP | separate heat and power |
| SHRA | Sacramento Housing and Redevelopment Agency |
| SIP | State Implementation Plan |
| SLCPs | Short-Lived Climate Pollutants |
| SMUD | Sacramento Municipal Utility District |
| SO _x | sulfur dioxide |

| | |
|-------------------|--|
| State Water Board | State Water Resources Control Board |
| TAC | technical advisory committee |
| TCR | The Climate Registry |
| TDV | Time Dependent Valuation |
| TE | thermal efficiency |
| TOD | transit-oriented development |
| TRB | Transportation Research Board |
| TRUs | Transport Refrigeration Units |
| U.S. DOE | U.S. Department of Energy |
| U.S. EPA | U.S. Environmental Protection Agency |
| U.S.C. | United States Code |
| UC Davis | University of California, Davis |
| UHI | urban heat island |
| UNIDAD | United Neighbors in Defense Against Displacement |
| USDN | Urban Sustainability Directors Network |
| USFS | United States Forest Service |
| USGS | United States Geological Survey |
| VMT | vehicle miles traveled |
| VOC | volatile organic compounds |
| VTA | Valley Transportation Authority |
| WARM | Waste Reduction Model |
| WBE | women-owned business enterprise |
| WMO | World Meteorological Organization |
| WUCOLS | Water Use Classification of Landscape Species |
| WUI | wildland-urban interface |
| ZEBs | zero-emission buses |
| ZNE | zero net energy |