California Air Resources Board

User Guide and Quantification Methodology

California Energy Commission
F-gas Reduction Incentive Program

California Climate Investments

FINAL
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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
HVAC	heating, ventilation, and air conditioning
HVAC-R	heating, ventilation, air conditioning, and refrigeration
kWh	kilowatt hours
lb	pounds
$MTCO_2e$	metric tons of carbon dioxide equivalent
NO_x	oxides of nitrogen
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometers
RMP	Refrigerant Management Program
ROG	reactive organic gas

List of Definitions

Term	Definition
Co-benefit	A social, economic, and/or environmental benefit as a result of the proposed project in addition to the GHG emission reduction benefit.
Energy and fuel cost savings	Changes in energy and fuel costs to the operator because of changing the quantity of energy or fuel used, changing to an alternative energy or fuel source, and renewable energy or fuel generation.
FRIP GGRF funds requested	Funds that are requested to be contributed to the project by FRIP.
Key variable	Project characteristics that contribute to a project's GHG emission reductions and signal an additional benefit (e.g., renewable energy generated).
Non-GGRF leveraged funds	Match funding contributed from all other sources that are not funded by the Greenhouse Gas Reduction Fund.
Other GGRF leveraged funds	Match funding contributed from other California Climate Investment programs, aside from FRIP, which source funding from the Greenhouse Gas Reduction Fund.
Quantification period	Number of years that the project activity will provide GHG emission reductions. Also referred to as "Project Life", "Useful Life", or "System Lifetime". For FRIP projects, the quantification period is the average lifetime of the refrigeration system.

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 at: www.arb.ca.gov/cci-expenditurerecords.

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 project type, as defined in the FRIP guidelines.[1] This methodology outlines the calculations used to estimate GHG emission reductions from installing or replacing conventional refrigeration systems with systems that are compatible with low global warming potential (GWP) alternatives, switching to lower GWP alternatives in existing refrigeration systems, and reducing the amount of refrigerant used in refrigeration systems. Additionally, this methodology outlines the calculations used to estimate GHG and air pollutant emission reductions from the use of refrigeration systems that are more energy efficient than conventional counterparts. This User Guide section also provides instructions for using the FRIP Benefits Calculator Tool (hereafter referred to as the "FRIP Tool") (see Section B) and example projects (see Section C).

The FRIP Tool automates methods described in this document. Projects will report the total project GHG emission reductions and co-benefits estimated using the FRIP Tool as well as the total dollars of GGRF funds requested per project GHG emission reductions ($/MTCO$_2$e).

[1] California Air Resources Board. 2020. FRIP Guidelines. https://ww2.arb.ca.gov/our-work/programs/FRIP/program-materials

Applicants must use the FRIP Tool to estimate GHG emission reductions and co-benefits of the proposed project. The FRIP Tool is available for download at: http://www.arb.ca.gov/cci-resources and https://ww2.arb.ca.gov/our-work/programs/FRIP/program-materials.

Using many of the same inputs required to estimate GHG emission reductions, the FRIP Tool estimates the following co-benefits and key variables from FRIP projects: energy and fuel cost savings ($) and fossil fuel-based energy use reductions (kWh). Key variables are project characteristics that contribute to a project's GHG emission reductions and signal an additional benefit. Additional co-benefits for which CARB assessment methodologies were not incorporated into the FRIP Tool may also be applicable to the project. Applicants should consult the FRIP guidelines, solicitation materials, and agreements to ensure they are meeting FRIP requirements. All CARB co-benefit assessment methodologies are available at: www.arb.ca.gov/cci-cobenefits.

Methodology Development

CARB developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability.[2] CARB developed the FRIP Quantification Methodology to be used to estimate the outcomes of proposed projects, inform project selection, 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 User Guide and Quantification Methodology and Draft FRIP Tool for public comment on July 9, 2020. This Final FRIP User Guide and Quantification Methodology and accompanying Final FRIP Tool have been updated to address public comments, where appropriate, and for consistency with updates to the FRIP Guidelines.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing

[2] California Air Resources Board. CCI Funding Guidelines for Administering Agencies. www.arb.ca.gov/cci-fundingguidelines

cost savings, lessening the impacts and effects of climate change, and strengthening community engagement. Co-benefit assessment methodologies are posted at: www.arb.ca.gov/cci-cobenefits.

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), available at: http://www.arb.ca.gov/cci-resources. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Program Assistance

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

- Questions on this document should be sent to: GGRFProgram@arb.ca.gov.
- For more information on CARB's efforts to support implementation of California Climate Investments, see: www.arb.ca.gov/auctionproceeds.
- Questions pertaining to the FRIP should be sent to: FRIP@arb.ca.gov.

Section B. Calculating GHG Emission Reductions using the FRIP Tool

GHG Quantification Methodology for FRIP Projects

Methods used in the FRIP Tool for estimating GHG emission reductions and air pollutant emission co-benefits by project type are provided in this section. For more information about how emission factors are used in CARB benefits calculator tools and are developed and updated, refer to the Database Documentation available at: https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials.

The FRIP Quantification Methodology accounts for GHG emission reductions from refrigerant replacement, refrigerant charge reduction, and onsite reductions in grid electricity consumption. In general, the GHG emission reductions are estimated in the FRIP Tool using the approach outlined in Table 1. The FRIP Tool also estimates air pollutant emission co-benefits and key variables using the same inputs used to estimate GHG emission reductions.

Table 1. General Approach to Quantification

Refrigeration System Improvement
GHG Emission Reductions = (Baseline system refrigerant emissions – Proposed system refrigerant emissions) + (Baseline system energy consumption emissions – Proposed system energy consumption emissions)

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

For more detail, the following sections provide specific equations about how refrigerant and energy consumption emissions are quantified in the tool.

GHG Emission Reductions from FRIP Projects

GHG emission reductions are quantified for the installation of or conversion to an ultra-low GWP refrigeration system or retrofit to a lower-GWP refrigerant, as well as energy efficiency improvements.

Equation 1: Total GHG Emission Reductions from FRIP Projects

$$ER_{GHG} = ER_{GHG,Refrig} + ER_{GHG,Elec}$$

Where,			Units
ER_{GHG}	=	Total GHG emission reductions from the project.	$MTCO_2e$
$ER_{GHG,\ Refrig}$	=	Total GHG emission reductions from low or lower-GWP refrigerant replacement and/or refrigerant charge reduction.	$MTCO_2e$
$ER_{GHG,\ Elec}$	=	Total GHG emission reductions from the installation, replacement, or retrofit of a more energy efficient refrigeration system.	$MTCO_2e$

Equation 1. The GHG emission reductions from FRIP projects are estimated as the sum of GHG emission reductions from refrigerant replacement, refrigerant charge reduction, and refrigeration system energy efficiency improvements, if applicable.

Equation 2: Total Refrigerant GHG Emission Reductions from Use of Ultra-low or Lower-GWP Refrigerant

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

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

Equation 2. Total refrigerant GHG emission reductions from the use of an ultra-low or lower-GWP refrigerant are estimated as the refrigerant emissions of the baseline refrigeration system, minus the refrigerant emissions of the refrigeration system proposed by the project.

Refrigerant GHG emissions from the refrigeration system are quantified as the sum of refrigerant leakage over the system's lifetime end-of-life refrigerant leakage, as shown in Equation 3 and Equation 4. Refrigerant GHG emissions are a function of the system's refrigerant charge. 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.

Equation 3: Total GHG Emissions from the Baseline Refrigerants

$$E_{GHG,Refrig,Base} = \sum[(RC_{BR} \times GWP_{BR} \times LR_{BR} \times Q) + (RC_{BR} \times GWP_{BR} \times PLC_{BR})] + \sum[(RC_{H} \times GWP_{H} \times LR_{H} \times Q) + (RC_{H} \times GWP_{H} \times PLC_{H})]/2{,}205$$

Where,		Units
$E_{GHG, Refrig, Base}$	= Total GHG emissions from baseline refrigeration systems (sum of all systems).	$MTCO_2e$
RC_{BR}	= Baseline refrigeration system charge.	lb
GWP_{BR}	= Global Warming Potential of the baseline refrigeration refrigerant.	[unitless]
LR_{BR}	= Baseline refrigeration refrigerant annual leakage rate.	percent/yr
Q	= Quantification period of the project.	years
PLC_{BR}	= Baseline refrigeration system end-of-life leakage.	percent
RC_{BH}	= Baseline HVAC refrigerant charge.	lb
GWP_{BH}	= Global Warming Potential of the baseline HVAC refrigerant.	[unitless]
LR_{BH}	= Baseline HVAC refrigerant annual leakage rate.	percent/yr
PLC_{BH}	= Baseline HVAC refrigerant end-of-life leakage.	percent
2,205	= Conversion factor from pounds to metric tons.	lb/MT

Equation 3. Total GHG emissions from the baseline systems are estimated as the sum of lifetime leakage emissions and end-of-life leakage emissions for the baseline refrigeration system and HVAC system (if applicable), divided by a conversion factor (2,205). Lifetime leakage emissions are a product of the refrigerant charge, global warming potential, annual leakage rate, and quantification period of the project. End-of-life leakage emissions are a product of the refrigerant charge, global warming potential, and end-of-life leakage.

Equation 4: Total GHG Emissions from the Proposed Project Refrigerants

$$E_{GHG,Refrig,Proj} = \sum[(RC_{PP} \times GWP_{PP} \times LR_{PP} \times N_{PP} \times Q) + (RC_{PP} \times GWP_{PP} \times PLC_{PP})] + \sum[(RC_{PS} \times GWP_{PS} \times LR_{PS} \times Q) + (RC_{PS} \times GWP_{PS} \times PLC_{PS})] / 2{,}205$$

Where,			Units
$E_{GHG, Refrig, Proj}$	=	Total GHG emission from the proposed refrigeration systems (sum of all systems).	$MTCO_2e$
RC_{PP}	=	Proposed refrigeration system primary refrigerant charge.	lb
GWP_{PP}	=	Global Warming Potential of the proposed primary refrigerant.	[unitless]
LR_{PP}	=	Annual leakage rate of the proposed primary refrigerant.	percent/yr
N_{PP}	=	Number of identical proposed primary refrigeration systems.	[unitless]
Q	=	Quantification period of the project.	years
PLC_{PP}	=	Proposed primary refrigerant end-of-life leakage.	percent
RC_{PS}	=	Proposed refrigeration system secondary refrigerant charge.	lb
GWP_{PS}	=	Global Warming Potential of the proposed secondary refrigerant.	[unitless]
LR_{PS}	=	Annual leakage rate of the proposed secondary refrigerant.	percent/yr
PLC_{PS}	=	Proposed secondary refrigerant end-of-life leakage.	percent
2,205	=	Conversion factor from pounds to metric tons.	lb/MT

Equation 4. Total GHG emissions from the proposed systems are estimated as the sum of lifetime leakage emissions and end-of-life leakage emissions for the proposed primary and secondary refrigerants, divided by a conversion factor (2,205). Lifetime leakage emissions are a product of the refrigerant charge, global warming potential, annual leakage rate, and quantification period of the project. If applicable, the product must also include the number of identical systems using the primary refrigerant. End-of-life leakage emissions are a product of the refrigerant charge, global warming potential, and end-of-life leakage.

Optionally, proposed projects may also receive credit for GHG emission reductions from improvements in energy efficiency, quantified as the difference in baseline and proposed annual grid electricity usage, as shown in Equation 5.

Equation 5: Total GHG Emission Reductions from Energy Efficiency Improvements

$$ER_{GHG,Elec} = \left[\sum_{i}^{N}(Elec_{Base} \times Q_{Base}) - \sum_{j}^{M}(Elec_{Proj} \times Q_{Proj})\right] \times EF_{GHG,Elec}$$

Where,			Units
$ER_{GHG, Elec}$	=	Total GHG emission reductions from the installation, replacement, or retrofit of a more energy efficient refrigeration system (sum of all systems).	$MTCO_2e$
$Elec_{Base}$	=	Annual electricity consumption of the baseline refrigeration system(s).	kWh/yr
Q_{Base}	=	Quantification period of the baseline refrigeration system(s).	years
$Elec_{Proj}$	=	Annual electricity consumption of the proposed refrigeration system(s).	kWh/yr
Q_{Proj}	=	Quantification period of the proposed refrigeration system(s).	years
$EF_{GHG, Elec}$	=	GHG emission factor for grid electricity.	$MTCO_2e/kWh$
N	=	Number of baseline systems	[unitless]
M	=	Number of proposed project systems	[unitless]

Equation 5. GHG emission reductions from the installation, replacement, or retrofit of a more energy efficient refrigeration system are estimated as the sum of the difference between the total baseline and proposed project scenario electricity consumption for all project systems, multiplied by the GHG emission factor for grid electricity.

Air Pollutant Emission Reductions from FRIP Projects

Air pollutant emission reductions are calculated as the sum of reductions in remote air pollutant emissions and local air pollutant emissions. Remote air pollutant emissions are emissions that occur away from the project site (e.g., grid electricity emissions resulting from an offsite power plant). Conversely, local air pollutant emissions are emissions that occur at the project site and directly impact the surrounding community (e.g., onsite natural gas combustion), not applicable for FRIP projects. For FRIP projects, there are no air pollutant emission reduction benefits directly associated with refrigerant replacement (i.e., system lifetime and end-of-life leakage), but there may be optional reductions in remote air pollutant emissions resulting from reduced energy consumption. Thus, only remote air pollutant emissions are potentially quantified for FRIP projects.

Equation 6: Remote Air Pollutant Emission Reductions from FRIP Projects

$$ER_{AP,Remote} = \left[\sum_{i}^{N}(Elec_{Base} \times Q_{Base}) - \sum_{j}^{M}(Elec_{Proj} \times Q_{Proj})\right] \times EF_{AP,Elec}$$

Where,			Units
$ER_{AP,\ Remote}$	=	Total offsite air pollutant emission reductions from refrigeration system improvement projects (sum of all systems).	lb
$Elec_{Base}$	=	Annual electricity consumption of the baseline refrigeration system(s).	kWh/yr
Q_{Base}	=	Quantification period of the baseline refrigeration system(s).	years
$Elec_{Proj}$	=	Annual electricity consumption of the proposed refrigeration system(s).	kWh/yr
Q_{Proj}	=	Quantification period of the proposed system(s).	years
$EF_{AP,\ Elec}$	=	Air pollutant emission factor for grid electricity.	lb/kWh
N	=	Number of baseline systems	[unitless]
M	=	Number of proposed project systems	[unitless]

Equation 6. Remote air pollutant emission reductions are estimated by the sum of total avoided air pollutant emissions from reduced onsite use of grid electricity. This is quantified as the sum of the difference between the total baseline and proposed scenario electricity consumption for all refrigeration systems, multiplied by the air pollutant emission factor for grid electricity

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 **Eligibility Reference** tab provides information about the types of project components and activities that are eligible under FRIP.

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

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

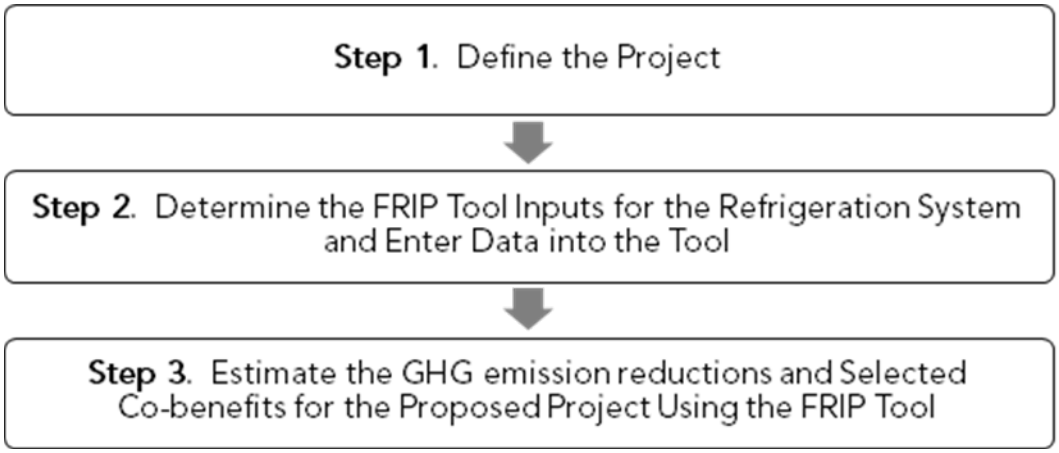
- Green fields indicate direct user input is required.
- Blue fields are optional and user input is not required.
- Grey fields indicate output or calculation fields that are automatically populated based on user entries and the calculation methods.
- Yellow fields offer helpful hints or important tips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

If an optional field is used, the applicant must submit additional supporting documentation (see the **Documentation** tab in the FRIP Tool).

Step-by-Step Guide for Applicants

Applicants should follow the steps outlined in Figure 1 to estimate the GHG emission reductions and selected co-benefits from the proposed project. Detailed instructions for each step are provided on subsequent pages. Example projects showing how to estimate the GHG emission reductions and selected co-benefits from a project are included in Section C.

Figure 1. Steps to Estimating GHG Emission Reductions and Selected Co-benefits



Step 1: Define the Project

Applicants must define the project by identifying the project type and the refrigeration system applicable for FRIP funding.

Project Types

The CARB FRIP reduces GHG emissions by replacing refrigerants with lower Global Warming Potential (GWP) alternatives, reducing refrigerant charge, and replacing refrigeration systems with more energy efficient alternatives. FRIP-eligible project types are categorized into two tiers depending on the technology of the refrigeration system and the installation site.[3] The five project types are categorized by the two-tiered approach depending on the technology of the refrigeration system:

- **Tier I**: Installation of an ultra-low-GWP refrigerant (< 10 GWP) at a new facility;
- **Tier I**: Full conversion to ultra-low-GWP refrigerant (< 10 GWP) at an existing facility;
- **Tier I**: Partial conversion to ultra-low-GWP refrigerant (< 10 GWP) at an existing facility;
- **Tier II**: Refrigerant retrofit from high-GWP (> 3900) to lower-GWP refrigerant (< 1500 GWP) at an existing facility without a permanent system charge reduction of at least 25%; and
- **Tier II**: Refrigerant retrofit from high-GWP (> 3900) to lower-GWP refrigerant (< 1500 GWP) at an existing facility with a permanent system charge reduction of at least 25%.

For all of these project types, each project requesting FRIP funding must include the installation of an ultra-low-GWP refrigerant or a refrigerant replacement to a lower GWP refrigerant.

Other project activities that may be quantified as part of a FRIP project include:

- Refrigerant charge reduction; and
- Installation of a new, or optimization of an existing refrigeration system to increase energy efficiency.

[3] California Air Resources Board. 2020. FRIP Guidelines. https://ww2.arb.ca.gov/resources/documents/frip-guidelines

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

Based upon the FRIP Quantification Methodology, some project-specific inputs are required in the FRIP Tool to estimate GHG emission reductions for the proposed projects, while other inputs are optional. The refrigeration system type, refrigerant type, and refrigerant charge are the key inputs required by the applicant. The energy usage of the baseline and proposed refrigeration system is optional. Conventional HVAC refrigerant type and charge are required only when the proposed refrigeration system is replaced by an HVAC-R integrated system. The leakage rates and quantification period are pre-determined based on system type and cannot be changed by the applicant.

Applicants do not need to calculate the GHG emission themselves using the methodologies previously discussed. Once applicants define and enter the inputs, the FRIP Tool automatically calculates GHG emission reductions from the proposed project.

In the FRIP Tool, CARB staff developed auto-populated assumptions that are automatically applied based upon the selected project type, type of system, and/or refrigerant charge size. Table 2, Table 3, Table 4, Table 5, and Table 6 outline the assumptions, as well as input requirements, for the FRIP. The requirements and assumptions are specific to each of the five project types and pertain to either the baseline system(s) or the new system(s) proposed by the project. Leakage rates are based on data collected through RMP as a function of system size. End-of-life leakage for microdistributed, self-contained cases, and indirect/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 tables, items in Green are required inputs by the user, items in Blue are optional inputs and items in Grey are automatically populated.

Table 2. Input Values and Assumptions for Tier I Projects Located at a New Facility

Inputs	Baseline System	Proposed System
Type of Refrigerant	For HVAC-R systems: • R-410A For all other systems: • R-448A or R-449A	Proposed refrigerant of choice (<10 GWP)
Refrigerant Charge (lb)	Equivalent charge size of a hypothetical centralized multipack DX system that meets the proposed facility refrigeration load (engineering design estimate) For proposed HVAC-R integrated projects, also provide the equivalent charge of a hypothetical HVAC system	Charge size that meets the proposed facility refrigeration load (engineering design estimate)
Annual Leakage Rate (%/yr)	For the refrigeration system, RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb. For HVAC-R systems, the following leakage rates apply for HVAC units: • 10% for <50 lb; • 7% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 1%. For indirect or cascade system: • 3%. For all other systems, RMP average leakage rates: • 15.0% for ≤50 lb; • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.
End-of-Life Leakage Rate (%)	For the refrigeration system, RMP average leakage rates: • 20% For HVAC-R systems, the following leakage rates apply for HVAC units: • 56% for <50 lb; • 20% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 98.5%. For all other systems: • 34% for ≤50 lb; • 20% for >50 lb.
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	Energy usage for an equivalent 448A or R-449A system that meets Title 24 requirements (based on engineering design estimate)	Energy usage beyond Title 24 requirements (based on engineering design estimate)

Table 3. Input Values and Assumptions for Tier I Full Conversion Projects Located at an Existing Facility

Inputs	Baseline System	Proposed System
Type of Refrigerant	Existing refrigerant in use, as reported to the RMP	Proposed refrigerant of choice (<10 GWP)
Refrigerant Charge (lb)	Existing system charge size as reported to the RMP For proposed HVAC-R integrated projects, also provide the charge of the HVAC system to be replaced	Charge size that meets the proposed facility refrigeration load (based on engineering design estimate)
Annual Leakage Rate (%/yr)	For the refrigeration system, RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb. For HVAC-R systems, the following leakage rates apply for HVAC units: • 10% for <50 lb; • 7% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 1%. For indirect or cascade system: • 3%. For all other systems, RMP average leakage rates: • 15.0% for ≤50 lb; • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.
End-of-Life Leakage Rate (%)	For the refrigeration system, RMP average leakage rates: • 20% For HVAC-R systems, the following leakage rates apply for HVAC units: • 56% for <50 lb; • 20% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 98.5%. For all other systems: • 34% for ≤50 lb; • 20% for >50 lb.
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	Energy usage for the existing system, if available	Energy usage beyond Title 24 requirements, if available (based on engineering design estimate)

Table 4. Input Values and Assumptions for Tier I Partial Conversion Projects Located at an Existing Facility

Inputs	Baseline System	Proposed System
Type of Refrigerant	Existing refrigerant in use, as reported to the RMP	Proposed refrigerant of choice (<10 GWP)
Refrigerant Charge (lb)	Partial charge size that is being permanently converted to ultra-low-GWP refrigerants For proposed HVAC-R integrated projects, also provide the charge of the HVAC system to be replaced	Charge size replacing the existing refrigerant (based on engineering design estimate)
Annual Leakage Rate (%/yr)	For the refrigeration system, RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb. For HVAC-R systems, the following leakage rates apply for HVAC units: • 10% for <50 lb; • 7% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 1%. For indirect or cascade system: • 3%. For all other systems, RMP average leakage rates: • 15.0% for ≤50 lb; • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.
End-of-Life Leakage Rate (%)	For the refrigeration system, RMP average leakage rates: • 20% For HVAC-R systems, the following leakage rates apply for HVAC units: • 56% for <50 lb; • 20% for 50 – 200 lb.	For microdistributed systems and self-contained cases: • 98.5%. For all other systems: • 34% for ≤50 lb; • 20% for >50 lb.
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	Energy usage for the existing system, if available. Sub-metering for the portion that would be converted to an ultra-low GWP system would be required for the data to be valid.	Energy usage beyond Title 24 requirements, if available (based on engineering design estimate)

Table 5. Input Values and Assumptions for Tier II Refrigerant Retrofit Projects Located at an Existing Facility

Inputs	Baseline System	Proposed System
Type of Refrigerant	Existing refrigerant in use, as reported to the RMP (>3900 GWP)	Proposed refrigerant of choice (<1500 GWP)
Refrigerant Charge (lb)	Existing system charge size, as reported to the RMP	Proposed system charge size after the refrigerant retrofit
Annual Leakage Rate (%/yr)	RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.	RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.
End-of-Life Leakage Rate (%)	20%	20%
Quantification Period (years)	10	10

Table 6. Input Values and Assumptions for Tier II Refrigerant Retrofit Projects Located at an Existing Facility, Accompanied by a Permanent Charge Reduction of at least 25%

Inputs	Baseline System	Proposed System
Type of Refrigerant	Existing refrigerant in use, as reported to the RMP (>3900 GWP)	Proposed refrigerant of choice (<1500 GWP)
Refrigerant Charge (lb)	Existing system charge size, as reported to the RMP	Proposed system charge size after the refrigerant retrofit and charge reduction (≤75% of baseline)
Annual Leakage Rate (%/yr)	RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.	RMP average leakage rates: • 15.6% for >50 – <200 lb; • 22.9% for 200 – <2000 lb; • 24.2% for ≥2000 lb.
End-of-Life Leakage Rate (%)	20%	20%
Quantification Period (years)	10	10

Applicant Inputs for the FRIP Tool

In summary, Table 7 identifies the required data inputs needed from the applicant to estimate the GHG emission reductions and selected co-benefits for the proposed project with the FRIP Tool by component.

Table 7. Required FRIP Tool Inputs for Eligible Projects

ALL PROJECTS

General Information (Project Info worksheet)
• Project Name;
• Project Address;
• Contact Name;
• Contact Phone Number;
• Contact Email;
• Date Calculator Completed;
• Total FRIP GGRF (and LADWP) Funds Requested (i.e., total amount of funds requested from this solicitation to implement the project);
• Total Refrigeration System Cost (i.e., FRIP and LADWP funds requested plus other funds to cover the remaining project cost of the refrigeration system, including company funds and public agency/utility funds); and
• Project Completion Date (MM/DD/YY).
 	
Quantification Inputs (Inputs Worksheet)
• Project Information;
  ○ Project Type;
  ○ HVAC-R System (Yes/No);
  ○ Description of Project Activity;
• Baseline Refrigeration System;
  ○ Type of Refrigeration Refrigerant;
  ○ Refrigeration Refrigerant Charge (lb);
  ○ Annual Electricity Usage, per Refrigeration System (kWh/yr) [Optional];
  ○ Type of HVAC Refrigerant [If Applicable];
  ○ HVAC Refrigerant Charge (lb) [If Applicable];
  ○ Annual Electricity Usage, per HVAC System (kWh/yr) [If Applicable, Optional];
• Proposed Project Refrigeration System;
  ○ Type of System;
  ○ Number of Identical Primary Refrigeration Systems;
  ○ Type of Primary Refrigerant;
  ○ Primary Refrigerant Charge per System (lb);
  ○ Type of Secondary Refrigerant [If Applicable];
  ○ Secondary Refrigerant Charge (lb) [If Applicable]; and
  ○ Annual Electricity Usage, per System (kWh/yr) [Optional].

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Applicants must use the FRIP Tool to calculate GHG emission reductions from the proposed project. The FRIP Tool can be downloaded from: www.arb.ca.gov/cci-resources.

Based on the inputs entered for the refrigeration system, the **Benefits Summary** tab automates and displays the estimated:

- GHG Emission Reductions
  - Refrigerant GHG Emission Reductions ($MTCO_2e$);
  - Total FRIP GGRF (and LADWP) Funds per Refrigerant GHG Emission Reductions ($/MTCO_2e$);
  - Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO_2e$);
  - Electricity GHG Emission Reductions ($MTCO_2e$);
  - Total Refrigerant and Electricity GHG Emission Reductions ($MTCO_2e$);
  - Total FRIP GGRF (and LADWP) Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO_2e$);
- Energy Efficiency Benefits
  - Energy and fuel cost savings ($);
  - Fossil fuel based energy use reductions (kWh);
  - Local, Remote, and Total NO_x emission reductions (lb);
  - Local, Remote, and Total ROG emission reductions (lb); and
  - Local, Remote, and Total $PM_{2.5}$ emission reductions (lb).

Note: Some projects may entail multiple refrigeration systems (i.e., more than one baseline or proposed project systems). For example, an applicant 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 project system while leaving the other blank, as necessary. Continuing the example, an applicant would fill out one row for the baseline refrigeration system one of the proposed refrigeration systems; on the next row, the applicant would fill out information for the other proposed refrigeration system and leave the baseline system inputs blank.

Section C. Example Projects

The following are hypothetical projects[4] to demonstrate how the FRIP Tool would be used by applicants and the inputs and assumptions needed to use the Calculator Tool. The sample projects below do not include examples of the supporting documentation that is required of actual project applicants. All examples will follow the four steps listed below, as thoroughly detailed in this User Guide and Quantification Methodology, to demonstrate the information needed to complete the FRIP Tool to calculate project GHG emission reductions.

Steps to calculating project GHG emission reductions using the Tool:

- Step 1: Define the Project
- Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool
- Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Once all steps are completed, the FRIP Tool will produce a Benefits Summary.

Overview of the example projects

The following are five hypothetical example projects. There are three Tier I project types that are categorized by the refrigeration system and the installation site scenarios. There are two Tier II project types that are categorized by the installation site and charge reduction scenarios. The following examples of each project type include hypothetical eligible component(s), project assumptions and baselines, and characteristics that apply to the projects. The information provided in the examples below will be used to complete the four steps to determine GHG emission reductions using the FRIP Tool.

[4] The hypothetical project has not undergone verification of any FRIP requirements; all assumptions about location type and project features are for FRIP Tool demonstration purposes only.

Example Project #1: Installation at a New Facility

Overview of the proposed project

A grocery store is opening in a newly constructed facility. The applicant proposes to install an ultra-low-GWP refrigerant (< 10 GWP) at the new facility: An integrated HVAC-R (Heating, ventilation, air conditioning and refrigeration) R-717 (Ammonia)/R-744 (Carbon Dioxide) Cascade system. The project has the following characteristics:

- The applicant plans to install a HVAC-R R-717 (Ammonia)/R-744 (Carbon Dioxide) system for refrigeration of the products as well as for space conditioning in the grocery store.
- The system refrigerants have a combined GWP of 1, which is a weighted average of the two refrigerants.
- Through an engineering design estimate, the baseline charge is determined for a hypothetical R-448A refrigeration system that would have been used if the store owner decided not to install an ultra-low GWP system. The hypothetical commercial air conditioning system that would have been used in place of the integrated HVAC-R system are three R-410 systems with a charge size of 30 lb.

Methods to apply

Step 1: Define the Project

Figure 2. Example Project #1 – General project information

General Project Information (Project Info tab)
• Project Name: California Grocery Store • Project Address: 1111 Example Dr., Example City, CA 95000 • Contact Name: John Smith • Contact Phone Number: (916) 123-4567 • Contact Email: john.smith@CGS.org • Date Calculator Completed: 8/1/2020 • Total FRIP GGRF (and LADWP) Funds Requested ($): $50,000 • Total Refrigeration System Cost ($): $1,000,000 • Project Completion Date (MM/DD/YY): 8/1/2021

Figure 3. Example Project #1 – General information entered into FRIP Tool

Project Name:	California Grocery Store
Project ID:	*To be completed by CARB*
Project Address:	1111 Example Dr., Example City, CA 95000
Applicant ID:	*To be completed by CARB*
Contact Name:	John Smith
Contact Phone Number:	(916) 123-4567
Contact Email:	john.smith@CGS.org
Date Calculator Completed:	8/1/2020
Total FRIP GGRF (and LADWP) Funds Requested ($):	$ 50,000
Total Refrigeration System Cost ($):	$ 1,000,000
Project Completion Date (MM/DD/YYYY):	8/1/2021

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

The refrigerant charge of the baseline system is based on the hypothetical R-448A system determined through an engineering design estimate. The refrigerant charge of the proposed new system is also determined through an engineering design estimate.

The following input values and assumptions pertain to the project, as shown in Table 8.

Table 8. Example Project #1 – Input values and assumptions

Inputs	Baseline System	Proposed System
Type of Refrigeration Refrigerant	Refrigeration System: • R-448A HVAC Systems: • R-410A	Primary Refrigerant: • R-717 (Ammonia) Secondary Refrigerant: • R-744 (Carbon Dioxide)
Refrigeration Refrigerant Charge (lb)	Refrigeration System: • 3,000 lb HVAC Systems: • 30 lb	Primary Refrigerant: • 200 lb Secondary Refrigerant: • 2,200 lb
Annual Leakage Rate (%/yr)	Refrigeration System: • 24.2% (based on RMP average leakage rates for system) HVAC Systems: • 10%	Primary Refrigerant: • 3% Secondary Refrigerant: • 24.2%
End-of-Life Leakage Rate (%)	Refrigeration System: • 20% HVAC Systems: • 56%	Primary Refrigerant: • 20% Secondary Refrigerant: • 20%
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	Refrigeration System: • 1,050,000 kWh/yr HVAC Systems: • 20,000 kWh/yr	1,000,000 kWh/yr

Based upon the proposed project, the following information would be required for the **Inputs** tabs:

Figure 4. Example Project #1 – Refrigerant information

ALL PROJECTS (Inputs tab)

Input Row 1:

- Project Information:
  - Project Type: Tier I at New Facility
  - HVAC-R System (Yes/No): Yes
  - Description of Project Activity: Install new HVAC-R system
- Baseline Refrigeration System:
  - Type of Refrigeration Refrigerant: R-448A
  - Refrigeration Refrigerant Charge (lb): 3,000
  - Annual Electricity Usage, per Refrigeration System (kWh/yr): 1,050,000
  - Type of HVAC Refrigerant: R-410A
  - HVAC Refrigerant Charge (lb): 30
  - Annual Electricity Usage, per HVAC System (kWh/yr): 20,000
- Proposed Project Refrigeration System:
  - Type of System: Indirect or Cascade System
  - Number of Identical Primary Refrigeration Systems: 1
  - Type of Primary Refrigerant: R-717 (Ammonia)
  - Primary Refrigerant Charge per System (lb): 200
  - Type of Secondary Refrigerant: R-744 (Carbon Dioxide)
  - Secondary Refrigerant Charge (lb): 2,200
  - Annual Electricity Usage, per System (kWh/yr): 1,000,000

Input Row 2:

- Description of Project Activity: Install new HVAC-R system
- Baseline Refrigeration System:
  - Type of HVAC Refrigerant: R-410A
  - HVAC Refrigerant Charge (lb): 30
  - Annual Electricity Usage, per HVAC System (kWh/yr): 20,000

Input Row 3:

- Description of Project Activity: Install new HVAC-R system
- Baseline Refrigeration System:
  - Type of HVAC Refrigerant: R-410A
  - HVAC Refrigerant Charge (lb): 30
  - Annual Electricity Usage, per HVAC System (kWh/yr): 20,000

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Enter the project information into the FRIP Tool's **Inputs** tab to estimate GHG emission reductions and other benefits from the project's refrigerant replacement.

Figure 5. Example Project #1 – FRIP Tool Inputs Tab, Project Information and Baseline System Inputs

Project Information				Baseline Refrigeration System Inputs					
#	Project Type	HVAC-R System (Yes/No)	Description of Project Activity	Type of Refrigeration Refrigerant	Refrigeration Refrigerant Charge (lb)	Annual Electricity Usage, per Refrigeration System (kWh/yr)	Type of HVAC Refrigerant	HVAC Refrigerant Charge (lb)	Annual Electricity Usage, per HVAC System (kWh/yr)
1	Tier I at New Facility	Yes	Install new HVAC-R system	R-448A	3,000.00	1,050,000	R-410A	30.00	20,000
2	Tier I at New Facility	Yes	Install new HVAC-R system				R-410A	30.00	20,000
3	Tier I at New Facility	Yes	Install new HVAC-R system				R-410A	30.00	20,000

Figure 6. Example Project #1 – FRIP Tool Inputs Tab, Proposed System Inputs

Proposed Project Refrigeration System Inputs						
Type of System	Number of Identical Primary Refrigeration Systems	Type of Primary Refrigerant	Primary Refrigerant Charge per System (lb)	Type of Secondary Refrigerant	Secondary Refrigerant Charge (lb)	Annual Electricity Usage, per System (kWh/yr)
Indirect or Cascade System	1	R-717 (Ammonia)	200.00	R-744 (Carbon Dioxide)	2,200.00	1,000,000

Figure 7. Example Project #1 – FRIP Tool Inputs Tab, Baseline System Assumptions

Baseline Refrigeration System Assumptions				
Refrigeration Annual Leakage Rate (%/yr)	Refrigeration End-of-Life Leakage (%)	HVAC Annual Leakage Rate (%/yr)	HVAC End-of-Life Leakage (%)	Quantification Period (years)
24.2%	20.0%	10.0%	56.0%	15
		10.0%	56.0%	15
		10.0%	56.0%	15

Figure 8. Example Project #1 – FRIP Tool Inputs Tab, Proposed System Assumptions

Proposed Project Refrigeration System Assumptions				
Primary Refrigerant Annual Leakage Rate (%/yr)	Primary Refrigerant End-of-Life Leakage (%)	Secondary Refrigerant Annual Leakage Rate (%/yr)	Secondary Refrigerant End-of-Life Leakage (%)	Quantification Period (years)
3.0%	20.0%	24.2%	20.0%	15

Figure 9. Example Project #1 – FRIP Tool Inputs Tab, Calculated GHG Emission Reductions

Refrigerant GHG Emission Reductions			Electricity GHG Emission Reductions		
Baseline System GHG Emissions ($MTCO_2e$)	Proposed System GHG Emissions ($MTCO_2e$)	Total Refrigerant GHG Emission Reduction ($MTCO_2e$)	Baseline System Electricity Usage (kWh)	Proposed System Electricity Usage (kWh)	Total Grid Electricity GHG Reduction ($MTCO_2e$)
7,282	4	7,395	16,050,000	15,000,000	346
59			300,000		
59			300,00		

The **Benefits Summary** tab displays the GHG emission reductions and other co-benefits and key variables from the project. GHG and air pollutant emission reductions are prorated according to the level of program funding contributed from FRIP and other California Climate Investments programs funded by GGRF, as applicable.

Figure 10. Example Project #1 – Benefits Summary tab outputs from FRIP Tool

Project Information		
Project Name		
Total FRIP GGRF (and LADWP) Funds Requested ($)	$	50,000
Non-GGRF Leveraged Funds ($)	$	950,000
Total System Cost ($)	$	1,000,000

Total GHG Summary	
Refrigerant GHG Emission Reductions (MTCO2e)	7,395
Total FRIP GGRF (and LADWP) Funds per Refrigerant GHG Emission Reductions ($/MTCO2e)	7
Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO2e)	135
Electricity GHG Emission Reductions (MTCO2e)	376
Total Refrigerant and Electricity GHG Emission Reductions (MTCO2e)	7,771
Total FRIP GGRF (and LADWP) Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO2e)	6

Co-benefits and Key Variables Summary			
			FRIP GGRF Funds
Energy and Fuel Cost Savings ($)			$217,470
Fossil Fuel Based Energy Use Reductions (kWh)			1,650,000
Criteria and Toxic Air Pollutant Emission Reductions	**Local**	**Remote**	**Total**
NO_x emission reductions (lb)		211	211
ROG emission reductions (lb)		34	34
$PM_{2.5}$ emission reductions (lb)		53	53

Example Project #2: Full Conversion at Existing Facility

Introduction

The following is a hypothetical project[5] to demonstrate how the FRIP Tool would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a Tier I full conversion project at an existing facility, and has the following characteristics:

- The grocery store has decided to convert all of their high-GWP R-507A refrigeration systems to R-744 (carbon dioxide) condensing units along with R-290 self-contained cases.
- The grocery store currently has two R-507A refrigeration systems, one with a charge size of 1,000 lb and another with a charge size of 800 lb.
- The grocery store will install four R-744 (Carbon Dioxide) condensing units and 25 R-290 self-contained cases. Each of the condensing units have 150 pounds of charge. Each of the R-290 cases have 0.330 lb (~150 g) of charge.

[5] The hypothetical project has not undergone verification of any FRIP requirements; all assumptions about location type and project features are for FRIP Tool demonstration purposes only.

Methods to apply

Step 1: Define the Project

Figure 11. Example Project #2 – General project information

General Project Information (Project Info tab)
• Project Name: Refrigerant Replacement Project • Project Address: 1234 Example St., Example City, CA 95000 • Contact Name: Jane Smith • Contact Phone Number: (916) 987-6543 • Contact Email: jane.smith@grocer.org • Date Calculator Completed: 8/2/2020 • Total FRIP GGRF (and LADWP) Funds Requested ($): $100,000 • Total Refrigeration System Cost ($): $500,000 • Project Completion Date (MM/DD/YY): 10/1/2021

Figure 12. Example Project #2 – General information entered into FRIP Tool

Project Name:	Refrigerant Replacement Project
Project ID:	*To be completed by CARB*
Project Address:	1234 Example St., Example City, CA 95000
Applicant ID:	*To be completed by CARB*
Contact Name:	Jane Smith
Contact Phone Number:	(916) 987-6543
Contact Email:	jane.smith@grocer.org
Date Calculator Completed:	8/1/2020
Total FRIP GGRF (and LADWP) Funds Requested ($):	$ 100,000
Total Refrigeration System Cost ($):	$ 500,000
Project Completion Date (MM/DD/YYYY):	10/1/2021

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

The refrigerant charge of the existing system was based data reported to CARB's RMP. The refrigerant charge of the new system is based upon values that will be reported to CARB's RMP when the system first becomes operational.

The following input values and assumptions pertain to the project, shown in Table 9.

Table 9. Example Project #2 – Input values and assumptions

Inputs	Baseline System	Proposed System
Type of Refrigeration Refrigerant	Refrigeration System 1: • R-507A Refrigeration System 2: • R-507A	Refrigeration System 1: Primary Refrigerant: • R-290 Refrigeration System 2: Primary Refrigerant: • R-744 (Carbon Dioxide)
Refrigeration Refrigerant Charge (lb)	Refrigeration System 1: • 1,000 lb Refrigeration System 2: • 800 lb	Refrigeration System 1: Primary Refrigerant: • 0.330 lb Refrigeration System 2: Primary Refrigerant: • 150 lb
Annual Leakage Rate (%/yr)	Refrigeration System 1: • 22.9% (based on RMP average leakage rates for system) Refrigeration System 2: • 22.9% (based on RMP average leakage rates for system)	Refrigeration System 1: Primary Refrigerant: • 1% Refrigeration System 2: Primary Refrigerant: • 15.6%
End-of-Life Leakage Rate (%)	Refrigeration System 1: • 20% Refrigeration System 2: • 20%	Refrigeration System 1: Primary Refrigerant: • 98.5% Refrigeration System 2: Primary Refrigerant: • 20%
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	Refrigeration System 1: • 250,000 kWh/yr Refrigeration System 2: • 200,000 kWh/yr	Refrigeration System 1: • 250 kWh/yr each Refrigeration System 2: • 100,000 kWh/yr each

Based upon the proposed project, the following information would be required for the **Inputs** tabs:

Figure 13. Example Project #2 – Refrigerant information

ALL PROJECTS (Inputs tab)

Input Row 1:

- Project Information:
  - Project Type: Tier I at Existing Facility, Full Conversion
  - HVAC-R System (Yes/No): No
  - Description of Project Activity: Replace R-507A refrigeration system with R-290 self-contained cases and carbon dioxide condensing units
- Baseline Refrigeration System:
  - Type of Refrigeration Refrigerant: R-507
  - Refrigeration Refrigerant Charge (lb): 1,000
  - HVAC Refrigerant Charge (lb):
  - Annual Electricity Usage, per Refrigeration System (kWh/yr): 250,000
- Proposed Project Refrigeration System:
  - Type of System: Self-Contained Cases (No Water Loop)
  - Number of Identical Primary Refrigeration Systems: 25
  - Type of Primary Refrigerant: R-290 (Propane)
  - Primary Refrigerant Charge per System (lb): 0.330
  - Type of Secondary Refrigerant:
  - Secondary Refrigerant Charge (lb):
  - Annual Electricity Usage, per System (kWh/yr): 250

Input Row 2:

- Project Information:
  - Description of Project Activity: Replace R-507A refrigeration system with R-290 self-contained cases and carbon dioxide condensing units
- Baseline Refrigeration System:
  - Type of Refrigeration Refrigerant: R-507
  - Refrigeration Refrigerant Charge (lb): 800
  - HVAC Refrigerant Charge (lb):
  - Annual Electricity Usage, per Refrigeration System (kWh/yr): 200,000
- Proposed Project Refrigeration System:
  - Type of System: Condensing Unit
  - Number of Identical Primary Refrigeration Systems: 4
  - Type of Primary Refrigerant: R-744 (Carbon Dioxide)
  - Primary Refrigerant Charge per System (lb): 150
  - Type of Secondary Refrigerant:
  - Secondary Refrigerant Charge (lb):
  - Annual Electricity Usage, per System (kWh/yr): 100,000

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Enter project information into the FRIP Tool's **Inputs** tab to estimate GHG emission reductions from the project's refrigerant replacement.

Figure 14. Example Project #2 – FRIP Tool Inputs Tab, Project Information and Baseline System Inputs

Project Information				Baseline Refrigeration System Inputs					
#	Project Type	HVAC-R System (Yes/No)	Description of Project Activity	Type of Refrigeration Refrigerant	Refrigeration Refrigerant Charge (lb)	Annual Electricity Usage, per Refrigeration System (kWh/yr)	Type of HVAC Refrigerant	HVAC Refrigerant Charge (lb)	Annual Electricity Usage, per HVAC System (kWh/yr)
1	Tier I at Existing Facility, Full Conversion	No	Replace R-507A refrigeration system with R-290 self-contained cases and carbon dioxide condensing units	R-507	1,000.00	250,000			
2	Tier I at Existing Facility, Full Conversion	No	Replace R-507A refrigeration system with R-290 self-contained cases and carbon dioxide condensing units	R-507	800.00	200,000			

Figure 15. Example Project #2 – FRIP Tool Inputs Tab, Proposed System Inputs

Proposed Project Refrigeration System Inputs						
Type of System	Number of Identical Primary Refrigeration Systems	Type of Primary Refrigerant	Primary Refrigerant Charge per System (lb)	Type of Secondary Refrigerant	Secondary Refrigerant Charge (lb)	Annual Electricity Usage, per System (kWh/yr)
Self-Contained Cases (No Water Loop)	25	R-290 (Propane)	0.33			250
Condensing Unit	4	R-744 (Carbon Dioxide)	150.00			100,000

Figure 16. Example Project #2 – FRIP Tool Inputs Tab, Baseline System Assumptions

Baseline Refrigeration System Assumptions				
Refrigeration Annual Leakage Rate (%/yr)	Refrigeration End-of-Life Leakage (%)	HVAC Annual Leakage Rate (%/yr)	HVAC End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%	[redacted]		15
22.9%	20.0%			15

Figure 17. Example Project #2 – FRIP Tool Inputs Tab, Proposed System Assumptions

Proposed Project Refrigeration System Assumptions				
Primary Refrigerant Annual Leakage Rate (%/yr)	Primary Refrigerant End-of-Life Leakage (%)	Secondary Refrigerant Annual Leakage Rate (%/yr)	Secondary Refrigerant End-of-Life Leakage (%)	Quantification Period (years)
1.0%	98.5%			15
15.6%	20.0%			15

Figure 18. Example Project #2 – FRIP Tool Inputs Tab, Calculated GHG Emission Reductions

Refrigerant GHG Emission Reductions			Electricity GHG Emission Reductions		
Baseline System GHG Emissions ($MTCO_2e$)	Proposed System GHG Emissions ($MTCO_2e$)	Total Refrigerant GHG Emission Reduction ($MTCO_2e$)	Baseline System Electricity Usage (kWh)	Proposed System Electricity Usage (kWh)	Total Grid Electricity GHG Reduction ($MTCO_2e$)
6,571	0	11,826	3,750,000	93,750	150
5,256	1		3,000,000	6,000,000	

The **Benefits Summary** tab displays the GHG emission reductions and other co-benefits and key variables from the project. GHG and air pollutant emission reductions are prorated according to the level of program funding contributed from FRIP and other California Climate Investments programs funded by GGRF, as applicable.

Figure 19. Example Project #2 – Benefits Summary tab outputs from FRIP Tool

Project Information		
Project Name		
Total FRIP GGRF (and LADWP) Funds Requested ($)	$	100,000
Non-GGRF Leveraged Funds ($)	$	400,000
Total System Cost ($)	$	500,000

Total GHG Summary	
Refrigerant GHG Emission Reductions (MTCO2e)	11,826
Total FRIP GGRF (and LADWP) Funds per Refrigerant GHG Emission Reductions ($/MTCO2e)	8
Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO2e)	42
Electricity GHG Emission Reductions (MTCO2e)	150
Total Refrigerant and Electricity GHG Emission Reductions (MTCO2e)	11,976
Total FRIP GGRF (and LADWP) Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO2e)	8

Co-benefits and Key Variables Summary			
			FRIP GGRF Funds
Energy and Fuel Cost Savings ($)			$86,494
Fossil Fuel Based Energy Use Reductions (kWh)			656,250
Criteria and Toxic Air Pollutant Emission Reductions	**Local**	**Remote**	**Total**
NO_x emission reductions (lb)		84	84
ROG emission reductions (lb)		13	13
$PM_{2.5}$ emission reductions (lb)		21	21

Example Project #3: Partial Conversion at Existing Facility

Introduction

The following is a hypothetical project[6] to demonstrate how the FRIP Tool would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a Tier I partial conversion project at an existing facility, and has the following characteristics:

- The grocery store is planning to convert a portion of their existing refrigeration systems that are used for low-temperature refrigeration.
- The system they plan to replace is an R-448A system with a charge size of 500 lb.
- The new system to be installed is a R-744 (Carbon Dioxide) system with a charge size of 300 lb.

[6] The hypothetical project has not undergone verification of any FRIP requirements; all assumptions about location type and project features are for FRIP Tool demonstration purposes only.

Methods to apply

Step 1: Define the Project

Figure 20. Example Project #3 – General project information

General Project Information (Project Info tab)
• Project Name: Fruit Store Retrofit • Project Address: 123 Example St., Example City, CA 95000 • Contact Name: John Lee • Contact Phone Number: (916) 987-6543 • Contact Email: john.lee@FS.org • Date Calculator Completed: 9/1/2020 • Total FRIP GGRF (and LADWP) Funds Requested ($): $75,000 • Total Refrigeration System Cost ($): $150,000 • Project Completion Date (MM/DD/YY): 12/1/2021

Figure 21. Example Project #3 – General information entered into FRIP Tool

Project Name:	Fruit Store Retrofit
Project ID:	*To be completed by CARB*
Project Address:	123 Example St., Example City, CA 95000
Applicant ID:	*To be completed by CARB*
Contact Name:	John Lee
Contact Phone Number:	(916) 987-6543
Contact Email:	john.lee@FS.org
Date Calculator Completed:	9/1/2020
Total FRIP GGRF (and LADWP) Funds Requested ($):	$ 75,000
Total Refrigeration System Cost ($):	$ 150,000
Project Completion Date (MM/DD/YYYY):	12/1/2021

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

The refrigerant charge of the existing system was based data reported to CARB's RMP. The refrigerant charge of the new system is based upon values that will be reported to CARB's RMP when the system first becomes operational.

The following input values and assumptions pertain to the project, as shown in Table 10.

Table 10. Example Project #3 – Input values and assumptions

Inputs	Baseline System	Proposed System
Type of Refrigeration Refrigerant	Refrigeration System: • R-448A	Primary Refrigerant: • R-744 (Carbon Dioxide)
Refrigeration Refrigerant Charge (lb)	Refrigeration System: • 500 lb (determined by an engineering design estimate)	Primary Refrigerant: • 300 lb
Annual Leakage Rate (%/yr)	Refrigeration System: • 22.9% (based on RMP average leakage rates for system)	Primary Refrigerant: • 22.9%
End-of-Life Leakage Rate (%)	Refrigeration System: • 20%	Primary Refrigerant: • 20%
Quantification Period (years)	15	15
Energy Consumption, per System (kWh/yr)	N/A	N/A

Based upon the proposed project, the following information would be required for the **Inputs** tabs:

Figure 22. Example Project #3 – Refrigerant information

ALL PROJECTS (Inputs tab)

• Project Information:
  o Project Type: Tier I at Existing Facility, Partial Conversion
  o HVAC-R System (Yes/No): No
  o Description of Project Activity: Partial conversion to CO2 system
• Baseline Refrigeration System:
  o Type of Refrigeration Refrigerant: R-448A
  o Refrigeration Refrigerant Charge (lb): 500
  o Annual Electricity Usage, per Refrigeration System (kWh/yr):
• Proposed Project Refrigeration System:
  o Type of System: Centralized DX System
  o Number of Identical Primary Refrigeration Systems: 1
  o Type of Primary Refrigerant: R-744 (Carbon Dioxide)
  o Primary Refrigerant Charge per System (lb): 500
  o Annual Electricity Usage, per System (kWh/yr):

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Enter the project information into the FRIP Tool's **Inputs** tab to estimate GHG emission reductions and other benefits from the project's refrigerant replacement.

Figure 23. Example Project #3 – FRIP Tool Inputs Tab, Project Information and Baseline System Inputs

Project Information				Baseline Refrigeration System Inputs					
#	Project Type	HVAC-R System (Yes/No)	Description of Project Activity	Type of Refrigeration Refrigerant	Refrigeration Refrigerant Charge (lb)	Annual Electricity Usage, per Refrigeration System (kWh/yr)	Type of HVAC Refrigerant	HVAC Refrigerant Charge (lb)	Annual Electricity Usage, per HVAC System (kWh/yr)
1	Tier I at Existing Facility, Partial Conversion	No	Partial conversion to CO2 system	R-448A	500.00				

Figure 24. Example Project #3 – FRIP Tool Inputs Tab, Proposed System Inputs

Proposed Project Refrigeration System Inputs						
Type of System	Number of Identical Primary Refrigeration Systems	Type of Primary Refrigerant	Primary Refrigerant Charge per System (lb)	Type of Secondary Refrigerant	Secondary Refrigerant Charge (lb)	Annual Electricity Usage, per System (kWh/yr)
Centralized DX System	1	R-744 (Carbon Dioxide)	500.00			

Figure 25. Example Project #3 – FRIP Tool Inputs Tab, Baseline System Assumptions

Baseline Refrigeration System Assumptions				
Refrigeration Annual Leakage Rate (%/yr)	Refrigeration End-of-Life Leakage (%)	HVAC Annual Leakage Rate (%/yr)	HVAC End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%			15

Figure 26. Example Project #3 – FRIP Tool Inputs Tab, Proposed System Assumptions

Proposed Project Refrigeration System Assumptions				
Primary Refrigerant Annual Leakage Rate (%/yr)	Primary Refrigerant End-of-Life Leakage (%)	Secondary Refrigerant Annual Leakage Rate (%/yr)	Secondary Refrigerant End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%			15

Figure 27. Example Project #3 – FRIP Tool Inputs Tab, Calculated GHG Emission Reductions

Refrigerant GHG Emission Reductions			Electricity GHG Emission Reductions		
Baseline System GHG Emissions ($MTCO_2e$)	Proposed System GHG Emissions ($MTCO_2e$)	Total Refrigerant GHG Emission Reduction ($MTCO_2e$)	Baseline System Electricity Usage (kWh)	Proposed System Electricity Usage (kWh)	Total Grid Electricity GHG Reduction ($MTCO_2e$)
1,143	1	1,142			0

The **Benefits Summary** tab displays the GHG emission reductions and other co-benefits and key variables from the project. GHG and air pollutant emission reductions are prorated according to the level of program funding contributed from FRIP and other California Climate Investments programs funded by GGRF, as applicable.

Figure 28. Example Project #3 – Benefits Summary tab outputs from FRIP Tool

Project Information		
Project Name		
Total FRIP GGRF (and LADWP) Funds Requested ($)	$	75,000
Non-GGRF Leveraged Funds ($)	$	75,000
Total System Cost ($)	$	150,000

Total GHG Summary	
Refrigerant GHG Emission Reductions (MTCO2e)	1,142
Total FRIP GGRF (and LADWP) Funds per Refrigerant GHG Emission Reductions ($/MTCO2e)	66
Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO2e)	131
Electricity GHG Emission Reductions (MTCO2e)	0
Total Refrigerant and Electricity GHG Emission Reductions (MTCO2e)	1,142
Total FRIP GGRF (and LADWP) Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO2e)	66

Co-benefits and Key Variables Summary			
			FRIP GGRF Funds
Energy and Fuel Cost Savings ($)			
Fossil Fuel Based Energy Use Reductions (kWh)			
Criteria and Toxic Air Pollutant Emission Reductions	**Local**	**Remote**	**Total**
NO_x emission reductions (lb)			
ROG emission reductions (lb)			
$PM_{2.5}$ emission reductions (lb)			

Example Project #4: Refrigerant Retrofit

Introduction

The following is a hypothetical project[7] to demonstrate how the FRIP Tool would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a refrigerant retrofit from R-404A (high-GWP, > 3900) to R-449A (lower-GWP, < 1500 GWP). This qualifies as a Tier II project at an existing facility without a permanent system charge reduction of at least 25%. Specifically, the project has the following characteristics:

- The existing R-404A refrigeration system has a charge size of 1,500 lb.
- The refrigeration system will be retrofitted to use R-449A.

[7] The hypothetical project has not undergone verification of any FRIP requirements; all assumptions about location type and project features are for FRIP Tool demonstration purposes only.

Methods to apply

Step 1: Define the Project

Figure 29. Example Project #4 – General project information

General Project Information (Project Info tab)
• Project Name: California Grocer • Project Address: 123 Example Lane., Example City, CA 95000 • Contact Name: Jane Doe • Contact Phone Number: (916) 123-1234 • Contact Email: jane.doe@CG.com • Date Calculator Completed: 8/10/2020 • Total FRIP GGRF (and LADWP) Funds Requested ($): $16,875 • Total Refrigeration System Cost ($): $67,500 • Project Completion Date (MM/DD/YY): 9/15/2021

Figure 30. Example Project #4 – General information entered into FRIP Tool

Project Name:	California Grocer	
Project ID:	*To be completed by CARB*	
Project Address:	123 Example Lane, Example City, CA 95000	
Applicant ID:	*To be completed by CARB*	
Contact Name:	Jane Doe	
Contact Phone Number:	(916) 123-1234	
Contact Email:	jane.doe@CG.com	
Date Calculator Completed:	8/10/2020	
Total FRIP GGRF Funds (and LADWP) Requested ($):	$	16,875
Total Refrigeration System Cost ($):	$	67,500
Project Completion Date (MM/DD/YYYY):		9/15/2021

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

The refrigerant charge of the existing system was based data reported to CARB's RMP. The refrigerant charge of the new system is based upon values that will be reported to CARB's RMP when the system first becomes operational.

The following input values and assumptions pertain to the project, as shown in Table 11.

Table 11. Example Project #4 – Input values and assumptions

Inputs	Baseline System	Proposed System
Type of Refrigeration Refrigerant	Refrigeration System: • R-404A	Primary Refrigerant: • R-449A
Refrigeration Refrigerant Charge (lb)	Refrigeration System: • 1,500 lb	Primary Refrigerant: • 1,575 lb
Annual Leakage Rate (%/yr)	Refrigeration System: • 22.9% (based on RMP average leakage rates for system)	Primary Refrigerant: • 22.9%
End-of-Life Leakage Rate (%)	Refrigeration System: • 20%	Primary Refrigerant: • 20%
Quantification Period (years)	10	10
Energy Consumption, per System (kWh/yr)	N/A	N/A

Based upon the proposed project, the following information would be required for the **Inputs** tabs:

Figure 31. Example Project #4 – Refrigerant information

ALL PROJECTS (Inputs tab)

• Project Information:
  o Project Type: Tier II Refrigerant Retrofit
  o Description of Project Activity: Retrofit from R-404A to R-449A
• Baseline Refrigeration System:
  o Type of Refrigerant: R-404A
  o Refrigerant Charge (lb): 1,500
  o Annual Electricity Usage, per Refrigeration System (kWh/yr):
• Proposed Project Refrigeration System:
  o Type of System: Centralized DX System
  o Number of Identical Primary Refrigeration Systems: 1
  o Type of Primary Refrigerant: R-449A
  o Primary Refrigerant Charge per System (lb): 1,575
  o Annual Electricity Usage, per System (kWh/yr):

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Enter the project information into the FRIP Tool's **Inputs** tab to estimate GHG emission reductions and other benefits from the project's refrigerant replacement.

Figure 32. Example Project #4 – FRIP Tool Inputs Tab, Project Information and Baseline System Inputs

Project Information				Baseline Refrigeration System Inputs					
#	Project Type	HVAC-R System (Yes/No)	Description of Project Activity	Type of Refrigeration Refrigerant	Refrigeration Refrigerant Charge (lb)	Annual Electricity Usage, per Refrigeration System (kWh/yr)	Type of HVAC Refrigerant	HVAC Refrigerant Charge (lb)	Annual Electricity Usage, per HVAC System (kWh/yr)
1	Tier II Refrigerant Retrofit		Retrofit from R-404A to R-449A	R-404A	1,500.00				

Figure 33. Example Project #4 – FRIP Tool Inputs Tab, Proposed System Inputs

Proposed Project Refrigeration System Inputs						
Type of System	Number of Identical Primary Refrigeration Systems	Type of Primary Refrigerant	Primary Refrigerant Charge per System (lb)	Type of Secondary Refrigerant	Secondary Refrigerant Charge (lb)	Annual Electricity Usage, per System (kWh/yr)
Centralized DX System	1	R-449A	1,575.00			

Figure 34. Example Project #4 – FRIP Tool Inputs Tab, Baseline System Assumptions

Baseline Refrigeration System Assumptions				
Refrigeration Annual Leakage Rate (%/yr)	Refrigeration End-of-Life Leakage (%)	HVAC Annual Leakage Rate (%/yr)	HVAC End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%			10

Figure 35. Example Project #4 – FRIP Tool Inputs Tab, Proposed System Assumptions

Proposed Project Refrigeration System Assumptions				
Primary Refrigerant Annual Leakage Rate (%/yr)	Primary Refrigerant End-of-Life Leakage (%)	Secondary Refrigerant Annual Leakage Rate (%/yr)	Secondary Refrigerant End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%			10

Figure 36. Example Project #4 – FRIP Tool Inputs Tab, Calculated GHG Emission Reductions

Refrigerant GHG Emission Reductions			Electricity GHG Emission Reductions		
Baseline System GHG Emissions ($MTCO_2e$)	Proposed System GHG Emissions ($MTCO_2e$)	Total Refrigerant GHG Emission Reduction ($MTCO_2e$)	Baseline System Electricity Usage (kWh)	Proposed System Electricity Usage (kWh)	Total Grid Electricity GHG Reduction ($MTCO_2e$)
6,645	2,483	4,161			0

The **Benefits Summary** tab displays the GHG emission reductions and other co-benefits and key variables from the project. GHG and air pollutant emission reductions are prorated according to the level of program funding contributed from FRIP and other California Climate Investments programs funded by GGRF, as applicable.

Figure 37. Example Project #4 – Benefits Summary tab outputs from FRIP Tool

Project Information		
Project Name		
Total FRIP GGRF (and LADWP) Funds Requested ($)	$	16,875
Non-GGRF Leveraged Funds ($)	$	50,625
Total System Cost ($)	$	67,500

Total GHG Summary	
Refrigerant GHG Emission Reductions (MTCO2e)	4,161
Total FRIP GGRF (and LADWP) Funds per Refrigerant GHG Emission Reductions ($/MTCO2e)	4
Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO2e)	16
Electricity GHG Emission Reductions (MTCO2e)	0
Total Refrigerant and Electricity GHG Emission Reductions (MTCO2e)	4,161
Total FRIP GGRF (and LADWP) Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO2e)	4

Co-benefits and Key Variables Summary			
			FRIP GGRF Funds
Energy and Fuel Cost Savings ($)			
Fossil Fuel Based Energy Use Reductions (kWh)			
Criteria and Toxic Air Pollutant Emission Reductions	**Local**	**Remote**	**Total**
NO_x emission reductions (lb)			
ROG emission reductions (lb)			
$PM_{2.5}$ emission reductions (lb)			

Example Project #5: Refrigerant Retrofit with Charge Reduction

Introduction

The following is a hypothetical project[8] to demonstrate how the FRIP Tool would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a refrigerant retrofit from R-507A (high-GWP, > 3900) to R-449A (lower-GWP, < 1500 GWP) along with a 75% charge reduction. This qualifies as a Tier II project at an existing facility with a permanent system charge reduction of at least 25%. Specifically, the project has the following characteristics:

- The existing R-507A refrigeration system has a charge size of 2,500 lb.
- The refrigeration system will be retrofitted to use R-449A and the system architecture will be changed to reduce the charge size to 1,200 lb.

[8] The hypothetical project has not undergone verification of any FRIP requirements; all assumptions about location type and project features are for FRIP Tool demonstration purposes only.

Methods to apply

Step 1: Define the Project

Figure 38. Example Project #5 – General project information

General Project Information (Project Info tab)
• Project Name: Local Corner Store • Project Address: 321 Example Ct., Example City, CA 95000 • Contact Name: John Doe • Contact Phone Number: (916) 987-9876 • Contact Email: john.doe@LCS.net • Date Calculator Completed: 8/5/2020 • Total FRIP GGRF Funds Requested ($): $38,500 • Total Refrigeration System Cost ($): $150,000 • Project Completion Date (MM/DD/YY): 10/31/2021

Figure 39. Example Project #5 – General information entered into FRIP Tool

Project Name:	Local Corner Store	
Project ID:	*To be completed by CARB*	
Project Address:	321 Example Ct., Example City, CA 95000	
Applicant ID:	*To be completed by CARB*	
Contact Name:	John Doe	
Contact Phone Number:	(916) 987-9876	
Contact Email:	john.doe@LCS.net	
Date Calculator Completed:	8/5/2020	
Total FRIP GGRF Funds Requested ($):	$	38,500
Total Refrigeration System Cost ($):	$	150,000
Project Completion Date (MM/DD/YYYY):		10/31/2021

Step 2: Determine the FRIP Tool Inputs for the Refrigeration System and Enter Data into the Tool

The refrigerant charge of the existing system was based data reported to CARB's RMP. The refrigerant charge of the new system is based upon values that will be reported to CARB's RMP when the system first becomes operational.

The following input values and assumptions pertain to the project, as shown in Table 12.

Table 12. Example Project #5 – Input values and assumptions

Inputs	Baseline System	Proposed System
Type of Refrigeration Refrigerant	Refrigeration System: • R-507A	Primary Refrigerant: • R-449A
Refrigeration Refrigerant Charge (lb)	Refrigeration System: • 2,500 lb	Primary Refrigerant: • 1,200 lb
Annual Leakage Rate (%/yr)	Refrigeration System: • 24.2% (based on RMP average leakage rates for system)	Primary Refrigerant: • 22.9% (based on RMP average leakage rates for system)
End-of-Life Leakage Rate (%)	Refrigeration System: • 20%	Primary Refrigerant: • 20%
Quantification Period (years)	10	10
Energy Consumption, per System (kWh/yr)	N/A	N/A

Based upon the proposed project, the following information would be required for the **Inputs** tabs:

Figure 40. Example Project #5 – Refrigerant information

ALL PROJECTS (Inputs tab)

- Project Information:
  - Project Type: Tier II Refrigerant Retrofit with Charge Reduction
  - Description of Project Activity: Refrigerant retrofit and charge reduction
- Baseline Refrigeration System:
  - Type of Refrigerant: R-507
  - Refrigerant Charge (lb): 2,500
  - Annual Electricity Usage, per Refrigeration System (kWh/yr):
- Proposed Project Refrigeration System:
  - Type of System: Centralized DX System
  - Number of Identical Primary Refrigeration Systems: 1
  - Type of Primary Refrigerant: R-449A
  - Primary Refrigerant Charge per System (lb): 1,200
  - Type of Secondary Refrigerant:
  - Secondary Refrigerant Charge (lb):
  - Annual Electricity Usage, per System (kWh/yr):

Step 3: Estimate GHG Emission Reductions and Selected Co-benefits for the Proposed Project Using the FRIP Tool

Enter the project information into the FRIP Tool's **Inputs** tab to estimate GHG emission reductions and other benefits from the project's refrigerant replacement.

Figure 41. Example Project #5 – FRIP Tool Inputs Tab, Project Information and Baseline System Inputs

Project Information				Baseline Refrigeration System Inputs					
#	Project Type	HVAC-R System (Yes/No)	Description of Project Activity	Type of Refrigeration Refrigerant	Refrigeration Refrigerant Charge (lb)	Annual Electricity Usage, per Refrigeration System (kWh/yr)	Type of HVAC Refrigerant	HVAC Refrigerant Charge (lb)	Annual Electricity Usage, per HVAC System (kWh/yr)
1	Tier II Refrigerant Retrofit with Charge Reduction		Refrigerant retrofit and charge reduction	R-507	2,500.00				

Figure 42. Example Project #5 – FRIP Tool Inputs Tab, Proposed System Inputs

Proposed Project Refrigeration System Inputs						
Type of System	Number of Identical Primary Refrigeration Systems	Type of Primary Refrigerant	Primary Refrigerant Charge per System (lb)	Type of Secondary Refrigerant	Secondary Refrigerant Charge (lb)	Annual Electricity Usage, per System (kWh/yr)
Centralized DX System	1	R-449A	1,200.00			

Figure 43. Example Project #5 – FRIP Tool Inputs Tab, Baseline System Assumptions

Baseline Refrigeration System Assumptions				
Refrigeration Annual Leakage Rate (%/yr)	Refrigeration End-of-Life Leakage (%)	HVAC Annual Leakage Rate (%/yr)	HVAC End-of-Life Leakage (%)	Quantification Period (years)
24.2%	20.0%			10

Figure 44. Example Project #5 – FRIP Tool Inputs Tab, Proposed System Assumptions

Proposed Project Refrigeration System Assumptions				
Primary Refrigerant Annual Leakage Rate (%/yr)	Primary Refrigerant End-of-Life Leakage (%)	Secondary Refrigerant Annual Leakage Rate (%/yr)	Secondary Refrigerant End-of-Life Leakage (%)	Quantification Period (years)
22.9%	20.0%			10

Figure 45. Example Project #5 – FRIP Tool Inputs Tab, Calculated GHG Emission Reductions

Refrigerant GHG Emission Reductions			Electricity GHG Emission Reductions		
Baseline System GHG Emissions ($MTCO_2e$)	Proposed System GHG Emissions ($MTCO_2e$)	Total Refrigerant GHG Emission Reduction ($MTCO_2e$)	Baseline System Electricity Usage (kWh)	Proposed System Electricity Usage (kWh)	Total Grid Electricity GHG Reduction ($MTCO_2e$)
11,840	1,892	9,948			0

The **Benefits Summary** tab displays the GHG emission reductions and other co-benefits and key variables from the project. GHG and air pollutant emission reductions are prorated according to the level of program funding contributed from FRIP and other California Climate Investments programs funded by GGRF, as applicable.

Figure 46. Example Project #5 – Benefits Summary tab outputs from FRIP Tool

Project Information		
Project Name		
Total FRIP GGRF Funds Requested ($)	$	38,500
Non-GGRF Leveraged Funds ($)	$	111,500
Total System Cost ($)	$	150,000

Total GHG Summary	
Refrigerant GHG Emission Reductions (MTCO2e)	9,948
Total FRIP GGRF Funds per Refrigerant GHG Emission Reductions ($/MTCO2e)	4
Total System Cost per Refrigerant GHG Emission Reductions ($/MTCO2e)	15
Electricity GHG Emission Reductions (MTCO2e)	0
Total Refrigerant and Electricity GHG Emission Reductions (MTCO2e)	9,948
Total FRIP GGRF Funds per Total Refrigerant and Electricity GHG Emission Reductions ($/MTCO2e)	4

Co-benefits and Key Variables Summary			
			FRIP GGRF Funds
Energy and Fuel Cost Savings ($)			
Fossil Fuel Based Energy Use Reductions (kWh)			
Criteria and Toxic Air Pollutant Emission Reductions	**Local**	**Remote**	**Total**
NO_x emission reductions (lb)			
ROG emission reductions (lb)			
$PM_{2.5}$ emission reductions (lb)			

Section D. 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. (2018). California Greenhouse Gas Inventory for 2000-2016 – by Sector and Activity. Retrieved from https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_sum_2000-16.pdf.

California Air Resources Board. (2018). High-GWP Refrigerants. Retrieved from: https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants.

California Energy Commission. (2018). California Electrical Energy Generation. Retrieved from https://www.energy.ca.gov/almanac/electricity_data/electricity_generation.html.