California Air Resources Board

Quantification Methodology and User Guide

F-gas Reduction Incentive Program

California Climate Investments

Final
November 6, 2024

Table of Contents

List of Acronyms and Abbreviations

Acronym	Term
CARB	California Air Resources Board
F-gas	fluorinated gas
FRIP	F-gas Reduction Incentive Program
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
GWP	global warming potential
HFC	hydrofluorocarbon
lb	pounds
$MTCO_2e$	metric tons of carbon dioxide equivalent
ODS	ozone-depleting substance
RMP	Refrigerant Management Program

Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emission reductions; strengthening the economy; improving public health and the environment; and providing benefits to residents of disadvantaged communities, low-income communities, and low-income households, collectively referred to as "priority populations." Where applicable and to the extent feasible, California Climate Investments must maximize economic, environmental, and public health co-benefits to the State.

The California Air Resources Board (CARB) is responsible for providing guidance on estimating the GHG emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefits calculator tools. CARB develops these methodologies and tools based on the project types eligible for funding by each administering agency, as reflected in the program expenditure records available on the *California Climate Investments Expenditure Records webpage*.

For the CARB F-gas Reduction Incentive Program (FRIP), CARB staff developed this FRIP User Guide and Quantification Methodology (hereafter referred to as the "User Guide") to provide guidance for estimating the GHG emission reductions and selected co-benefits of each proposed or installed project type, as defined in the *FRIP Funding Guidelines*. This methodology outlines the calculations used to estimate GHG emission reductions from installing or replacing conventional refrigeration systems utilizing high global warming potential (GWP) refrigerants with systems utilizing lower-GWP alternatives, switching to lower GWP alternatives in existing refrigeration systems, and reducing the amount of high-GWP refrigerant used in refrigeration systems. The User Guide section also provides instructions for using the FRIP Benefits Calculator Tool (hereafter referred to as the "FRIP Tool") (see Section B).

The FRIP Tool automates methods described in this document. Projects will report the total project GHG emission reductions estimated using the FRIP Tool as well as the total FRIP funds requested per project GHG emission reductions ($/MTCO2e). Users can use the FRIP Tool to estimate GHG emission reductions of the proposed or installed project(s). The FRIP Tool is available for download on the *California Climate Investments resources webpage*.

The FRIP Tool also automates and outputs estimates on reductions in ozone-depleting substances (ODS) and hydrofluorocarbons (HFC).

Additional co-benefits for which CARB assessment methodologies were not incorporated into the FRIP Tool may also be applicable to the project. Users should

consult the FRIP Funding Guidelines, solicitation materials, and agreements to ensure they meet FRIP requirements. All CARB co-benefit assessment methodologies are available on the *California Climate Investments Co-benefit Assessment Methodologies webpage*.

Methodology Development

CARB developed this Quantification Methodology consistent with the guiding principles of *California Climate Investments Funding Guidelines for Administering Agencies*, including ensuring transparency and accountability. CARB developed the FRIP Quantification Methodology to estimate the outcomes of proposed or installed projects and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emission reduction estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the FRIP project types. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level. CARB released the Draft FRIP Quantification Methodology and Draft FRIP Tool for public comment on August 1, 2024, and the Revised Draft FRIP Quantification Methodology and Revised Draft FRIP Tool for public comment on October 14, 2024. This Final FRIP Quantification Methodology and accompanying FRIP Tool have been updated to reflect project types anticipated for funding and for consistency with the FRIP Funding Guidelines.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing cost savings, lessening the impacts and effects of climate change, and strengthening community engagement. Co-benefit assessment methodologies are posted on the *California Climate Investments Co-benefit Assessment Methodologies webpage*.

Tools

The FRIP Tool relies on CARB developed emission factors. CARB has established a single repository for emission factors used in CARB benefits calculator tools, referred to as the *California Climate Investments Quantification Methodology Emission Factor*

Database (Database). The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Users must use the FRIP Tool to estimate the GHG emission reductions of the proposed or installed projects. The FRIP Tool can be downloaded from the *California Climate Investments resources webpage*.

Program Assistance

Users should use the following resources for additional questions and comments:

- Questions on this document should be sent to the *GGRF program email*.
- For more information on CARB's efforts to support implementation of California Climate Investments, see the *California Climate Investments webpage*.
- Questions pertaining to FRIP should be sent to the *FRIP email*.

The availability of specific fields in the FRIP calculator tool is not an indicator that the corresponding characteristic is eligible under the current FRIP solicitation. Refer to the *FRIP Funding Guidelines* for eligibility requirements and other program information.

Section B. Methods

The following section provides details on the methods supporting GHG emission reductions in the FRIP Tool. For more information about how emission factors are used in CARB benefits calculator tools and are developed and updated, refer to the Database Documentation.

Users are not required to manually calculate GHG emissions for their proposed or installed project using this methodology; it is outlined for informational purposes only and is already built into the FRIP Tool. Users need only enter their project-specific information into the tool following the instructions in this User Guide and the tool will automatically estimate GHG emission reductions associated with their proposed or installed project(s).

For more detail, the following sections provide specific equations about the emission reductions associated with the installation of or conversion to an ultra-low-GWP refrigeration system or retrofit to a lower-GWP refrigerant.

General Approach

The FRIP Quantification Methodology accounts for GHG emission reductions from refrigerant replacement and refrigerant charge reduction. In general, the GHG emission reductions are estimated in the FRIP Tool using the approach outlined in Equation 1.

Equation 1. Total GHG Emission Reductions from Use of Ultra-low- or Lower-GWP Refrigerant(s)

$$ER_{GHG,\ Refrig} = E_{GHG,\ Refrig,\ Base} - E_{GHG,\ Refrig,\ Proj}$$

Table 1. Variable Definitions for Equation 1

Variable	Variable Definition	Units
$ER_{GHG,\ Refrig}$	Total GHG emission reductions from ultra-low- or lower-GWP refrigerant replacement and/or refrigerant charge reduction.	$MTCO_2e$
$ER_{GHG,\ Refrig,\ Base}$	Total GHG emission from baseline refrigeration systems (sum of all systems).	$MTCO_2e$
$ER_{GHG,\ Refrig,\ Proj}$	Total GHG emission from proposed or installed refrigeration systems (sum of all systems).	$MTCO_2e$

Refrigerant GHG emissions from the refrigeration system are quantified as the sum of refrigerant leakage over the system's lifetime and end-of-life refrigerant leakage, as shown in Equation 2. Refrigerant GHG emissions are a function of the system's refrigerant charge and leak rate. Lifetime refrigerant leakage occurs over a refrigeration system's lifetime during its operation as well as during servicing and maintenance. End-of-life emissions occur when refrigeration systems reach the end of their life. Table 3 outlines the leak rate assumptions, by system, used in the FRIP Tool.

Equation 2. GHG Emissions from the Baseline (Existing) and Proposed or Installed Refrigerants

$$E_{GHG,\ Refrig} = \sum [(RC \times GWP \times AL \times Q) + (RC \times GWP \times ELL)] \div 2,205$$

Table 2. Variable Definitions for Equation 2

Variable	Variable Definition	Units
$E_{GHG,\ Refrig}$	Total GHG emissions from refrigeration systems (sum of all baseline or proposed/installed systems).	$MTCO_2e$
RC	Refrigeration system charge.	pounds (lb)
GWP	Global warming potential of refrigerant.	[unitless]
AL	Annual leak rate.	percent/year
Q	Quantification period of the project.	years
ELL	Refrigeration system end-of-life leakage.	percent
2,205	Conversion factor from pounds to metric tons.	lb/MT

Using the FRIP Tool

Users should begin with the "Read Me" tab, which contains general information about the FRIP Tool. Key terms used throughout the FRIP Tool are defined in the "Definitions and Conversions" tab. The "Documentation" tab provides details on the documentation requirements to allow the calculations to be reviewed and replicated.

The "1. Project Info" tab prompts users to enter general project information.

The "2. Inputs" tab identifies detailed inputs required by the user, generally requiring project-specific data or assumptions. Input and output fields are color coded:

- Green fields indicate direct user input is required.
- Blue fields are optional and user input is not required.
- Grey fields indicate output or calculation fields that are automatically populated based on user entries and the calculation methods.
- Yellow fields offer helpful hints or important tips to the user.
- Black fields are not applicable and no user input is necessary.

The user must submit supporting documentation for all required fields. If an optional field is used, the user must submit additional supporting documentation (see the "Documentation" tab in the FRIP Tool).

Step-by-Step Guide for Users

Users should follow the steps outlined below to estimate the GHG emission reductions from the proposed or installed project. Detailed instructions for each step are provided on subsequent pages.

- Step 1. Provide basic project information.
- Step 2. Input detailed project information for baseline and proposed or installed systems.
- Step 3. Estimate the GHG emission reductions for the proposed or installed project(s).

Step 1: Provide basic project information

Users must define the project by identifying the refrigeration sector and basic system information applicable for FRIP funding. Each project requesting FRIP funding must include the installation of an ultra-low-GWP refrigerant or a refrigerant replacement to a lower GWP refrigerant, as eligible per the FRIP Funding Guidelines.

In summary, the following list identifies the inputs needed on the "1. Project Info" tab.

- Date Calculator Completed;
- Project Name;
- Project Address;
- Legal Company Name;
- FRIP Funds Requested;
- Refrigeration Sector;
- Number of Existing Systems; and
- Number of Proposed or Installed Systems.

Step 2: Input detailed project information for baseline (existing) and proposed or installed systems

Based upon the FRIP Quantification Methodology, some project-specific inputs are required in the FRIP Tool to estimate GHG emission reductions for the proposed or installed projects, while other inputs are optional. The refrigeration system type, refrigerant type, and refrigerant charge are the key inputs required by the user. The leak rates and quantification period are pre-determined based on refrigeration sector, system type, and refrigerant charge size and cannot be changed by the user.

Users do not need to calculate the GHG emission themselves using the methodologies previously discussed. Once users define and enter the inputs, the FRIP Tool automatically estimates GHG emission reductions and other relevant outputs associated with the proposed or installed project.

In the FRIP Tool, CARB staff developed auto-populated assumptions that are automatically applied based upon the selected refrigeration sector, type of system, and/or refrigerant charge size. Table 3 outlines the assumptions, as well as input requirements, for FRIP. The requirements and assumptions are specific to each project type and pertain to either the baseline system(s) or the new system(s) proposed or installed by the project. Leak rates are based on data collected through the *Refrigerant Management Program* (RMP) as a function of system size and on CARB's *F-gas Emission Inventory Methodology*. End-of-life leakage for microdistributed and secondary/cascade systems are from CARB's F-gas inventory, which is based on field data and research studies. Similar to the tool, in the following table, items in Green are required inputs by the user, items in Blue are optional inputs and items in Grey are automatically populated.

Table 3. Input Values and Assumptions for Baseline (Existing) and Proposed or Installed Systems

Inputs	Baseline (Existing) System	Proposed or Installed System
System Type	Eligible existing system type from drop-down list	Eligible proposed or installed system type from drop-down list
Type of Refrigerant	Existing refrigerant in use, as reported under RMP. For indirect systems, this is the secondary refrigerant type.	Proposed or installed refrigerant of choice (<10 GWP). For indirect systems, this is the secondary refrigerant type.
Refrigerant Charge (lb)	Existing system charge size, as reported under RMP. For indirect systems, this is the secondary refrigerant charge size.	Charge size that meets the proposed or installed facility refrigeration load (for the proposed facility, this may be an engineering design estimate). For indirect systems, this is the secondary refrigerant charge size.
Type of Primary Refrigerant	Existing primary refrigerant in use, as reported under RMP	Proposed or installed primary refrigerant of choice (<2,200 GWP)
Primary Refrigerant Charge (lb)	Existing system primary refrigerant charge size, as reported under RMP	Charge size that meets the proposed or installed facility refrigeration load of the primary refrigerant (for the proposed facility, this may be an engineering design estimate)

Annual Leak Rate (%/yr)	Retail Food Refrigeration: • 15.0% for ≤50 lb; • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2,000 lb; • 24.2% for ≥2000 lb. Industrial Process Refrigeration: • 9.1% for secondary or cascade systems regardless of charge size;[1] • 15.0% for ≤50 lb; • 9.1% for >50 – <200 lb; • 12.5% for 200 – <2,000 lb; • 12.3% for ≥2000 lb. Cold Storage and Other Refrigeration: • 15.0% for ≤50 lb; • 3.7% for >50 – <200 lb; • 10.3% for 200 – <2,000 lb; • 14.8% for ≥2000 lb.	Retail Food Refrigeration: • 1.0% for microdistributed systems regardless of charge size; • 15.6% for secondary or cascade systems regardless of charge size; • 15.0% for ≤50 lb; • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2,000 lb; • 24.2% for ≥2000 lb. Industrial Process Refrigeration: • 1.0% for microdistributed systems regardless of charge size; • 9.1% for secondary or cascade systems regardless of charge size; • 15.0% for ≤50 lb; • 9.1% for >50 – <200 lb; • 12.5% for 200 – <2,000 lb; • 12.3% for ≥2000 lb. Cold Storage and Other Refrigeration: • 1.0% for microdistributed systems regardless of charge size; • 3.7% for secondary or cascade systems regardless of charge size; • 15.0% for ≤50 lb; • 3.7% for >50 – <200 lb; • 10.3% for 200 – <2,000 lb; • 14.8% for ≥2000 lb.
End-of-Life Leak Rate (%)	For all systems:[2] • 34% for ≤50 lb; • 20% for >50 lb.	For microdistributed systems: • 98.5% regardless of charge size; For all other systems: • 34% for ≤50 lb; • 20% for >50 lb.

[1] Based on the projects funded under FRIP and RMP data, CARB may update the annual leak rate for all or a subset of secondary or cascade systems. Due to the negligible GHG impact of ultra-low-GWP refrigerants and in order to simplify FRIP Tool quantification, secondary refrigerants use the same average leak rates as primary refrigerants in indirect systems.

[2] End-of-life leak rates for indirect systems are based on the total charge size of the system (including both primary and secondary refrigerants).

Quantification Period (years)[3]	Retail Food Refrigeration: • 14 years for ≤50 lb; • 20 years for >50 – <200 lb; • 15 years for ≥200 lb; Industrial Process Refrigeration: • 20 years regardless of charge size; Cold Storage and Other Refrigeration: • 20 years regardless of charge size.	Retail Food Refrigeration: • 14 years for ≤50 lb; • 20 years for >50 – <200 lb; • 15 years for ≥200 lb; Industrial Process Refrigeration: • 20 years regardless of charge size; Cold Storage and Other Refrigeration: • 20 years regardless of charge size.

In summary, the following list identifies the inputs needed on the "2. Inputs" tab.

- Baseline Refrigeration System;
  - Existing System Type;
  - Existing Type of Refrigerant;
  - Existing Refrigerant Charge (lb);
  - Existing Primary Refrigerant Type [if applicable];
  - Existing Primary Refrigerant Charge (lb) [if applicable];
- Proposed or Installed Project Refrigeration System;
  - Proposed or Installed System Type;
  - Proposed or Installed Ultra-low-GWP Refrigerant Type;
  - Proposed or Installed Ultra-low-GWP Refrigerant Charge (lb);
  - Proposed or Installed Primary Refrigerant Type [if applicable]; and
  - Proposed or Installed Primary Refrigerant Charge (lb) [if applicable].

Step 3: Estimate the GHG emission reductions for the proposed or installed project(s)

Users must use the FRIP Tool to estimate GHG emission reductions from the proposed or installed project. The FRIP Tool also estimates reductions in HFCs and ODS' and associated GHG emission reductions from HFCs and ODS'.[4] Based on the inputs entered for the refrigeration system in steps 1 and 2, the "3. Benefits Summary" tab displays the estimated:

- GHG Emission Reductions
  - Total GHG Emission Reductions ($MTCO_2e$);
  - FRIP Funds per Total GHG Emission Reductions ($/MTCO_2e$);
- HFC- and ODS-related Reductions

[3] In indirect systems, the quantification period of the primary refrigerant is two-thirds of the displayed quantification period in the FRIP Tool.
[4] Tool outputs attribute HFC reductions to any refrigerant that is classified as an HFC and ODS reductions to any refrigerant that is not classified as an HFC.

- GHG Emission Reductions from HFC Reductions from Existing System to Mid-range GWP Refrigerant Retrofit Baseline (MTCO2e);[5]
- GHG Emission Reductions from HFC Reductions from Mid-range GWP Refrigerant Retrofit Baseline to Ultra-low-GWP Technology (MTCO2e);
- High-GWP HFC Reductions (lb);
- GHG Emission Reductions from High-GWP HFC Reductions (MTCO2e);
- High-GWP ODS Reductions (lb); and
- GHG Emission Reductions from High-GWP ODS Reductions (MTCO2e).

Note: *Some projects may entail multiple refrigeration systems (i.e., more than one baseline or proposed or installed project systems). For example, a user may propose replacing one centralized refrigeration system with two microdistributed refrigeration systems. In these instances, users can fill out any number of rows for either the baseline or proposed or installed system while leaving the others blank, as necessary. Continuing the example, a user would fill out one row for the baseline refrigeration system and one of the proposed or installed refrigeration systems; on the next row, the user would fill out information for the other proposed or installed refrigeration system and leave the baseline system inputs blank.*

[5] The FRIP Tool estimates reductions that come from transitioning to a mid-range GWP refrigerant by sector, as follows: 1,400 GWP for retail food refrigeration; 2,200 GWP for industrial process refrigeration; and 1,391 GWP for cold storage or other refrigeration. No mid-range GWP baseline is considered for ≤50 lb. Refrigeration Equipment to CDU.

Section C. References

The following references were used in the development of this Quantification Methodology and the FRIP Tool.

California Air Resources Board. (2016). 2016 SIP Emission Projection Data: 2012 Estimated Annual Average Emissions. Retrieved from: *https://www.arb.ca.gov/app/emsinv/2017/emssumcat_query.php?F_YR=2012&F_DIV=-4&F_SEASON=A&SP=SIP105ADJ&F_AREA=CA#0*.

California Air Resources Board. (2016). California's High Global Warming Potential Gases Emission Inventory: Emission Inventory Methodology and Technical Support Document. Retrieved from: *https://ww3.arb.ca.gov/cc/inventory/slcp/doc/hfc_inventory_tsd_20160411.pdf.*

California Air Resources Board. (2020). Public Hearing to Consider the Proposed Amendments to the Prohibitions on use of Certain Hydrofluorocarbons in Stationary Refrigeration, Chillers, Aerosols-Propellants, and Foam End-Uses Regulation. Staff Report: Initial Statement of Reasons. Retrieved from: *https://ww2.arb.ca.gov/rulemaking/2020/hfc2020.*

California Air Resources Board. (2023). Technical Support Document for California's 2000-2021 Greenhouse Gas Emissions Inventory. Retrieved from: *https://ww2.arb.ca.gov/ghg-inventory-data.*

California Air Resources Board. (2024). High-GWP Refrigerants. Retrieved from: *https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants.*