Refrigerant Avoided Cost Calculator and Fuel-Sub Calculator Technical Guidance

Refrigerant Emissions, Associated Costs, and Net Emissions for Fuel Substitution Measures

Contents

Definitions and Acronyms.....i

Introduction.....1-1

RACC-FSC Overview.....2-1

Baseline Guidance.....3-1

Stationary Refrigeration Measures.....4-1

Stationary Air-conditioning Measures.....5-1

Appliance Measures.....6-1

Appendix A: Fuel Substitution Measure Technical Documentation.....A-1

Appendix B: Extrapolated Avoided Costs for RACC.....B-1

Appendix C: Connecting RACC-FSC to DEER Database.....C-1

Appendix D: References.....D-1

Definitions and Acronyms

The following are definitions of all terminology and acronyms used for the RACC tool and this document.

Accelerated replacement (AR):	The Accelerated Replacement MAT is used for the replacement of existing equipment that could and would remain operational without program intervention. It is used in direct contrast to the normal replacement MAT, which is used when existing equipment either could not or would not remain operational. Early retirement (non-capacity expansion) measures and replacement of "operating equipment that when broken, non-functional, or unable to provide the intended service is typically repaired" can be classified as AR. New construction and capacity expansion cannot be classified as AR.
Add-On Equipment (AOE):	An Add-on Equipment (AOE) measure installs new equipment onto an existing or new host improving the nominal efficiency of the host system. The existing host system must be operational without the AOE, continue to operate as the primary service equipment for the existing load, and is able to fully meet the existing load at all times without the add-on component. The AOE must not be able to operate on its own. The actual energy reduction occurs at the host equipment, not at the add-on component, although any add-on component energy usage must be subtracted from the host savings. Behavioral, Retro-commissioning, and Operational (BRO): The BRO category includes measures that either restore or improve energy efficiency and can be reasonably expected to produce multi-year savings. BRO measures include information or educational programs that influence energy-related practices (behavioral), activities and installations that restore equipment performance to its nominal efficiency (i.e., rated, intended, or original efficiency (retro-commissioning)) but do not enhance the measure's nominal efficiency, and measures that improve the efficient operation of installed equipment (operational). BRO sub-elements are abbreviated as follows: • BRO-Bhv: BRO Behavioral • BRO-Op: BRO Operational • BRO-RCx: BRO Retro-commissioning
California Air Resources Board (CARB or ARB):	CARB or ARB refers to the California Air Resources Board.
Charge, or refrigerant charge:	The amount of refrigerant by mass contained in a refrigeration system. Charge is generally measured by grams, ounces, pounds (lb), or kilograms.
Charge reduction:	To reduce the refrigerant full charge amount through a mechanical system, change in the refrigeration circuit and not simply through a nominal full charge change.

Chiller:	A water or heat transfer fluid chilling equipment package custom built in place, or a factory-made and prefabricated assembly of one or more compressors, condensers, and evaporators, with interconnections and accessories including controls, designed for the purpose of cooling or heating water or a heat transfer fluid. A chiller is a machine specifically designed to make use of a vapor compression refrigeration cycle or absorption refrigeration cycle to transfer heat from a cold water or heat transfer fluid circulating system to the air, a heat transfer fluid, or another heat exchange media. Chillers can be water-cooled, air-cooled, or evaporatively cooled, and include, but are not limited to, rotary chillers, centrifugal chillers, and positive displacement chillers, including reciprocating, scroll, and screw chillers. Chillers include those used for comfort cooling, space and area cooling, or industrial process cooling. A chiller used for refrigeration in a retail food facility is considered an indirect type of "supermarket system."
Cold storage:	A refrigerated facility or warehouse used for the storage of temperature-controlled substances.
Commercial ice machine:	A non-residential ice machine and/or ice maker used in a commercial establishment to produce ice artificially for consumer use, including, but not limited to, a hotel, restaurant, or convenience store.
Commercial refrigeration, or retail food refrigeration:	Equipment designed to store and display chilled or frozen goods for commercial sale or use. This end-use includes, but is not limited to, the following categories of equipment: stand-alone units (equipment), refrigerated food processing and dispensing units (equipment), remote condensing units, and supermarket systems.
Company:	All businesses, affiliates, brands, or subsidiaries or franchises, owned or operated by the same parent company.
Component:	A part of a refrigeration system, including, but not limited to, condensing units, compressors, condensers, evaporators, and receivers; and all of its connections and subassemblies, without which the refrigeration system will not properly function or will be subject to failures.
Counterfactual:	In relation to the RACC, the counterfactual is the system and refrigerant condition contrary to the influence by a program. Can also be considered as the baseline case.
Cumulative replacement:	The addition of or change in multiple components within a three-year period.
Deemed measure:	A prescriptive energy-efficiency measure with predefined savings calculations, costs, eligibility, and other measure attributes.
Effective useful life (EUL):	An estimate of median number of years that the measures installed under the program are still in place and operable. EUL values are for the new equipment and are provided as years. Additionally, some industry practices like routine maintenance can extend equipment life beyond the estimated EUL values. The CPUC's Database for Energy Efficiency Resources (DEER) lists EULs for common equipment. The maximum useful life for the new equipment that is replacing the removed item is 20 years.
End-of-life (EOL) leakage event:	A large portion of the refrigerant leakage from a device comes from the end-of-life (EOL) leakage event, which occurs when a piece of equipment is retired or reaches the end of its EUL.
End-use:	Processes or classes of specific applications within industry sectors.

Existing conditions baseline:	An existing baseline refers to the actual load-serving operation of the existing equipment prior to its replacement, adjusted, where applicable, for the post-installed operation. The existing operations can be suboptimal, but it must reflect equipment performance that maintains essential services. In order to use an existing baseline, the existing equipment is expected to be able to meet customer current and anticipated future requirements (e.g., for the remaining life of the equipment). In the case of projects that occur concurrently with a change in ownership or a lessee, or a change in the function of the space (e.g., office to laboratory), or a substantial change (i.e., 30% or more) in the design occupancy there is no reference operation for existing conditions and the pre-existing conditions may not be applicable to the project.
Fuel substitution measure:	Fuel substitution measures, in the context of energy efficiency programs, involve energy efficiency projects where all or a portion of the existing energy use is converted from one fuel to another (i.e., natural gas to electricity or vice versa). Only equipment powered by electricity and/or natural gas fuels and provided by a CPUC-regulated investor-owned utility or a municipal utility are eligible to participate under fuel substitution measures. Measures involving non-utility (unregulated) fuels, such as propane or fuel oil, are termed as fuel switching measures. Fuel switching measures are outside the scope of the Fuel Substitution Decision and hence, are not considered in this technical guidance.
Full energy savings:	The increase or decrease in site energy usage reported by the investor-owned utility after converting the change in energy into new fuel units as prescribed by D.19-08-009. The full energy savings value is used in utility reporting and not used to calculate cost effectiveness. These energy savings converted into the new fuel units using the conversion factors (1 Therm = 29.3 kWh and 1 kWh = 0.03413 Therms) are defined as full energy savings.
Global warming potential (GWP):	The amount that a substance contributes to global warming relative to carbon dioxide. A substance with a GWP of 100 contributes 100 times as much to global warming given the same mass as CO_2. For the purposes of this document, the GWP or Global Warming Potential Value (GWP Value) means the 100-year GWP value first published by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Working Group 1 Report (AR4) (IPCC, 2007); and if not contained in AR4, then the GWP Value means the 100-year GWP value published by the IPCC in its Fifth Assessment Working Group 1 Report (AR5) (IPCC 2013).
Greenhouse gas (GHG):	Carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), nitrogen trifluoride (NF_3) sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other fluorinated gases.
Greenhouse gas potential (GHGp):	GHGp = Σ(Charge × GWP) Where: ∑ is the sum of the products of charge multiplied by the GWP for each separate type of refrigerant.
Hydrofluorocarbon (HFC):	A class of GHGs that are organic compounds containing hydrogen, fluorine, and carbon; primarily used as refrigerants, foam blowing agents, aerosols-propellants, solvents, and fire suppressants.

Industry standard practice (ISP) or standard practice:	An estimate of the activity or installation that would take place absent the energy efficiency program as required by code, regulation, or law, or as expected to occur as standard practice. The standard practice baseline activity or installation must meet the anticipated functional, technical, and economic needs of the customer, building, or process and provide a comparable level of service as the energy efficiency measure. A standard practice baseline must comply with all codes, regulations, and standards when the project commences, including but not limited to minimum building energy efficiency requirements; emissions requirements; federal, state, and local government regulations; other regulatory agencies. The standard practice need not to comply with local reach codes. The standard practice must represent a typical or commonly implemented practice, although it need not be the predominant (i.e., greater than 50%) practice. The selected standard practice must be reasonable to implement. Industry Standard Practice studies may provide suggestions or requirements for common practices. Standard practices are generally accepted as superior to other alternatives (e.g., a customer's standard way of complying with legal or ethical requirements, or a customer's preference for the best product with superior efficiency in customized design). Justification for selection of a Standard Practice Baseline (e.g., current purchasing trends, customer considerations) should be provided. If only one activity or installation meets the customer's anticipated functional, technical, and economic needs, that option defines the standard practice by default. In cases where the existing conditions are more efficient than the standard practice, the existing conditions define the baseline. Use of the less efficient code or standard practice as the baseline is referred to as a "regressive baseline" and is not allowed—the baseline selected for calculating energy savings may not use more energy than existing conditions.
Life-cycle source Btu consumption:	Source Btu over the EUL of the measure. For dual-baseline measures, both first and second baseline usage and RUL and EUL-RUL should be used respectively while calculating life-cycle source Btu.
Low temperature refrigeration system:	A commercial or industrial process refrigeration system that maintains food, beverages, or other items at temperatures at or below 32 degrees Fahrenheit (0 degrees Celsius).
Measure application type (MAT):	A measure must be assigned a MAT to inform baseline, cost, and energy savings calculations. Implementers must classify all proposed energy efficiency measures into one of the approved MATs. The CPUC recognized standard MATs applicable to this technical guidance document include: • New construction (NC) • Normal replacement (NR) • Accelerated replacement (AR) • Add-on equipment (AOE) • Retrocommissioning (BRO-RCx)
Medium temperature refrigeration system:	A commercial or industrial process refrigeration system that maintains food, beverages, or other items at temperatures above 32 degrees Fahrenheit (0 degrees Celsius).
Methane leakage:	The amount of methane that leaks in between the production and use of natural gas. Upstream in-state methane leakage includes leakage during in-state production, processing, transmission, or distribution, while residential behind the meter methane leakage refers to leakage that happens after the natural gas enters a residential building but before use in a device. It's important to note that upstream out-of-state methane leakage is not included in this calculator since it is not included in the California Air Resources Board (CARB) inventory.

National supermarket chain:	A retail food chain, brand name, or business operating more than 100 retail food facilities in the United States.
New construction (NC):	The NC MAT is used where equipment is installed in either a new area or an area that has been subject to a major renovation, to expand capacity of existing systems, or to serve a new load. The NC MAT is used where there is no reference operation for existing conditions, such as with new construction, expansions, added load, a change in the function of the space (e.g., office to laboratory), or a substantial change (e.g., ~30% or more) in design occupancy. For NC measures, the baseline is the standard practice, or code baseline in place at the time the permit involving the measure was issued.
New chiller or new chiller equipment:	Any chiller equipment or chiller system end-use sectors listed in Table 3, section 95374(c) that is: • First installed using new components, used components, or a combination of new and used components; or • Modified such that: - The capacity is increased through the addition of motor-bearing components, including evaporators, compressors, or condensers; or - Within any 3-year time period, the system has undergone cumulative replacements of motor-bearing components in full or exceeding 50%of the capital cost of replacing all of the motor-bearing components in the entire chiller system.
New energy service:	Serving loads in the existing building that were not served before, such as the addition of an air conditioning system which did not exist prior to the fuel substitution measure.
New facility:	Any of the following: (1) new construction; (2) an existing facility not previously used for cold storage, retail food refrigeration, commercial refrigeration, industrial process refrigeration, or ice rinks; or (3) an existing facility used for cold storage, retail food refrigeration, commercial refrigeration, or industrial process refrigeration that has undergone replacement of 75% or more of its evaporators (by number) and 100% of its compressor racks and condensers.
New fuel:	The fuel that replaces the original fuel because of a fuel substitution measure.
New refrigeration equipment:	Either of the following: • Any refrigeration equipment that is: - First installed using new components, used components, or a combination of new and used components; or - Modified such that: ○ The nominal compressor capacity is increased; or ○ The system has undergone cumulative replacements, within any three-year time period, of components in full or exceeding 50% of the capital cost of replacing the entire refrigeration system, excluding the cost of refrigerated display cases. • Any refrigeration equipment in a new facility that is first installed using new components, used components, or a combination of new and used components, applicable to refrigeration end-use sectors listed in Table 3, section 95374(c) or Table 4, section 95374(d), in the following: (A) New construction; (B) An existing facility not previously used for cold storage, retail food refrigeration, commercial refrigeration, industrial process refrigeration, or ice rinks; or (C) An existing facility used for cold storage, retail food refrigeration, commercial refrigeration, or industrial process refrigeration that has undergone replacement of 75% or more of its evaporators (by number) and 100% of its compressor racks, condensers, and connected evaporator loads.

Normal replacement (NR):	The NR MAT is used where existing equipment (including add-on equipment) has either failed, no longer meets current or anticipated needs, or is planned to be replaced due to normal remodeling or retrofit activities during the normal course of business or ownership. For NR measures, the baseline is the standard practice or code in place at the time the project commenced. The NR MAT may be applied to any measure or program, with certain exceptions, and without a burden of proof. This MAT includes measures that previously fit into the now-retired replace on burnout (ROB) MAT.
Original fuel:	The primary fuel that was in use prior to the fuel substitution measure.
Refrigerant, or refrigerant gas:	Any substance, including blends and mixtures, that is a compound or gas used in vapor compression cycle refrigeration for heat transfer purposes and provides a cooling or warming effect.
Refrigerant avoided cost calculator (RACC):	Models the net-present value of avoided costs benefited from changes in greenhouse gas emissions from measure or activities that involve refrigerants.
Refrigerant charge, or charge:	See “Charge, or refrigerant charge”.
Refrigerant leakage:	The amount of refrigerant that leaks from a device during its lifetime. Many electric-powered temperature regulation devices use refrigerants (e.g., air conditioning units, refrigerators, freezers, heat pumps, and more). Most devices that contain refrigerants allow the refrigerant to slowly leak throughout their life. Some devices require top-ups of refrigerant throughout their usable life, thus potentially causing the lifetime amount of refrigerant leaked to be greater than 100% for a single device. At the end of life, federal law mandates the recovery of refrigerants, but many are vented, creating a high end-of-life (EOL) leakage. Not all refrigerants impact global warming equally.
Refrigerant registration and reporting system or R3 database:	The web-based tool for registration, reporting, and fee payment by facilities using at least one refrigeration system containing more than 50 lb. of refrigerant.
Refrigerated food processing and dispensing equipment:	Equipment that dispenses and/or processes a variety of food and beverage products by either combining ingredients, mixing or preparing them at the proper temperature, or by function as a holding tank to deliver the product at the desired temperature or to deliver chilled ingredients for the processing, mixing and preparation. Some may use a refrigerant in a heat pump or utilize waste heat from the cooling system to provide hot beverages. Some may also provide heating functions to melt or dislodge ice or for sanitation purposes. This equipment can be self-contained or connected by piping to a dedicated condensing unit located elsewhere. Equipment within this end-use category include but are not limited to chilled and frozen beverages (carbonated and non-carbonated, alcoholic and non-alcoholic); frozen custards, gelato, ice cream, Italian ice, sorbets, and yogurts; milkshakes, slushies, and smoothies; and whipped cream.
Refrigeration:	The use of a refrigerant gas to mechanically move heat from one region to another to create a cooled region via a vapor compression cycle.

Refrigeration equipment or refrigeration system:	Any stationary device that is designed to contain and use refrigerant gas, including any device listed in section 95374(a), Table 1 under the general end-use "Refrigeration," section 95374(b), Table 2 under the general end-use "Household Refrigerators and Freezers," section 95374(c), Table 3 under the general end-use "Cold Storage Warehouses," "Industrial Process Refrigeration," or "Ice Rinks," or section 95374(d), Table 4 under the general end-use "Retail Food Refrigeration." For a device with multiple independent circuits, each circuit is considered a separate article of equipment. Refrigeration equipment is used in retail food refrigeration, cold storage, industrial process refrigeration and cooling (not using a chiller), ice rinks, and other refrigeration applications.
Remaining useful life (RUL):	An estimate of the median number of years that equipment being replaced under the program would have remained in place and operable had the program not intervened.
Remote condensing units:	Refrigeration equipment or units that have a central condensing portion and may consist of one (and sometimes two) compressor(s), one condenser, and one receiver assembled into a single unit, which is normally located external to the sales area. The condensing portion (and often other parts of the system) is located outside the space or area cooled by the evaporator. Remote condensing units are commonly installed in convenience stores, specialty shops (e.g., bakeries, butcher shops), supermarkets, restaurants, and other locations where food is stored, served, or sold.
Retail food facility:	A facility that sells food and uses at least one retail food refrigeration equipment unit or refrigeration system with more than 50 lb. of a refrigerant with a GWP value of 150 or greater. "Retail food facility" includes supermarkets, grocery stores, and all other food merchandising stores.
Retail food refrigeration or commercial refrigeration:	See "Commercial refrigeration, or retail food refrigeration"
Retirement:	The permanent removal from service of a refrigeration system or component, rendering it unfit for use by the current or any future owner or operator.
Retro-commissioning:	Measures that either restore or improve energy efficiency and that can be reasonably expected to produce multi-year savings. They result in performance that does not exceed the nominal (rated or original) efficiency of the existing condition. Resolution E-4818 directed that all measures which utilize a degraded performance baseline and/or are restorative of performance in nature be classified as retro-commissioning (BRO-RCx).
Retrofit or refrigerant retrofit:	The replacement of the refrigerant used in refrigeration equipment with a different refrigerant, and any related changes to the refrigeration equipment required to maintain its operation and reliability following refrigerant replacement.
Site energy consumption:	Energy consumed at the site of the fuel substitution measure installation, such as a home or business.
Site energy savings:	Energy savings evaluated at the "site" level which include the net savings from the displaced original fuel usage and the increased new fuel usage.
Source energy consumption:	Conversion of retail energy forms (kWh, Therm) into the Btu required to generate and deliver the energy to the site. Only the source energy from depletable fossil-fuel resources such as natural gas and coal are considered; the source energy from non-depletable (i.e., renewable energy) sources such as solar, wind, and hydro-electric is considered as zero Btus. This conversion is used to compare the relative impacts of switching between fuel sources at the source or Btu level for the fuel substitution test required for fuel-substitution measures.
Source energy savings:	Energy savings evaluated at the "site" level which—for fuel substitution measures—include the net savings from the displaced original fuel usage and the increased new fuel usage.

Stand-alone units or equipment:	Refrigerators, freezers, and reach-in coolers (either open or with doors) where all refrigeration components are integrated and, for the smallest types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an electricity supply to begin operation. “Stand-alone Units or Equipment” does not include commercial ice machines.
Standard practice baseline:	Estimates the annual energy consumption of the activity or installation that would take place absent the energy efficiency program as required by code, regulation, or law, or as expected to occur as standard practice. The standard practice baseline activity or installation must meet the anticipated functional, technical, and economic needs of the customer, building, or process and provide a comparable level of service as the energy efficiency measure. A standard practice baseline must comply with all codes, regulations, and standards when the project commences, including but not limited to: minimum building energy efficiency requirements; emissions requirements; federal, state, and local government regulations; other regulatory agencies. The standard practice need not comply with local reach codes. The standard practice must represent a typical or commonly implemented practice, although it need not be the predominant (i.e., greater than 50%) practice. The selected standard practice must be reasonable to implement. Industry standard practice studies may provide suggestions or requirements for common practices. Standard practices are generally accepted as superior to other alternatives (e.g., a customer’s standard way of complying with legal or ethical requirements, or a customer’s preference for the best product with superior efficiency in customized design). Justification for selection of a standard practice baseline (e.g., current purchasing trends, customer considerations) should be provided. If only one activity or installation meets the customer’s anticipated functional, technical, and economic needs, that option defines the standard practice by default. In cases where the existing conditions are more efficient than the standard practice, the existing conditions define the baseline.
Stationary:	The system meets at least one of the following conditions: • Installed in a building, structure, or facility • Attached to a foundation, or if not attached, will reside at the same building, structure, or facility for more than 12 consecutive months • Located permanently at the same facility for at least two consecutive years and operates at that facility a total of at least 90 days each year
Supermarket systems:	Multiplex or centralized systems designed to cool or refrigerate, which operate with rack(s) of compressors installed in a machinery room. Two main design classifications are used: direct and indirect systems. • “Direct Systems” means the refrigerant circulates from the machinery room to the sales area, where it evaporates in display-case heat exchangers, and then returns in vapor phase to the suction headers of the compressor racks. Another direct supermarket design, often referred to as a distributed refrigeration system, uses an array of separate compressor racks located near the display cases rather than having a central compressor rack system. • “Indirect Systems” means the system uses a central refrigeration system to cool a secondary fluid that is then circulated throughout the store to the cases. This includes secondary loop systems and cascade refrigeration. A chiller used in retail food facilities to cool a secondary fluid subsequently used to cool food, beverage, and displayed products is considered an indirect refrigeration system.

Total system benefit (TSB):	An expression, in dollars, of the lifecycle energy, ancillary services, generation capacity, transmission and distribution capacity, and GHG benefits of energy efficiency activities, on an annual basis. The 2021 Energy Efficiency Potential and Goals study states that TSB represents the total benefits, or "avoided costs," that a measure provides to the electric and natural gas systems. The factors included in avoided costs are defined through the CPUC Integrated Distributed Energy Resources (IDER) proceeding.
Vending machines:	Self-contained units that dispense goods that must be kept cold or frozen.
Very low temperature refrigeration or cooling:	A refrigeration or cooling system that maintains temperatures below -58 degrees Fahrenheit (-50 degrees Celsius), including, but not limited to, medical and laboratory freezers, specialized industrial process cooling applications, and extreme temperature environmental testing.
Weighted average of cost of capital (WACC):	Represents the average cost of all capital assets that a company currently holds.
Weighted-average GWP:	Means ∑ (charge x GWP) / ∑ charge where charge equals the weight in pounds (lb.) of each individual type of refrigerant, refrigerant blend, or heat transfer fluid used in refrigeration equipment and systems. ∑ in the numerator is the sum of the products of charge multiplied by the GWP for each separate type of refrigerant. ∑ in the denominator is the sum of all refrigerant charge in all refrigeration equipment with more than 50 pounds of refrigerant.

section 1
Introduction

Since the 2006 signing of the Global Warming Solutions Act, AB 32, California has been at the forefront of national electrification and decarbonization efforts to reduce its carbon footprint, slow the rate of global warming, and create a more sustainable future for all. These initiatives include phasing out high-Global Warming Potential (GWP) refrigerants, promoting the use of alternative refrigerants with lower GWP values, and encouraging the switch from gas appliances to electric ones, which often contain refrigerants. In August 2019, California Public Utilities Commission (CPUC) Decision 19-08-009 adopted the fuel substitution test and directed CPUC staff to issue technical guidelines for fuel substitution measures including, but not limited to, guidance on the calculation of source energy savings and environmental offsets for fuel substitution measures. While the fuel substitution technical guidelines were previously contained within a standalone document, they have been incorporated into this refrigerant technical guidance document in 2024 since most fuel substitution measures involve the use of refrigerants.

Various California and federal regulations have begun mandating the use of lower-GWP alternative refrigerants in new heating ventilation and air conditioning (HVAC), stationary refrigeration equipment, and process cooling equipment. Retail businesses with stationary refrigeration systems, such as grocery stores and convenience stores, currently use high-GWP refrigerants and are seeking ways to retrofit or replace systems with lower-GWP and natural refrigerants. Regulations targeting the phase-down of high-GWP refrigerants have many California stakeholders looking for ways to incorporate lower-GWP refrigerants and to reduce their GHG emissions within energy efficiency measures. Additionally, energy efficiency measures that include a fuel substitution component, where all or a portion of the existing energy use is converted from one CPUC-regulated fuel to another, must undergo a fuel-substitution test. The test is designed to ensure that both the source energy savings and environmental offsets stemming from the measure are a net positive.

This document provides stakeholders with detailed guidance on how to use the CPUC's combined Refrigerant Avoided Cost Calculator (RACC) and Fuel-Substitution Calculator (FSC). Much of the environmental offsets stemming from

Document Navigation

Use the following symbols to navigate through the guidance document.

Previous page

Next page

Click on section tabs to move through the guide

Click to open dialogue boxes

Click to close dialogue boxes

Click to return to the cover page

Indicates worksheet within the RACC tool

fuel-substitution measures are calculated within the RACC. The RACC is used to quantify the costs and benefits associated with incurred and avoided refrigerant emissions and the FSC ensures fuel-substitution measures comply with source energy and environmental impact requirements (hereinafter referred to as Part One and Part Two of the Fuel Substitution Test, respectively). This technical guidance is not a static document and will require periodic updates to incorporate new policy and information.

ENERGY EFFICIENCY POLICY BACKGROUND

To more fully capture the climate and grid impacts of energy efficiency measures in California, the Total System Benefit (TSB) metric was introduced as the primary metric to measure the accomplishments of the energy efficiency portfolio. CPUC directed (D.21-05-031) that goals for the energy efficiency portfolio shall be in the form of TSB starting in 2024. That is, in 2024 TSB replaces annual electric energy, electric demand, and gas (kWh, kW, and Therm) savings as the key performance indicator for energy efficiency measures in California. Beginning in 2018, the CPUC staff oversaw the development of the Avoided Cost Calculator (ACC), for the intent of quantifying the TSB of a measure in dollars. The ACC aims to model the avoided costs that demand side resources create with respect to the avoided generation and distribution of energy.

Included in the ACC platform is the Refrigerant ACC or RACC, designed specifically to model the carbon dioxide (CO_2) equivalent impacts of refrigerant emissions in addition to the lifecycle avoided energy and emissions costs of energy efficiency and feul-substitution measures. The RACC allows users to specify the refrigerant type and other refrigerant-specific parameters for a given application. Using the California Air Resource Board's (CARB) emission estimates by application type, the RACC provides the avoided cost in dollars over the lifetime of the appliance or measure. The outputs of the RACC will be critical to represent the environmental impacts low-GWP refrigerant measures may have relative to their high-GWP baseline equivalents. While the RACC has the potential to be a transformative tool used to accelerate the adoption of low-GWP refrigerants, proper guidance is needed to ensure users are characterizing baselines and claiming benefits accurately.

The original Fuel Substitution Calculator (v1.0) was released in 2019. In 2022, a draft Fuel Substitution Calculator (v2.0) was released to include changes in data and methodology in the CPUC ACC. The draft version of the calculator included updated grid emissions factors and source energy factors, based on recent activity in the CPUC's Integrated Resources Plan (IRP) Proceeding. It also incorporated methane leakage and refrigerant leakage emissions, consistent with data and methodology included in the 2022 ACC. This draft version was never adopted as there were significant concerns that some fuel-substitution measure package permutations that had previously passed the fuel substitution test were no longer passing due to the inclusion of CO_2e emissions caused by refrigerant leakage.

On a separate track, the Deemed RACC was updated in 2023 to align with the updates made to the "2022 ACC Refrigerant Calculator version 1b updated.xlsx." While implementing this update, it became evident that the fuel substitution calculator would benefit from having access to some of the same enhancements. In late 2023, the "RACC-FSC_v3.0.xlsx" was built by incorporating the functionality of the fuel substitution calculator into the latest RACC workbook. The most noteworthy of the enhancements include:

- The lifecycle refrigerant emissions and their costs are determined on one worksheet while—for fuel substitution measures—those same lifecycle refrigerant emissions are used to determine the net emissions for Part Two of the fuel substitution test on another worksheet. This ensures that they remain aligned by relying upon the same assumptions and data sources.
- Known updates to the GWP of refrigerants that are permitted for use in manufactured equipment or field-installed equipment are considered when determining the refrigerant emissions for a future year. These limits are established by both the CARB and the U.S. Environmental Protection Agency. In the RACC-FSC, these limits are used to signal to the user when selected refrigerants exceed known code limits and to establish the baseline for the refrigerant emissions and their costs.
- In both the "Deemed Measure RACC Workbook v2.2.xlsx," posted to CEDARS in August 2022, and the "2022 ACC Refrigerant Calculator version 1b updated.xlsx," the end-of-life (EOL) refrigerant leakage emissions for the counterfactual baselines—at Accelerated Replacement (AR) measure applications—were prorated by the extent

to which their equipment lives coincided with the measure life. In the RACC-FSC 3.0, these EOL emissions are no longer prorated as they are thought to better reflect the net emissions that result from the measure's implementation.

- Data tables that reside in the DEER database that are used by the RACC-FSC_v3.0.xlsx and may be updated more frequently than the workbook, itself, are now connected to it. This enables users to refresh the table contents within the workbook when an update is announced on the "DEER Change Log" webpage that involves one of the connected tables.
- A flag has been added to both the RACC and the FSC worksheets to indicate when documentation has been gathered to prove that the refrigerant that was contained within the existing, decommissioned equipment was appropriately recovered by the contractor. When this flag is set to TRUE, the end-of-life emissions of the existing case are "credited" towards the measure case for both the Normal Replacement (NR) and the AR measure application types (MAT). Doing so results in an increase to the refrigerant avoided costs.
- For residential heat pump fuel substitution measures, a set of climate-zone specific weights were established that are to be used to determine the counterfactual standard case energy usage, energy savings, net emissions, and refrigerant emissions costs. These weights were informed using the trendline that was created when looking at the difference between the space cooling rates observed in California homes during the California Energy Commissions 2009 Residential Appliance Saturation Study (RASS) and the 2019 RASS. These weights are used to impute cooling energy usage and refrigerant leakage emissions when residential heat pumps are installed where no cooling was previously installed.

FUEL SUBSTITUTION POLICY BACKGROUND

CPUC D.19-08-009 adopted the fuel substitution test and ordered the creation of this fuel substitution guidance document. The overarching guidance for fuel substitution measures is described in this section. A more comprehensive fuel substitution guidance, which includes the data and equations behind the source energy and emissions calculations, is provided in Appendix A. D.19-08-009 provides direction on the Fuel Substitution Test, fuel substitution measure eligibility, and utility credits for savings claims.

CPUC D.92-02-075 established the "three-prong test" which established the original requirements for fuel substitution measures to be eligible for energy efficiency incentives. The three-prong test was designed to avoid encouraging fuel substitution programs with a predominantly load-building character. The Fuel Substitution Test replaces the three-prong test as the eligibility standard for fuel substitution measures.

Fuel substitution measures, in the context of energy efficiency programs, involve energy efficiency projects where all or a portion of the existing energy use is converted from one fuel to another (i.e., natural gas to electricity or vice versa). Only equipment powered by electricity and/or natural gas fuels and provided by a CPUC-regulated investor-owned utility or a municipal utility are eligible to participate under fuel substitution measures.

Measures involving non-utility (unregulated) fuels, such as propane or fuel oil, are termed as fuel switching measures. Fuel switching measures are outside the scope of the Fuel Substitution Decision (D.19-08-009) and hence, are not considered in this technical guidance.

D.19-08-009 stated that fuel substitution measures must pass the Fuel Substitution Test to be eligible for energy efficiency incentives. The Fuel Substitution Test has two components:

1. The measure must not increase total source energy.
2. The measure must not adversely impact the environment.

As previously indicated. the above requirements are referred to as Part One and Part Two of the Fuel Substitution Test. The Fuel Substitution Test no longer requires individual measures to pass a cost effectiveness threshold, as previously required in the three-prong test. Instead, fuel substitution measures are treated the same as other energy efficiency measures wherein cost-effectiveness is assessed at the portfolio level (i.e., Total Resource Cost test). The factors that contribute to the determination of the net source energy and net emissions for each custom application or permutation of a given measure package are described in detail in Appendix A.

HOW TO USE THIS GUIDE

This guidance document provides a detailed summary of the RACC-FSC 3.0 workbook. **Section 2** provides an overview describing how the workbook is structured, descriptions of the individual worksheets, and the input and output cells found within those worksheets. **Section 3** covers how to determine an appropriate baseline for the applications covered in this document. This includes measure application type, measure life, leakage rates, charge level, applicable regulations, and required documentation. **Section 4** includes example stationary refrigeration equipment measures. **Section 5** includes example stationary refrigeration measures. **Section 6** includes example appliance equipment measures. **Table 1-1** below provides an index of the example measures included in this document. These examples show how to use the RACC-FSC for refrigerant emissions claims and fuel substitution calculationsassociated with various technologies, measure application types, MATs, and refrigerants.

Table 1-1. Index of RACC-FSC measure example walkthroughs included in this document

Measure end use	Measure description	MAT	Refrigerants	Fuel substitution	Section / page
Stationary refrigeration	Complete system replacement with natural refrigerant system retail food refrigeration system with natural refrigerants, >50 lb. charge systems	AR	**(Low/Med temp)** Msr: CO2 (R-744) Std: <150 GWP Pre/Ext: R-404A **(High temp)** Msr: Propane (R-290) Std: <150 GWP Pre/Ext: R-407A	No	4-1
Stationary refrigeration	Complete system replacement with natural refrigerant system, >50 lb. charge systems	NR	**(Low/Med temp)** Msr: CO2 (R-744) Std: <150 GWP Pre/Ext: NA **(High temp)** Msr: Propane (R-290) Std: <150 GWP Pre/Ext: NA	No	4-14
Stationary refrigeration	Cascade retail food partial system replacement with hybrid refrigerant system, >50 lb. charge systems	AR	**(Low/Med temp)** Msr: CO2 (R-744) Std: R-448A Pre/Ext: R-404A	No	4-25
Stationary refrigeration	Cascade retail food partial system replacement with hybrid refrigerant, >50 lb. charge systems	NR	**(Low/Med temp)** Msr: CO2 (R-744) Std: R-448A Pre/Ext: NA	No	4-37
Stationary refrigeration	Commercial Ice machines	NR	Msr: CO2 (R-744) Std: R-404A Pre/Ext: NA	No	4-47
Stationary refrigeration	Stand-alone units	NR	Msr: Isobutane (R-600a) Std: Isobutane (R-600a) Pre/Ext: NA	No	4-57
Stationary refrigeration	Refrigerated food processing and dispensing equipment	NR	Msr: CO2 (R-744) Std: HFC-134a Pre/Ext: NA	No	4-58
Stationary refrigeration	Cold storage warehouse system, 50-200 lb.	AR	Msr: CO2 (R-744) Std: <300 GWP Pre/Ext: R-404A	No	4-68
Stationary refrigeration	Cold storage warehouse system, 50-200 lb.	NR	Msr: CO2 (R-744) Std: R-449A Pre/Ext: NA	No	4-79
Stationary air-conditioning	Air-cooled HVAC chiller	NR	Msr: R-454B Std: <700 GWP Pre/Ext: NA	No	5-1

Measure end use	Measure description	MAT	Refrigerants	Fuel substitution	Section / page
Stationary air-conditioning	Air-cooled HVAC chiller	AR	Msr: R-454B Std: <700 GWP Pre/Ext: HFC-134a	No	5-1
Stationary air-conditioning	Unitary Air-Cooled AC and gas furnace, RTU with R-32, Commercial	NR	Msr: HFC-32 Std: <700 GWP Pre/Ext: NA	No	5-13
Stationary air-conditioning	Unitary Air-Cooled AC and gas furnace, RTU with R-32, Commercia	AR	Msr: HFC-32 Std: <700 GWP Pre/Ext: R-410A	No	5-13
Stationary air-conditioning	Central heat pump replacing residential gas furnace and weighted baseline AC cooling	AR	Msr: R-454B Std: R-454B, None Pre/Ext: R-410A, None	Yes	5-23
Stationary air-conditioning	Central heat pump replacing residential gas furnace and weighted baseline AC cooling	NR	Msr: R-454B Std: R-454B Pre/Ext: NA	Yes	5-23
Stationary air-conditioning	Ductless heat pump replacing residential gas furnace and weighted baseline AC cooling	NR	Msr: HFC-32 Std: HFC-32 Pre/Ext: NA	Yes	5-41
Appliance	Heat pump water heater, residential, fuel-substitution	NR	Msr: HFC-134a Std: None Pre/Ext: NA	Yes	6-1
Appliance	Heat pump water heater, residential, fuel-substitution	AR	Msr: HFC-134a Std: None Pre/Ext: None	Yes	6-1
Appliance	Heat pump clothes dryer, residential, fuel-substitution	NR	Msr: HFC-134a Std: None Pre/Ext: NA	Yes	6-15
Appliance	Residential refrigerator, freezer	AR	Msr: Isobutane (R-600a) Std: Isobutane (R-600a) Pre/Ext: HFC-134a	No	6-27
Appliance	Residential refrigerator, freezer	NR	Msr: Isobutane (R-600a) Std: Isobutane (R-600a) Pre/Ext: HFC-134a (EOL recovery)	No	6-27

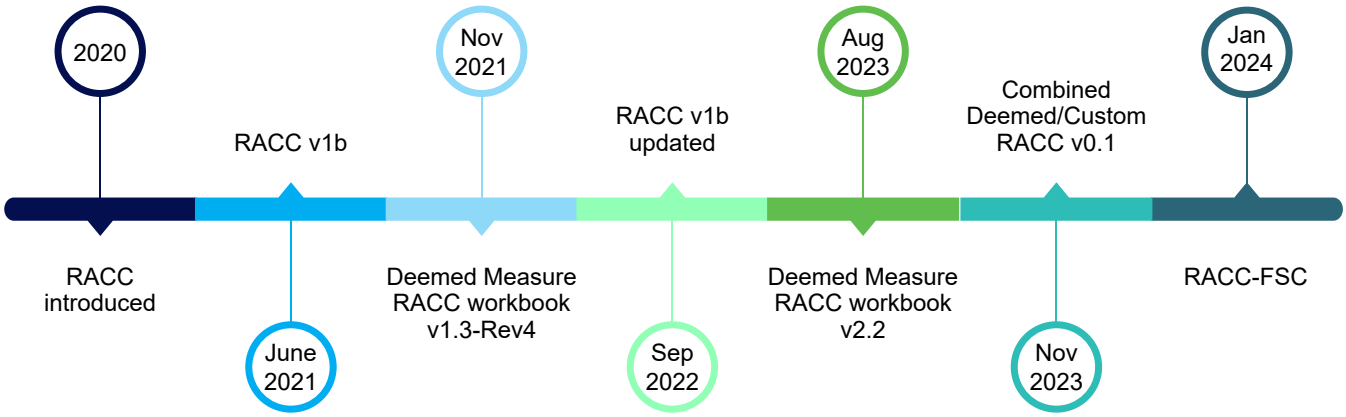
section 2

RACC-FSC Overview

As part of the Forward-Looking Low-GWP Refrigerant Transition Impacts Study, DNV was tasked to review and provide a technical guidance document to the 2022 ACC Refrigerant Calculator v1b updated.xlsx workbook. In conducting this task, DNV reviewed the equations and data provided in the v1b updated workbook, identified errors in the workbook, and looked for general improvement opportunities. DNV proposed a series of improvements to the RACC to address baseline GWP requirements, correct existing errors, and allow the document to be updated in a more fluid fashion. While this was occurring, a deemed version of the RACC, "Deemed Measure RACC Workbook v2.2.xlsx," was submitted to the CPUC and posted to CEDARS on August 25, 2023. In an effort to provide a single workbook capable of modeling both deemed and custom measures using the latest GWP baselines and regulations, DNV combined proposed enhancements to the RACC v1b updated with the Deemed Measure RACC Workbook v2.2.xlsx to create the DC RACC v0.

In **Figure 2-1** below, we have provided a timeline of the RACC's history and updates.

Figure 2-1. RACC timeline



WORKBOOK COLOR CODING AND INDEX

The RACC-FSC workbook includes color coding for the worksheet tabs, grouping each worksheet by category as shown below.

Worksheet color coding

	User inputs worksheets
	Results outputs worksheet
	Constants and dropdown worksheets
	DEER tables
	2022 Refrigerant ACC worksheets in use

Additionally, within the User Inputs Worksheets category, tables include column header color coding indicating which columns require user input, which are calculation steps, lookup formulas, and final outputs.

Column Heading color coding

	Input, enter a value
	Input, select from a dropdown list
	Custom input (only)
	Calculation step
	Lookup formula
	Final outputs

The RACC-FSC also includes conditional cell formatting to alert the user when a value replaced a formula, value exceed CARB limit, or the device builder value has been replaced.

Conditional formatting

100	Yellow with red border = value replaced formula
800	Orange with red border = value exc
526.00	Constants and dropdown worksheets

WORKSHEETS

This section summarizes the different worksheets found in the RACC-FSC. Detailed examples of common measures, with RACC-FSC screenshots and input explanations are found in **Section 4. Stationary Refrigeration**, **Section 5. Stationary Air-Conditioning**, and **Section 6. Appliances**.

User Inputs Worksheets	**0 Refrig Research**
	1 Device Builder
	2 RACC
	3 FSC
Results Outputs Worksheets	**4 eTRM Export**
	5 RACC Charts
	6 FSC Pivot
Constants and Dropdown Worksheets	**Constants + Dropdowns**
DEER Tables	**RACC_FSC_InputTracker_DEER**
	BldgWts_DEER
	CARB_EPA_GWP_Limits_DEER
	CARB_RefrigLeaks_DEER
	EUL_basis_DEER
	OtherRatesACC_DEER
	Refrigerant_DEER
	RefrigerantACC_DEER
	TechType_DEER
2022 RACC Worksheets in Use	**ACC Inputs**
	Refrigerant Leakage
	Refrigerant GWPs + Dates
	RACC Change Log
FuelSub_2022	**Reference**
	Annual Factors
	Methane Leakage
	Long-run Emissions Inputs

IMPROVING WORKBOOK PERFORMANCE

The RACC-FSC is a large and complex workbook that will run slowly on many computers. Users will have a better experience is they can pursue the options described below, in order of decreasing effectiveness:

1. Upgrade installation of Office 365 from the typical 32-bit installation to the 64-bit installation.
2. If user has access to Remote Desktop, populate the workbook using that platform so that it is not competing with other resources on user's computer.
3. Within Excel, turn off automatic calculations by selecting the "Formulas" ribbon, clicking on the dropdown list at "Calculation Options," and selecting "Manual." This can be very helpful while user is entering lots of data in the process of populating the RACC-FSC for a given measure package under development. Once user has reached the point when viewing calculated results is desired, press F9—or the "Calculate Now" button on the ribbon—to update calculations in all open workbooks or press SHIFT+F9 to update only those calculations on the current worksheet. Note that many calculations performed on the 3 FSC worksheet rely on the calculation results on the 2 RACC worksheet.
4. On either the 2-RACC or the 3-FSC worksheets, there is a cell that can turn on or off conditional formatting. Extensive conditional formatting was used on these two worksheets to help guide the user as they make data entry decisions.

0 Refrig Research

This worksheet was previously named ***Refrigerant Research 2021*** in the version of the Deemed RACC Workbook v2.2.xlsx available at CEDARS. It was revised to produce this workbook so that it could be added to as measure package developers add to the body of measure packages and provide supporting documentation for establishing new or updated refrigerant charge amounts (lb.) per normalizing unit (NormUnit).

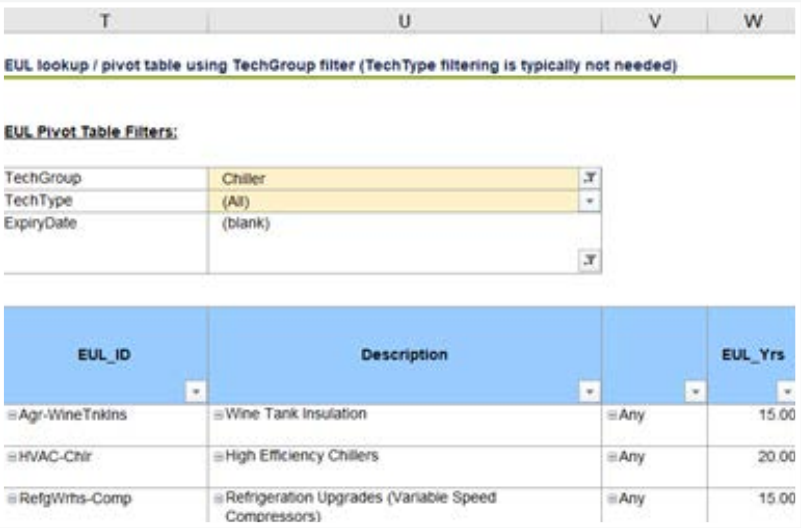
This worksheet is not linked to the **1 Device Builder** worksheet since it is difficult to enforce consistent naming conventions. Rather, the user may draw from the Refrigerant Charge and Common Refrigerant fields and manually enter these for new device types as they are developed on the **1 Device Builder** worksheet.

Users may add research findings to this worksheet for consideration to be used for a specific measure package or custom application.

1 Device Builder

This worksheet is used to define the equipment (device types) to be used in the **2 RACC worksheet**. Start by checking if the desired device type(s) are already present in the table. If the device(s) needed are not found, please add new devices to the last row.

DeviceType	This is a user-specified text field describing the type of equipment. This field will be used to select the DeviceType for each case on the 2 RACC worksheet.
TechTypeID	These are the TechTypeIDs recognized by the DEER database. If one that is needed is unavailable, please email DEERsupport@dnv.com.
TechTypeDesc	This is the TechType description associated with the TechTypeID selected from the previous column.
NormUnit	This field defines the normalizing unit for the device type. Deemed measures will use the pre-populated NormUnit. Custom applications may replace this with "Each" where site-specific information is available.
TechGroup (NormUnit)	This is auto-generated using the TechGroup (appearing to the left of the colon in the TechTypeID) and the associated NormUnit. The TechGroup (NormUnit) will need to be selected on the 2 RACC worksheet for each case (Msr, Std, Pre/Ext) of a given row.
CARB_Sector	Select from one of the CARB-recognized sectors in the dropdown list provided.
CARB_DeviceType	Select from the CARB-recognized device types within the CARB_Sector chosen in the preceding column. These are used to auto-populate the four columns to the right with CARB-approved values. *Note: CARB_DeviceTypes differ from CARB_End-Uses*
Common Refrigerant Type(s)	For a given DeviceType, it can be helpful to users if one or more of the commonly used refrigerants are provided here, but this is optional. This field is not auto-populated and mush be copied from 0 Refrig Research worksheet as appropriate.
RefrigCharge Pounds per CARB (lb/Each)	When adding a new DeviceType to this table to be used for a deemed measure, it is imperative that the value entered into this field be documented on the 0 Refrig Research worksheet. This will be reviewed by the Measure Package Reviewer once submitted.
RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	In the RefrigCharge Pounds Per NormUnit (copied from 0 Refrig Research worksheet) column enter in researched refrigerant charge per normalized unit based on research input into 0 Refrig Research worksheet.
Annual Leakage Rate per CARB	This value is auto-populated based upon the selected CARB_DeviceType. This value is NOT to be modified. If site-specific information is available for a custom application, this can be customized on the 2 RACC worksheet.
q_EOL per CARB	
t_EOL per CARB	

EUL_ID	Using the pivot table located to the right of this table (column T), filter on the TechGroup to see the available list of DEER-recognized EUL_IDs. It may be helpful to also filter on the TechType, but it is not usually necessary. (COPYEUL_ID and paste as text). EUL pivot table:  T U V W EUL lookup / pivot table using TechGroup filter (TechType filtering is typically not needed) EUL Pivot Table Filters: TechGroup: Chiller TechType: (All) ExpiryDate: (blank) EUL_ID | Description | EUL_Yrs Agr-WineTnkIns | Wine Tank Insulation | Any | 15.00 HVAC-Chlr | High Efficiency Chillers | Any | 20.00 RefgWrhs-Comp | Refrigeration Upgrades (Variable Speed Compressors) | Any | 15.00
EUL_Yrs	The EUL_Yrs value will be populated here once the EUL_ID has been entered in the column to the left. This is NOT to be modified as this is a DEER-approved value.
CDindex	Do not modify. These fields enable nested dropdown lists.
CDrows	Do not modify. These fields enable nested dropdown lists.

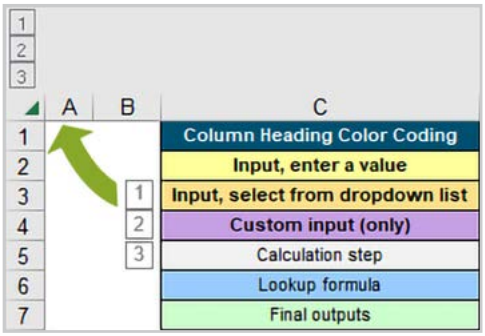
2 RACC

The 2 RACC worksheet is where users define the necessary inputs for the measure case and counterfactual case parameters of the activity to generate an avoided cost value. The measure case means the proposed system or proposed refrigerant that is going to be installed. The counterfactual represents the baseline scenario that represents either the existing equipment/refrigerants or the minimum compliance condition.

Revealing/Concealing Grouped Columns

Since the 2 RACC worksheet is more than 100 columns wide, many of the columns were grouped together to show only key columns. The fewest columns are shown when the "1" button is toggled as shown in **Figure 2-2**. Those columns that are more likely to be used for custom applications are revealed when the "2" button is toggled. To see all columns, toggle the "3" button.

Figure 2-2. Buttons to reveal or conceal grouped columns appear in upper left corner



General Inputs

General inputs include all common inputs used for all measures calculated.

General inputs	Notes	
Refrig. Cost Basis	GHG Value from Natural Gas ACC	
Dollar Year	2022	→ Select latest ACC
GWP Time Horizon	100-yr	→ Locked to 100-yr
WACC selection	Statewide	→ Statewide for Deemed
Active WACC%	7.54%	

Refrigerant Cost Basis is a description of the origin of the costs that are to be used to monetize refrigerant emissions. The options thus far include:

- GHG Value from Natural Gas ACC: for measures to be offered in program years 2024 and 2025
- GHG Adder from Electric ACC: for measures that were offered in program years 2022 and 2023

Dollar Year is the year the NPV is evaluated. This is a fixed value, to ensure a common dollar year across all projects and measures. The dollar year typically equals the year that the ACC values were updated (e.g., the 2022 ACCs use the 2022 dollar year).

GWP Time Horizon is the length of time the GWP effect of a refrigerant is evaluated at. The 100-year GWP is the current default metric used in the RACC. This is a fixed value.

WACC Selection is a drop-down menu used to select the region considered for the WACC. The options include PG&E, SCE, SDG&E, and Statewide. Deemed measures shall use the statewide selection. Custom measures/programs have the option to select a regional WACC.

Active WACC% shows the WACC value based on the WACC selection field.

Calculator Input Table

The Calculator Input table is where measure inputs are defined. Each row of the table represents a single, distinct measure offering for deemed measures. Custom measures may input a single measure by using a single row, multiple measures for a single project with multiple rows, or complex measures with multiple refrigerants (i.e., a cascade refrigeration system with two refrigerant types) by using two or more rows.

Status

Status Alert	*Description*
"OK"	No issues detected in measure calculation row
"Calc. error"	
"GWP>CARB Limit"	Refrigerant GWP selected for one or more devices exceeds CARB GWP limit in place for the device install year
"Missing inputs"	Required inputs for calculation missing

The Status field indicates several alerts for measure calculation errors or missing inputs.

Measure Definition

Column	*Description*
Measure description	Enter a description of the measure in this field. It is also sometimes helpful to add a description of the baseline(s).
Msr Install Year	Select measure year from the dropdown list.
MeasAppType	Select the measure application type from the dropdown list.

The Measure Application Type (MAT) represents how an energy efficiency measure is applied to a project and provides the basis for measure baseline, cost, and energy savings determination per D.16-08-019 and updated in Resolution E-4818. For RACC calculations, only the following four MATs are considered: Normal Replacement (NR), New Construction (NC), Accelerated Replacement (AR), or Add-on Equipment (AOE). The table that follows shows which cases must be populated depending upon the MAT for a given permutation.

Case	NC	NR	AR	AOE	Details
Measure (Msr)	X	X	X	X	
Standard Practice (Std)	X	X	X		For the counterfactual AR case, it is assumed that the standard practice equipment will be installed at the end of the existing equipment's EUL.
Existing (Pre/Ext)			X	X	For deemed measures, it is assumed that the existing equipment has a remaining useful life (RUL) equal to 1/3 of its EUL.

As a reminder, we have included this legend for column heading color coding on each page of this section where we summarize the worksheets.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

CARB Sector, Building Category, End-Use

Group	Column	Description
1	**CARB_Sector**	Select appropriate CARB_Sector from the sector categories recognized by CARB. This should match the CARB_Sector for the Device Type, from the 1 Device Builder worksheet.
1	**CARB_BldgCategory**	Select from the building categories recognized by CARB. For a better understanding of these, see the CARB-EPA Limits worksheet.

The CARB Building Category and End-Use input is where users choose a compliance scenario that best describes the facility and equipment for the measure. All three of these parameters — CARB_Sector, CARB_BldgCategory, and CARB_End-Use — determine the GWP limits for the measure being modeled.

Measure Case, New Device (Msr)

Group	Column	Description
1	**Msr CARB_End-Use**	Select the measure device end use recognized by CARB. For a better understanding of these, see the CARB-EPA Limits worksheet.
1	**Msr TechGroup (NormUnit)**	Select the TechGroup (NormUnit) associated with the measure device according to the 1 Device Builder worksheet.
1	**Msr device type**	Select the measure device type from the list of devices associated with the selected Msr TechGroup (NormUnit).
2	**Msr NumUnit**	For deemed measures, this is always equal to 1; it may only be modified for custom applications. This value reflects the number of normalizing units to account for when calculating the refrigerant emissions costs for the given permutation. For example, when the normalizing unit is “Each,” NumUnit would reflect the number of units included in the custom application. When the normalizing unit is “CapTons,” NumUnit would reflect the tons of cooling capacity of a device.
1	**Msr EUL_ID**	The DEER-approved EUL_ID is automatically populated based on the Device Type selected.
1	**Msr EUL_Yrs**	The DEER-approved EUL_Yrs value is automatically populated based on the Device Type selected.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Counterfactual New (Std)

Group	Column	Description
1	**Std CARB_End-Use**	Select the standard device end use recognized by CARB. For a better understanding of these, see the CARB-EPA Limits worksheet.
1	**Std TechGroup (NormUnit)**	Select the TechGroup (NormUnit) associated with the standard (counterfactual) device according to the 1 Device Builder worksheet.
1	**Std device type**	Select the standard (counterfactual) device type from the list of devices associated with the selected Std TechGroup (NormUnit).
2	**Std NumUnit**	For deemed measures, this is always equal to 1; it may only be modified for custom applications. This value reflects the number of normalizing units to account for when calculating the refrigerant emissions costs for the given permutation. For example, when the normalizing unit is “Each,” NumUnit would reflect the number of units included in the custom application. When the normalizing unit is “CapTons,” NumUnit would reflect the tons of cooling capacity of a device.
1	**Std EUL_ID**	The DEER-approved EUL_ID is automatically populated based on the Device Type selected.
1	**Std EUL_Yrs**	The DEER-approved EUL_Yrs value is automatically populated based on the Device Type selected.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Measure Existing (Pre) / Counterfactual Existing (Ext)

Group	Column	Description
	Pre Refrigerant Reclaimed Flag	Use this field to indicate if reasonable documentation is provided as proof the existing device refrigerant gas was reclaimed. **If refrigerant gas recovery is claimed for NR measures, all existing device specifications (end-use, TechGroup (NormUnit), and device type) must be filled out where normally they would not.** ***NOTE:* The CPUC is still reviewing the viability of claiming existing refrigerant recovery/reclamation with increased documentation. Until further notice, no emissions impacts from refrigerant gas recovery can be claimed.**
1	**Pre/Ext CARB_End-Use**	Select the existing device end use recognized by CARB. For a better understanding of these, see the CARB-EPA Limits worksheet. **Required only for the AR and AOE measure application types.**
1	**Pre/Ext TechGroup (NormUnit)**	Select the TechGroup (NormUnit) associated with the existing device according to the 1 Device Builder worksheet. **Required only for the AR and AOE measure application types.**
1	**Required only for the AR and AOE measure application types.**	Select the device type from the dropdown menu for the measure existing (Pre) / counterfactual existing (Ext) device. The dropdown list of available devices is determined by the TechGroup (NormUnit) selection. **Required only for the AR and AOE measure application types.**
2	**Pre/Ext NumUnit**	This is the quantity of number of normal units modeled by this measure. Default is 1 and should only be modified for custom measures. An example of when this value should be changed is for duplicate custom measures for the same device, with identical parameters and a normal unit of “Each.” This value acts like a quantity number for the number of devices to be included in the measure calculations.
1	**Pre/Ext EUL_ID**	The EUL_ID field is automatically populated based on the Device Type selected.
1	**Pre/Ext EUL_Yrs**	The EUL_Yrs field is automatically populated based on the Device Type selected.
2	**Pre/Ext Install Year**	Default Pre/Ext Install Year is defined by the measure installation year and the EUL of the Pre/Ext device. The default assumption is the Pre/Ext device has an RUL of 1/3 the EUL, and that the existing system installation year occurred 2/3 of the EUL from the measure installation year. This value may be changed for Custom measures only. Credible evidence is required to deviate from the DEER-approved RUL values.
2	**Pre/Ext Install Year Basis**	Default is “Deemed.” If the Pre/Ext Install Year value is adjusted, this value will change to display as “Custom.”

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

EULs and RUL

Group	Column	Description
1	**Msr EUL, Rounded**	Measure, new device EUL in years, rounded to nearest whole number to calculate costs of refrigerant leakage.
1	**Std EUL, Rounded**	Counterfactual new / standard device EUL in years, rounded to nearest whole number to calculate costs of refrigerant leakage.
1	**Pre/Ext EUL, Rounded**	Measure existing / counterfactual existing device EUL in years, rounded to nearest whole number to calculate costs of refrigerant leakage.
1	**Pre/Ext RUL, Rounded**	Measure existing / counterfactual existing device RUL in years, rounded to nearest whole number to calculate costs of refrigerant leakage.

All of these are calculation steps, no input required.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Refrigerants and GWP

Group	Column	Description
1	Msr Predefined Common Refrigerant(s)	Common refrigerant type according to 1 Device Builder worksheet (for reference only). If this field contains "None," then the device type — per the 1 Device Builder worksheet — will not have any refrigerants listed.
1	Std Predefined Common Refrigerant(s)	
1	Pre/Ext Predefined Common Refrigerant(s)	
1	Msr Refrigerant Type	Select refrigerant type for Avoided Cost Calculation for each device case from the dropdown menu. The list of refrigerant types available on the dropdown menu excludes any refrigerant prohibited for all applications based on the installation year of each device case. If an applicable refrigerant is not listed, users may select "User Specified (GWP=)" from the refrigerant type dropdown list. Users will have to specific the GWP manually in the GWP columns.
1	Std Refrigerant Type	
1	Pre/Ext Refrigerant Type	
1	Msr GWP limit per CARB-EPA	This field lists the GWP limit per CARB or EPA refrigerant regulation, whichever is more stringent. The GWP limits are based on the CARB_Sector, CARB_BldgCategory, CARB_End-Use, and MeasAppType fields. If a refrigerant is selected with GWP that exceeds the limits, the Status column will show the "GWP>CARB Limit" alert, and an appropriate refrigerant type selected or user specified GWP less than the limit input in the GWP columns.
1	Std GWP limit per CARB-EPA	
1	Pre/Ext GWP limit per CARB-EPA	
1	Msr GWP	GWP of the selected refrigerants used to calculate CO_2 equivalent emissions due to leaks. This field is automatically populated based on the selected refrigerant type. However, users may manually override field is the "user specified (GWP=)" type is selected.
1	Std GWP	
1	Pre/Ext GWP	
2	Msr GWP, User Specified	These fields are for custom inputs of the refrigerant GWP, usually when a refrigerant type of "User Specified (GWP=?)" is selected.
2	Std GWP, User Specified	
2	Pre/Ext GWP, User Specified	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Refrigerant Charge

Group	Column	Description
1	**Msr refrigerant charge (lb/NormUnit) per Device Builder**	Refrigerant charge (lb/NormUnit) per 1 Device Builder worksheet for each device type. If no refrigerant charge was input into the “RefrigCharge Pounds Per NormUnit” (copy from the 0 Refrig Research) column in the Device Builder, this displays as a “0”, and a site-specific charge will need to be input into the appropriate custom input refrigerant charge columns.
1	**Std refrigerant charge (lb/NormUnit) per Device Builder**	
1	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	
2	**Msr refrigerant charge (lb/NormUnit)**	These fields are for custom inputs of the refrigerant charge (lb/NormUnit). For deemed measures, the charge should be defined in the 1 Device Builder worksheet and the contents of these fields should typically not be modified.
2	**Std refrigerant charge (lb/NormUnit)**	
2	**Pre/Ext refrigerant charge (lb/NormUnit)**	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Annual and EOL Refrigerant Leakage Parameters

Group	Column	Description
1	Msr annual refrigerant leakage % per Device Builder	Annual refrigerant leakage percentage rate lookup, defined in the 1 Device Builder worksheet, sourced from CARB averages per CARB_DeviceType.
1	Std annual refrigerant leakage % per Device Builder	
1	Pre/Ext annual refrigerant leakage % per Device Builder	
2	Msr annual refrigerant leakage %	These fields are used to input custom annual refrigerant leakage rates for custom applications. Typically, users should not deviate from CARB average values. User-defined rates may only be used if the rate is less than the CARB average.
2	Std annual refrigerant leakage %	
2	Pre/Ext annual refrigerant leakage %	
1	Msr gross EOL refrigerant leakage % per Device Builder	EOL refrigerant loss rate lookup, defined in the 1 Device Builder worksheet, sourced from CARB averages per CARB_DeviceType.
1	Std gross EOL refrigerant leakage % per Device Builder	
1	Pre/Ext gross EOL refrigerant leakage % per Device Builder	
2	Msr gross EOL refrigerant leakage %	These fields are used to input custom end of life (EOL) refrigerant loss rates for custom applications. Typically, users should not deviate from CARB average values. Custom defined rates may only be used if the rate is less than the CARB average.
2	Std gross EOL refrigerant leakage %	
2	Pre/Ext gross EOL refrigerant leakage %	
1	Msr t_EOL per Device Builder	This field indicates the number of years prior to EOL with no “top-off” refrigerant added to replace full charge (t_EOL) lookup, defined in the 1 Device Builder worksheet, sourced from CARB averages per CARB_DeviceType.
1	Std t_EOL per Device Builder	
1	Pre/Ext t_EOL per Device Builder	
2	Msr t_EOL	These fields are used to input custom t_EOL years for custom applications only. Users should not deviate from CARB average values. Custom defined values may only be used if the resulting rate is less than the CARB average, i.e., custom t_EOL years may be greater than the default, but not less.
2	Std t_EOL	
2	Pre/Ext t_EOL	

At this point in the calculation process, moving left to right, the Pre/Ext columns are divided into pairs of “Pre” columns for the existing equipment that is retired early for the measure case of AR applications and “Ext” columns for the existing equipment that is not retired early for the counterfactual case of AR applications or for the existing or host or host proxy equipment for AOE applications.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Device Installation and Retirement Years, Device Life Overlapping Measure Years

Group	Column	Description
1	Msr Start Year	The device installation year for each case is used to calculate the costs of refrigerant leakage emissions. These values also define which refrigerants populate the refrigerant dropdown lists for each case.
1	Std Start Year	
1	Pre Start Year	
1	Ext Start Year	
1	Msr End Year	The device retirement year for each case is based on the installation year and the device EUL or RUL.
1	Std End Year	
3	Std End Year for Chart	
1	Pre End Year	
1	Ext End Year	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

EOL Charge Remaining and Leakage Adjustments

Group	Column	Description
3	**Msr Net EOL Refrigerant Leakage, percent**	Adjusted EOL refrigerant leakage percent, based on the nominal EOL refrigerant leakage rate specified in an earlier column, and the percentage of charge remaining.
3	**Std Net EOL Refrigerant Leakage, percent**	
3	**Pre Net EOL Refrigerant Leakage, percent**	
3	**Ext Net EOL Refrigerant Leakage, percent**	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Refrigerant Emissions in Equivalent Metric Tonnes of CO_2

Group	Column	Description
3	**Msr Annual Leakage, tonne CO_2e per NormUnit**	These calculation steps are for the annual refrigerant leakage in units of metric tonnes of CO_2 equivalent emissions. These calculations are based on the refrigerant charge (lb.) contained in the device, annual leakage rate, and GWP of the device refrigerant.
3	**Std Annual Leakage, tonne CO_2e per NormUnit**	
3	**Pre Annual Leakage, tonne CO_2e per NormUnit**	
3	**Ext Annual Leakage tonne CO_2e per NormUnit**	
3	**Msr EOL Leakage, tonne CO_2e per NormUnit**	This calculation step is the measure, new (Msr) device EOL leakage in units of metric tonnes of CO_2 equivalent emissions. This leakage event occurs at the EOL of the Msr device case. This calculation is based on the remaining refrigerant charge (lb.) at EOL, EOL refrigerant leakage rate, and GWP of the device refrigerant.
3	**Std EOL Leakage, tonne CO_2e per NormUnit**	This calculation step is the counterfactual, new (Std) device EOL leakage in units of metric tonnes of CO_2 equivalent emissions. This leakage event occurs at the EOL of the Std case. For AR measures, the Std device installation date occurs once the counterfactual, existing (Ext) device reaches its RUL years. Therefore, the Std EOL leakage event is offset from the measure years by a number of years equal to the RUL of the Ext device. This calculation is based on the remaining refrigerant charge (lb.) at EOL, EOL refrigerant leakage rate, and GWP of the device refrigerant.
3	**Pre EOL Leakage, tonne CO_2e per NormUnit**	This field is only for AR measures. This calculation step is the measure, existing (Pre) device EOL leakage in units of metric tonnes of CO_2 equivalent emissions. This leakage event occurs at the EOL of the Pre device case. The Pre EOL leakage event in the RACC model occurs the year prior to the measure installation year. Emissions due to this leakage event are included as part of the measure emissions since the Pre device would not have been retired at this time in absence of the measure. This calculation is based on the remaining refrigerant charge (lb.) at EOL, EOL refrigerant leakage rate, and GWP of the device refrigerant.
3	**Ext EOL Leakage, tonne CO_2e per NormUnit**	This field is only for AR measures. This calculation step is the counterfactual, existing (Ext) device EOL leakage in units of metric tonnes of CO_2 equivalent emissions. This leakage event occurs at the EOL of the Ext device case. The EOL of the Ext device occurs at the RUL of the Ext device. This represents the counterfactual condition if the existing device continued to operate for the RUL and the EOL leakage event occurs several years later. This calculation is based on the remaining refrigerant charge (lb.) at EOL, EOL refrigerant leakage rate, and GWP of the device refrigerant.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

NPV Cost of Refrigerant Emissions Relative to Measure Start Year Dollars

Group	Column	Description
3	Msr Lifecycle Annual Leakage, tonne CO2e per NormUnit	These fields contain the lifecycle annual refrigerant leakage in units of metric tonnes of CO_2 equivalent emissions during those years that a given device overlaps with the measure life.
3	Std Lifecyle Annual Leakage, tonne CO2e per NormUnit	
3	Pre Lifecycle Annual Leakage, tonne CO2e per NormUnit	
3	Ext Lifecycle Annual Leakage, tonne CO2e per NormUnit	
3	Msr Lifecycle EOL Leakage, tonne CO2e per NormUnit	These fields contain the lifecycle EOL leakage event of a device in units of metric tonnes of CO_2 equivalent emissions.
3	Std Lifecycle EOL Leakage, tonne CO2e per NormUnit	
3	Pre Lifecycle EOL Leakage, tonne CO2e per NormUnit	
3	Ext Lifecycle EOL Leakage, tonne CO2e per NormUnit	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Inflation Adjusted NPV to Specific Dollar Year and Net Avoided Costs

Group	Column	Description
3	**Msr NPV Lifecycle Cost of Annual Leakage, Dollar per NormUnit**	These fields contain the NPV lifecycle costs of annual refrigerant leakage, based on the current GHG cost values from the ACC, a weighted IOU or Statewide discount rate (WACC) and adjusted for inflation back to the default dollar year (2022) to compare all measures against.
3	**Std NPV Lifecycle Cost of Annual Leakage, Dollar per NormUnit**	
3	**Pre NPV Lifecycle Cost of Annual Leakage, Dollar per NormUnit**	
3	**Ext NPV Lifecycle Cost of Annual Leakage, Dollar per NormUnit**	
3	**Msr NPV Lifecycle Cost of EOL Leakage, Dollar per NormUnit**	These fields contain the NPV lifecycle costs of EOL refrigerant leakage, based on the current GHG cost values from the ACC, a weighted IOU or Statewide discount rate (WACC) and adjusted for inflation back to the default dollar year (2022) to compare all measures against.
3	**Std NPV Lifecycle Cost of EOL Leakage, Dollar per NormUnit**	
3	**Pre NPV Lifecycle Cost of EOL Leakage, Dollar per NormUnit**	
3	**Ext NPV Lifecycle Cost of EOL Leakage, Dollar per NormUnit**	
3	**Measure Lifecycle NPV Cost, Dollar per NormUnit**	These fields contain the NPV of the total costs of the measure case (the Msr adjusted costs plus the Pre adjusted costs) and NPV of the total costs of the counterfactual case (the Std adjusted costs plus the Ext adjusted costs).
3	**Counter-factual Lifecycle NPV Cost, Dollar per NormUnit**	
3	**Refrigerant NPV Lifecycle Cost Avoided, Dollar per NormUnit**	This field contains the net NPV of the costs of refrigerant emissions avoided. Refrigerant NPV costs avoided per NormUnit (Net) = (Measure total NPV cost) – (Counterfactual total NPV cost)
3	**Is Avoided Net Cost >0?**	This field indicates whether the measure results in a positive net avoided cost benefit. If the avoided net cost > 0 the result is displayed as a benefit in the Refrig Bens per NormUnit column. If the avoided cost < 0 the result is displayed as a cost in the Refrig Costs per NormUnit column.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

Inflation-Adjusted Net NPV of Total Refrigerant Emissions to Specific Dollar Year

Group	Column	Description
1	**Msr Refrigerant NPV Lifecycle Cost, Dollar per NormUnit**	These fields contain the NPV of the sum of the costs of: • Annual refrigerant leakage • EOL refrigerant leakage event These are adjusted for inflation back to the default dollar year (2022) to enable comparison between permutations installed in different years.
1	**Std Refrigerant NPV Lifecycle Cost, Dollar per NormUnit**	
1	**Pre Refrigerant NPV Lifecycle Cost, Dollar per NormUnit**	
1	**Ext Refrigerant NPV Lifecycle Cost, Dollar per NormUnit**	
1	**Refrig Lifecycle Cost, Dollar per NormUnit**	Only one of these fields will be populated depending upon whether the net avoided emissions for the permutation are negative (or a cost) or positive (a benefit). Net avoided emissions represent the NPV of the total costs of the counterfactual case (the Std adjusted costs plus the Ext adjusted costs) minus the NPV of the total costs of the measure case (the Msr adjusted costs plus the Pre adjusted costs).
1	**Refrig Lifecycle Benefit, Dollar per NormUnit**	
2	**Msr Refrigerant NPV Cost Total, Dollar**	For deemed measures, these fields are an exact replica of those values presented in the previous six fields. For custom measures, the costs for each case are multiplied by their respective quantities (in NumUnit columns).
2	**Std Refrigerant NPV Cost Total, Dollar**	
2	**Pre Refrigerant NPV Cost Total, Dollar**	
2	**Ext Refrigerant NPV Cost Total, Dollar**	
2	**Total Refrigerant Emission Cost, Dollar**	
2	**Total Refrigerant Emissions Benefit, Dollar**	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

3 FSC

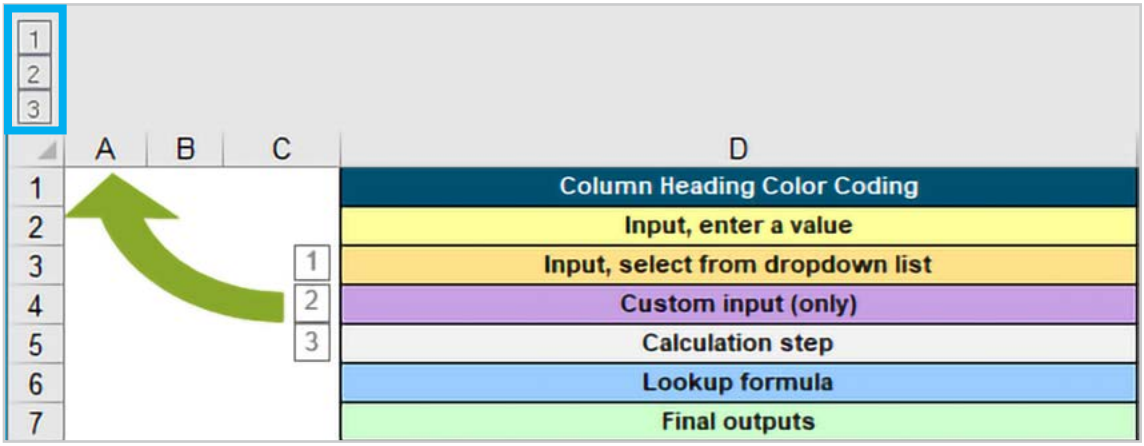
This section provides a focused summary of how to use the Fuel Substitution Calculator (FSC) worksheet. Please see Appendix A for a more detailed summary of the assumptions and formulas used by the “3 FSC” worksheet. This guidance outlines how users must:

- Determine a fuel substitution measure baseline.
- determine whether a fuel substitution measure permutation passes both parts of the fuel substitution test.
- Calculate the cost effectiveness of a fuel substitution measure.
- Report energy savings and goal reductions.

Revealing/Concealing Grouped Columns

Since the 3 FSC worksheet contains close to 100 columns, the column grouping functionality is leveraged (as was done on the 2 RACC worksheet) to hide columns used less-frequently. The fewest columns are shown when the “1” button is toggled as shown in Figure 2 3. Columns that are more likely to be used for custom applications are revealed when the “2” button is toggled. To see all columns, toggle the “3” button.

Figure 2-3. Buttons to reveal or conceal grouped columns appear in upper left corner



Fuel Substitution Calculator Input Table

The first field to be populated by the user, “RACC_Measure Description”, points each 3 FSC row to the RACC_Index to reference for a given measure package permutation. Typically, a single RACC_Index will be used for many measure package permutations and each FSC_Index will represent one set of permutations comprised of one or more delivery types. More details regarding the inputs needed for each FSC_Index are described in the tables that follow.

Group	*Column*	*Description*
1	**FSC_Index**	This is an auto-populated index for each fuel substitution measure permutation. For residential HVAC where the baseline does not necessarily include space cooling, three indices/rows will be necessary to create a permutation that uses a weighted baseline for cooling that is constructed from a permutation without cooling and a permutation with cooling.
1	**RACC_Index**	This is populated after the RACC_Measure Description column (D) has been filled.
1	**Overall Result**	This field indicates the status of the fuel substitution permutation data entry or test, including: “Missing inputs”, “PASS”, or “FAIL”.
1	**RACC_Measure Description**	The drop-down list described each of the entries on the 2 RACC worksheet. Each entry consists of the concatenation of the RACC_Index, the Measure Description, the Msr Install Year, and the MeasAppType.
1	**Offering ID Description**	This may contain the measure package’s offering ID and/or more descriptive text.
1	**Sector**	A drop-down list is used to select the building sector (Res, Com, Ind, or Ag)
1	**BldgType**	A drop-down list is used to select from the available building types in the chosen building sector.
1	**BldgVint**	A drop-down list is used to select from the available building vintages (Old, Ex, Rec, or New).
1	**BldgLoc**	A drop-down list is used to select from the 16 California climate zones.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next series of columns contain data that are drawn from the relevant RACC_Index.

Group	Column	Description
1	**Measure description**	Brought in from 2 RACC for the selected RACC_Index.
1	**Msr Install Year**	Brought in from 2 RACC for the selected RACC_Index
1	**MeasAppType**	Brought in from 2 RACC for the selected RACC_Index
1	**Msr Device Type**	Brought in from 2 RACC for the selected RACC_Index
2	**Msr NumUnit**	Only used for custom applications to indicate the number of NormUnits to be installed
1	**Standard Device Type**	Brought in from 2 RACC for the selected RACC_Index
2	**Std NumUnit**	Only used for custom applications to indicate the number of NormUnits of the counterfactual equipment that would have been installed.
1	**Std Device Cooling Proportion WeightID to Use, if Appropriate**	This is left blank except when a residential fuel substitution measure involves replacing space heating equipment without space cooling. In this case, the available WeightID, “FS-rImputedDX”, shall be chosen. The weights associated with this WeightID vary by climate zone. More information about how these values were derived is provided in Appendix A.
1	**Std Cooling Proportion for Imputed Impacts**	When a weighted baseline is used for imputing cooling, the proportion associated with the selected WeightID will be shown.
1	**FSC_Index for Basis of Imputed Impacts of Std Cooling Device**	When building a permutation for a weighted baseline for imputed cooling, the calculator must be told which FSC_Index contains the corresponding permutation that includes space cooling in the baseline case. Using the cooling energy usage from the entered FSC_Index, the weighted cooling will be determined by interpolating between the no-cooling case — in the current row of the table — using the associated Std Cooling Proportion for Imputed Impacts value (column S).
1	**Pre Refrigerant Reclaimed Flag**	Brought in from 2 RACC for the selected RACC_Index
1	**Pre/Ext Device Type**	Brought in from 2 RACC for the selected RACC_Index
2	**Pre/Ext NumUnit**	Only used for custom applications to indicate the existing number of NormUnits
1	**Pre/Ext Install Year**	Brought in from 2 RACC for the selected RACC_Index but may be modified for a custom application.
1	**Pre/Ext Install Year Basis**	Contains “Deemed” unless a custom Pre/Ext Install Year was entered.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next set of columns bring the refrigerant information in from the selected RACC_Index row on the 2 RACC worksheet.

Group	Column	Description
1	**Msr Refrigerant Type**	Brought in from 2 RACC for the selected RACC_Index.
1	**Std Refrigerant Type**	Brought in from 2 RACC for the selected RACC_Index
1	**Pre/Ext Refrigerant Type**	Brought in from 2 RACC for the selected RACC_Index
3	**Msr Lifecycle Annual Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Std Lifecycle Annual Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Pre Lifecycle Annual Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Ext Lifecycle Annual Leakage, tonne CO2e per Norm Unit**	Brought in from 2 RACC for the selected RACC_Index
3	**Msr Lifecycle EOL Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Std Lifecycle EOL Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Pre Lifecycle EOL Leakage, tonne CO2e per NormUnit**	Brought in from 2 RACC for the selected RACC_Index
3	**Ext Lifecycle EOL Leakage, tonne CO2e per Norm Unit**	Brought in from 2 RACC for the selected RACC_Index

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next set of columns are used to enter the annual energy usage by fuel type and by case.

Group	Column	Description
1	**Msr Annual Electric usage, kWh per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation.
1	**Msr Annual Natural Gas Usage, Therm per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation.
1	**Std Annual Electric usage, kWh per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation.
1	**Std Annual Natural Gas Usage, Therm per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation.
1	**Pre/Ext Annual Electric usage, kWh per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation
1	**Pre/Ext Annual Natural Gas Usage, Therm per NormUnit**	This value should be drawn from the relevant fuel substitution measure package permutation.
1	**Imputed Std Annual Usage, kWh per NormUnit**	This is left blank except when a weighted baseline of imputed cooling is used for a residential HVAC measure where the existing equipment did not provide cooling.
1	**1st Baseline Annual Savings, kWh per NormUnit**	These are calculated using the annual energy usage.
1	**1st Baseline Annual Savings,Therm per NormUnit**	These are calculated using the annual energy usage.
1	**2nd Baseline Annual Savings, kWh per NormUnit**	These are calculated using the annual energy usage.
1	**2nd Baseline Annual Savings, Therm per NormUnit**	These are calculated using the annual energy usage.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next set of columns, in Group 3, may be revealed by the user when more insight into the calculations performed to inform the fuel substitution tests is desired.

Group	Column	Description
3	**1st Baseline Lifecycle Savings, kWh per NormUnit**	These are calculated by multiplying the 1st baseline annual savings and the measure life (or the existing equipment remaining useful life for AR permutations)
3	**1st Baseline Lifecycle Savings, Therm per NormUnit**	These are calculated by multiplying the 1st baseline annual savings and the measure life (or the existing equipment remaining useful life for AR permutations)
3	**2nd Baseline Lifecycle Savings, kWh per NormUnit**	For AR permutations, these are calculated by multiplying the 2nd baseline annual savings and the measure life minus the remaining useful life of the existing equipment; they are zero for all other permutations.
3	**2nd Baseline Lifecycle Savings, Therm per NormUnit**	For AR permutations, these are calculated by multiplying the 2nd baseline annual savings and the measure life minus the remaining useful life of the existing equipment; they are zero for all other permutations.
3	**1st Baseline Lifecycle Electric Savings, MMBtu per NormUnit**	These are calculated by multiplying the annual source energy (MMBtu per kWh) values of the relevant ACC cycle by the 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**1st Baseline Lifecycle Natural Gas Savings, MMBtu per NormUnit**	These are calculated by converting from Therm to MMBtu.
3	**2nd Baseline Lifecycle Electric Savings, MMBtu per NormUnit**	These are calculated by multiplying the annual source energy (MMBtu per kWh) values of the relevant ACC cycle by the 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**2nd Baseline Lifecycle Natural Gas Savings, MMBtu per NormUnit**	These are calculated by converting from Therm to MMBtu.
3	**1st Baseline Lifecycle Electric Emissions, tonne CO2e per NormUnit**	These are calculated by multiplying the annual emissions rate (tonnes per MWh) values of the relevant ACC cycle by the methane leakage rates and the 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**1st Baseline Lifecycle Natural Gas Emissions, tonne CO2e per NormUnit**	These are calculated by multiplying the emissions rate (tonnes per Therm) and the 1st baseline lifecycle savings, in Therm per NormUnit.
3	**1st Baseline Lifecycle Electric Emissions, tonne CO2e per NormUnit**	These are calculated by multiplying the annual emissions rate (tonnes per MWh) values of the relevant ACC cycle by the methane leakage rates and the 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**1st Baseline Lifecycle Natural Gas Emissions, tonne CO2e per NormUnit**	These are calculated by multiplying the emissions rate (tonnes per Therm) and the 1st baseline lifecycle savings, in Therm per NormUnit.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next set of columns summarize the results of the fuel substitution test for a given deemed measure permutation.

Group	Column	Description
1	**Measure Refrigerant Emissions, tonne CO2e per NormUnit**	Measure case annual refrigerant emissions per 2 RACC
1	**Counterfactual Refrigerant Emissions, tonne CO2e per NormUnit**	Counterfactual case annual refrigerant emissions per 2 RACC
1	**Imputed Counterfactual Refrigerant Emissions, tonne CO2e per NormUnit**	Imputed counterfactual case annual refrigerant emissions
1	**Lifecycle Primary Energy Savings, MMBtu per NormUnit**	Lifecycle source energy must not increase to pass Test #1.
1	**Test #1 PASS/FAIL**	Result of Test #1
1	**Electric Lifecycle Emissions, tonne CO2e per NormUnit**	Net electric lifecycle emissions
1	**Natural Gas Lifecycle Emissions, tonne CO2e per NormUnit**	Net natural gas lifecycle emissions
1	**Refrigerant Lifecycle Emissions, tonne CO2e per NormUnit**	Net refrigerant lifecycle emissions
1	**Net Emissions, tonne CO2e per NormUnit**	Net emissions must not increase to pass Test #2.
1	**Test #2 PASS/FAIL**	Result of Test #2
1	**Refrigerant Emissions Lifecycle Net Benefit (NPV 2022$) per NormUnit**	Result of avoided refrigerant emissions costs from 2 RACC
1	**Msr GWP per RACC**	Brought in from 2 RACC for the selected RACC_Index
1	**If failing, maximum Msr Refrig. GWP to pass FuelSub Test Part 2**	If a given permutation does not pass Test #2, the maximum GWP of the measure refrigerant that would pass is provided; otherwise, this field remains blank.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

The next set of columns summarize the results of the fuel substitution test for a given deemed measure permutation.

Group	Column	Description
3	**Total 1st Baseline Annual Savings, kWh**	These are calculated using the annual energy usage multiplied by the number of units.
3	**Total 1st Baseline Annual Savings, Therm**	These are calculated using the annual energy usage multiplied by the number of units.
3	**Total 2nd Baseline Annual Savings, kWh**	These are calculated using the annual energy usage multiplied by the number of units.
3	**Total 2nd Baseline Annual Savings, Therm**	These are calculated using the annual energy usage multiplied by the number of units.
3	**Total 1st Baseline Lifecycle Savings, kWh**	These are calculated by multiplying the 1st baseline annual savings, the number of units, and the measure life (or the existing equipment remaining useful life for AR permutations).
3	**Total 1st Baseline Lifecycle Savings, Therm**	These are calculated by multiplying the 1st baseline annual savings, the number of units, and the measure life (or the existing equipment remaining useful life for AR permutations).
3	**Total 2nd Baseline Lifecycle Savings, kWh**	For AR permutations, these are calculated by multiplying the 2nd baseline annual savings, the number of units, and the measure life minus the remaining useful life of the existing equipment; they are zero for all other permutations.
3	**Total 2nd Baseline Lifecycle Savings, Therm**	For AR permutations, these are calculated by multiplying the 2nd baseline annual savings, the number of units, and the measure life minus the remaining useful life of the existing equipment; they are zero for all other permutations.
3	**Total 1st Baseline Lifecycle Electric Savings, MMBtu**	These are calculated by multiplying the annual source energy (MMBtu per kWh) values of the relevant ACC cycle by the Total 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**Total 1st Baseline Lifecycle Natural Gas Savings, MMBtu**	These are calculated by converting from the Total Therm to MMBtu.
3	**Total 2nd Baseline Lifecycle Electric Savings, MMBtu**	These are calculated by multiplying the annual source energy (MMBtu per kWh) values of the relevant ACC cycle by the Total 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**Total 2nd Baseline Lifecycle Natural Gas Savings, MMBtu**	These are calculated by converting from the Total Therm to MMBtu.
3	**Total 1st Baseline Lifecycle Electric Emissions, tonne CO2e**	These are calculated by multiplying the annual emissions rate (tonnes per MWh) values of the relevant ACC cycle by the methane leakage rates and the total 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**Total 1st Baseline Lifecycle Natural Gas Emissions, tonne CO2e**	
3	**Total 2nd Baseline Lifecycle Electric Emissions, tonne CO2e**	These are calculated by multiplying the annual emissions rate (tonnes per MWh) values of the relevant ACC cycle by the methane leakage rates and the total 1st baseline lifecycle savings, in kWh per NormUnit. More information is provided in Appendix A.
3	**Total 2nd Baseline Lifecycle Natural Gas Emissions, tonne CO2e**	

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

2	**Total Measure Refrigerant Emissions, tonne CO2e**	Total measure case annual refrigerant emissions per 2 RACC
2	**Total Counterfactual Refrigerant Emissions, tonne CO2e**	Total counterfactual case annual refrigerant emissions per 2 RACC
2	**Total Imputed Counterfactual Refrigerant Emissions, tonne CO2e**	Total imputed counterfactual case annual refrigerant emissions
2	**Total Lifecycle Primary Energy Savings, MMBtu**	Lifecycle source energy must not increase to pass Test #1.
2	**Total Test #1 PASS/FAIL**	Result of Test #1
2	**Total Electric Lifecycle Emissions, tonne CO2e**	Total net electric lifecycle emissions
2	**Total Natural Gas Lifecycle Emissions, tonne CO2e**	Total net natural gas lifecycle emissions
2	**Total Refrigerant Lifecycle Emissions, tonne CO2e**	Total net refrigerant lifecycle emissions
2	**Total Net Emissions, tonne CO2e**	Total net emissions must not increase to pass Test #2.
2	**Total Test #2 PASS/FAIL**	Result of Test #2
2	**Total Refrigerant Emissions Lifecycle Net Benefit (NPV 2022$)**	Result of avoided refrigerant emissions costs from 2 RACC multiplied by the number of units.

Column Heading Color Coding
Input, enter a value
Input, select from a dropdown list
Custom input (only)
Calculation step
Lookup formula
Final outputs

4 eTRM export

This worksheet is auto-populated by the 2 RACC worksheet results so that the refrigerant emissions costs or benefits are provided in a format that is easy to import into the permutations table of a measure package under development in the eTRM platform.

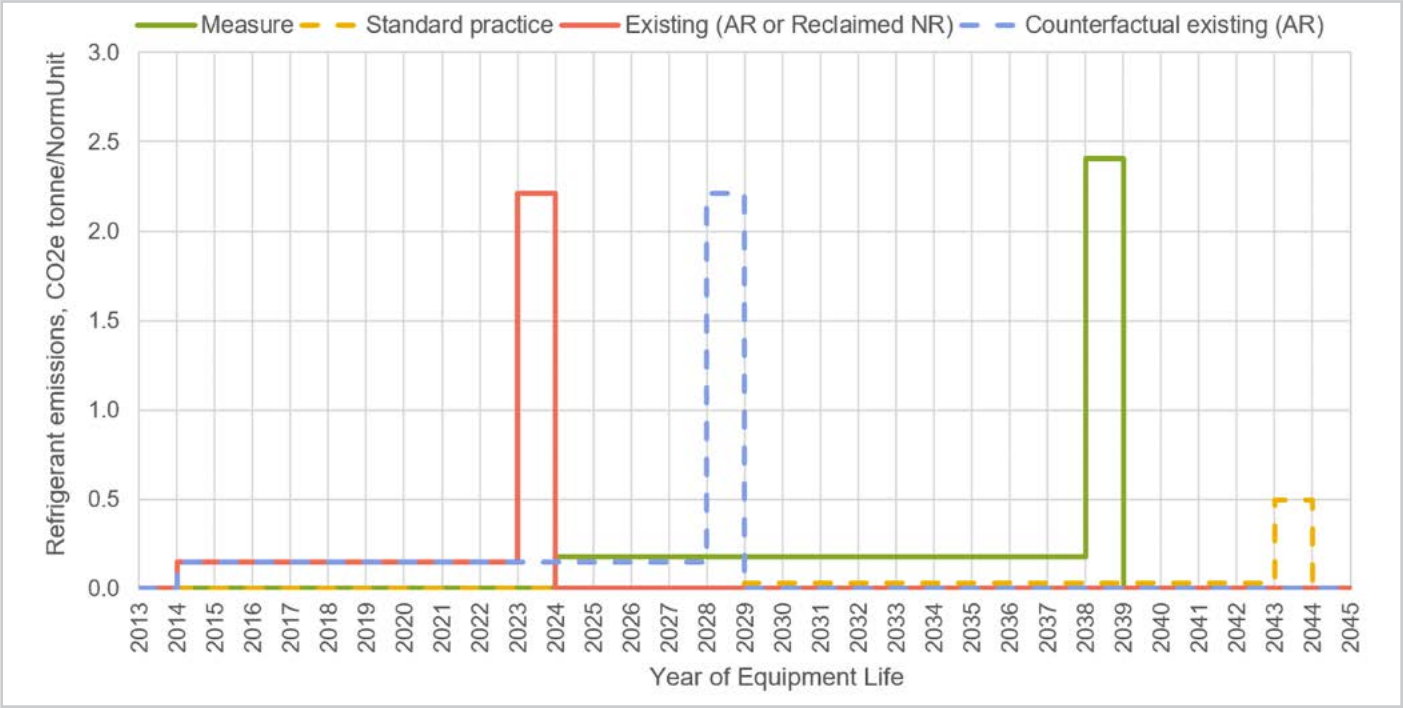
5 RACC Charts

A new worksheet was added to the workbook to allow the user to visually "walk through" the calculations performed to determine the lifetime net-present-value costs of a given measure's refrigerant emissions (per NormUnit and relative to the measure installation year $). Upon opening the "5 RACC Charts" worksheet, the user must select the index number for the measure to be charted. A description of each of the five charts is provided in each of the subsections that follow.

All Refrigerant Emissions by Year of Equipment Operation

Figure 2-4 (Chart 1) shows the annual refrigerant emissions (in metric tonnes of CO_2e per NormUnit) for each of the measure and baseline cases that are relevant to the given measure. The emissions shown in this chart reflect all of those—both coincident with and outside of the measure life.

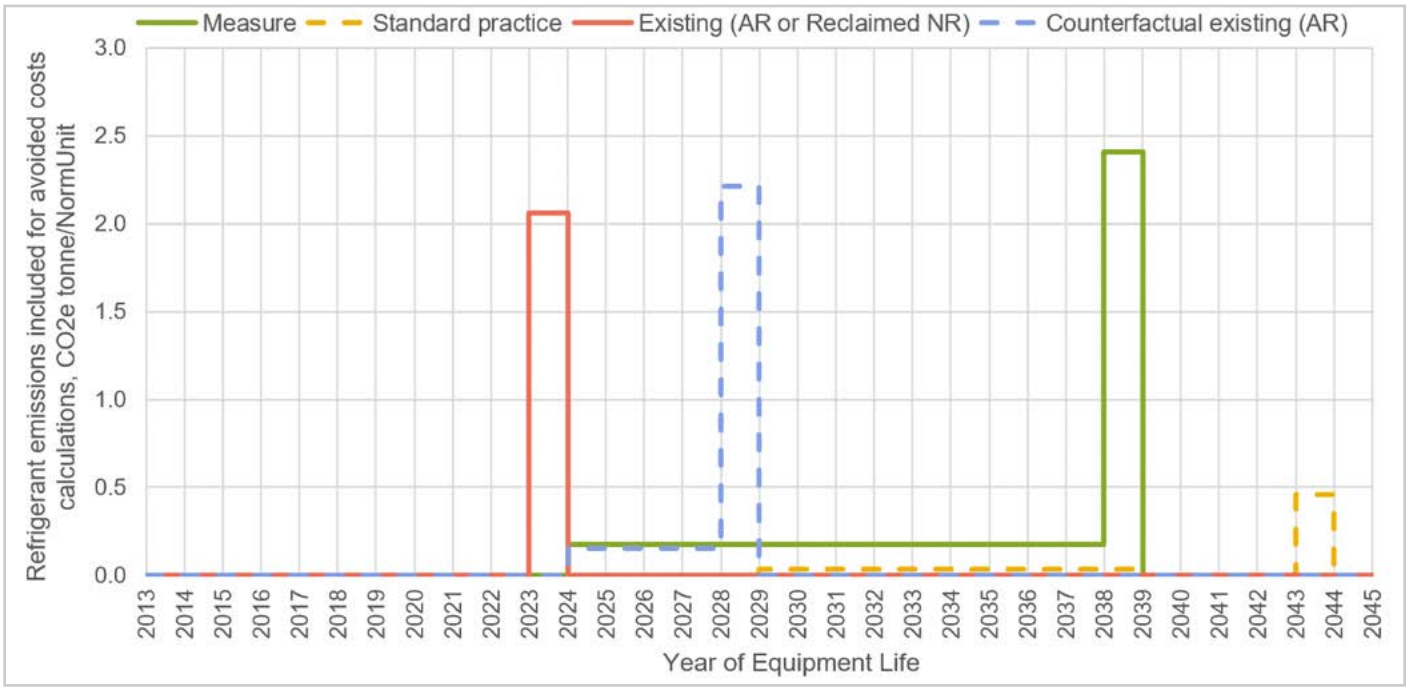
Figure 2-4: Chart 1 shows all annual refrigerant emissions over the life of each equipment case for an AR measure



Annual Refrigerant Emissions Used to Determine Refrigerant Avoided Costs

Figure 2-5 (Chart 2) shows only those annual refrigerant emissions that are considered for the calculation of the refrigerant emissions costs. Note that the annual emissions that occur outside of the measure life are reduced to zero.

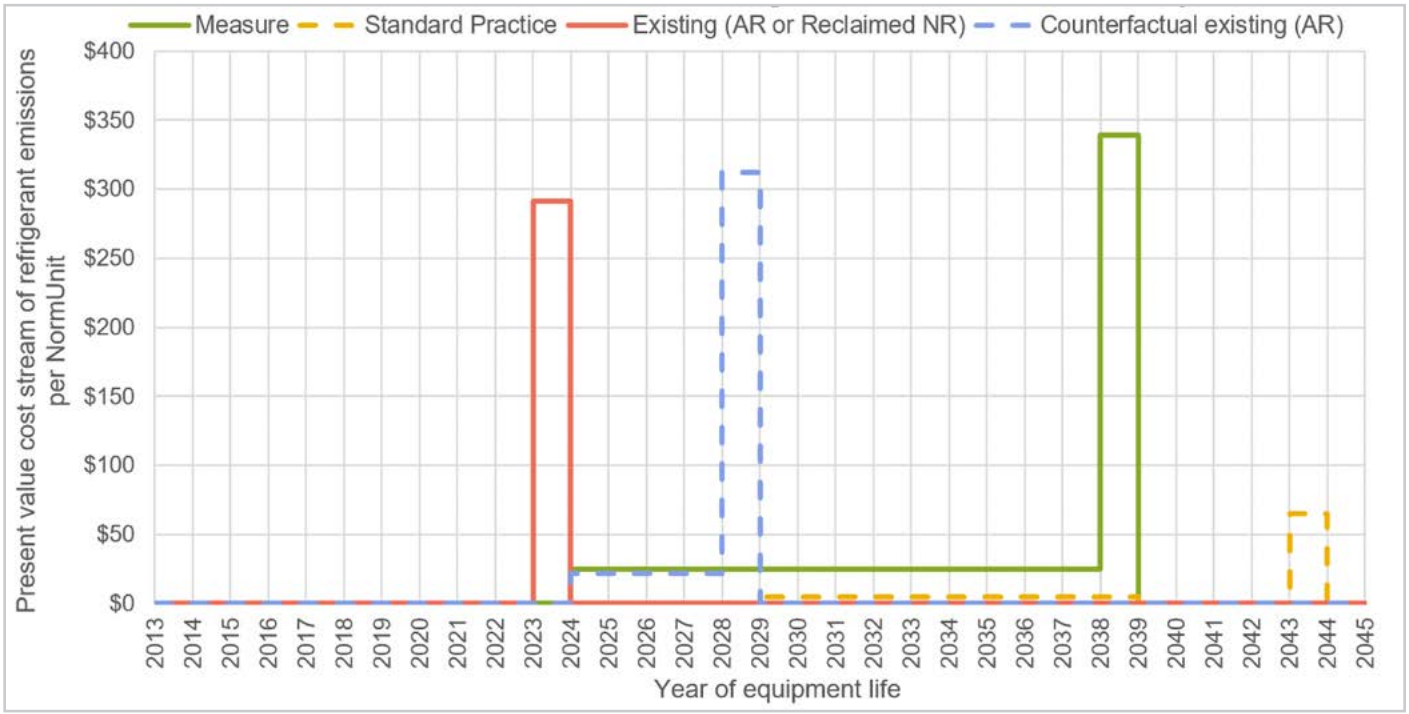
Figure 2-5: Chart 2 shows only those Refrigerant emissions that are considered when determining their costs



Present Value Cost Stream of Refrigerant Emissions

Figure 2-6 (Chart 3) shows the present value of the annual refrigerant emissions costs for each year for the dollar year used by the ACC in use.

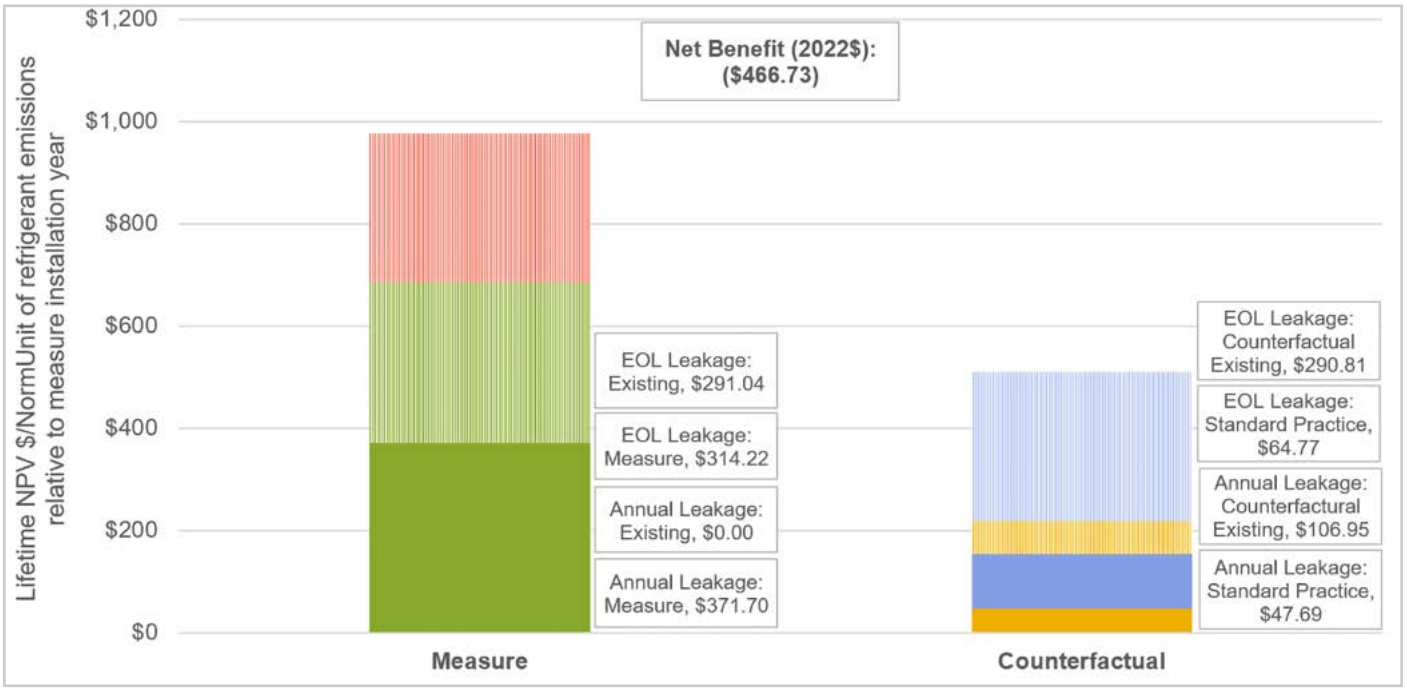
Figure 2-6: Chart 3: The present value cost stream of refrigerant emissions



Lifetime NPV of Refrigerant Emissions

The NPV of the lifecycle costs of the refrigerant emissions are added together, assuming a 2% rate of inflation, for the measure case and the counterfactual case. This overall result indicates whether the measure yields a net benefit or a net cost in 2022$ as shown in **Figure 2-7 (Chart 4)**. In general, if the measure contains refrigerant, but the baseline equipment did not, the net result will be a negative benefit.

Figure 2-7: Chart 4 shows the lifetime NPV costs of refrigerant emissions in 2022$



6 FSC Pivot

This worksheet contains a pivot table that can be refreshed to view a summary of the Fuel Substitution Test results on the 3 FSC worksheet across all of the permutations for a given measure package. An example is provided in **Figure 2-8** that shows the results for Part One and Part Two of the Fuel Substitution Test for a measure package (SWHC045-03) that involves replacing existing central AC with gas furnace systems with central heat pump systems for the residential sector in program years 2024 and 2025. The test results differ between 2024 and 2025 because EPA SNAP rules require that, as of January 1, 2025, HVAC heat pumps shall only use refrigerants with a GWP that does not exceed 700. For the purposes of this example, it is assumed that the refrigerant in use in 2024 is R-410A (2,088 GWP) and R-454B (466 GWP) in 2025, for both the measure and the counterfactual standard practice cases.

Figure 2-8. Color-coded pivot table to show net emissions avoided for fuel substitution permutations

Pre Refrigerant Reclaimed Flag	FALSE	Source Energy	Avoided tCO2e															
		Part 1	Part 2															
Net Emissions Avoided			Bldg Loc	Net Emissions Avoided, tonne CO2e per Cap-Ton (NormUnit)														
RACC_Measure Description	Offering ID Description	Test Part 1		CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AR: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS		3.8	3.7	3.4	3.4	3.2	1.8	2.3	1.9	2.0	1.8	3.7	3.7	4.0	3.7	1.4	3.7
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AO: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS		3.7	3.7	3.3	3.4	3.2	1.7	2.3	1.9	2.0	1.7	3.6	3.6	3.9	3.6	1.3	3.6
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AL: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS		3.7	3.6	3.3	3.3	3.1	1.7	2.3	1.8	1.9	1.7	3.5	3.5	3.8	3.6	1.2	3.5
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AI: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS		3.7	3.6	3.2	3.3	3.1	1.7	2.2	1.8	1.9	1.7	3.5	3.5	3.7	3.5	1.2	3.5
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AF: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS		3.7	3.6	3.2	3.3	3.1	1.7	2.2	1.8	1.9	1.6	3.4	3.5	3.7	3.5	1.1	3.4
1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS		3.6	3.5	3.2	3.2	3.1	1.7	2.2	1.7	1.8	1.6	3.4	3.4	3.6	3.4	1.1	3.4
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AR: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS		4.3	4.2	3.8	3.9	3.7	2.2	2.8	2.3	2.4	2.2	4.1	4.1	4.4	4.2	1.8	4.1
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AO: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS		4.2	4.1	3.7	3.8	3.6	2.2	2.7	2.3	2.4	2.2	4.0	4.1	4.3	4.1	1.7	4.0
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AL: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS		4.1	4.0	3.7	3.7	3.6	2.1	2.7	2.2	2.3	2.1	3.9	4.0	4.2	4.0	1.6	4.0
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AI: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS		4.1	4.0	3.7	3.7	3.6	2.1	2.7	2.2	2.3	2.1	3.9	4.0	4.2	4.0	1.6	3.9
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AF: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS		4.1	4.0	3.7	3.7	3.6	2.1	2.7	2.2	2.3	2.1	3.9	3.9	4.1	3.9	1.5	3.9
7: Res DXHP replacing central AC and gas furnace in 2025 (NR)	AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS		4.1	4.0	3.6	3.7	3.5	2.1	2.6	2.2	2.3	2.0	3.8	3.9	4.1	3.9	1.5	3.8

Change Log

This worksheet documents all changes to the RACC-FSC, developed on behalf of the CPUC by DNV, and previously the Deemed RACC, originally developed on behalf of SCE by Solaris Technical LLC. The Deemed RACC was used to develop the combined RACC-FSC workbook.

Reference Worksheets

Constants + Dropdowns

This worksheet contains all of the constants, named ranges, and dropdown menus in use in the RACC-FSC Workbook. Based on the Constants + Dropdowns worksheet contained in the Deemed RACC Workbook v2.2 available at CEDARS, more dropdown lists have been added to expand the functionality of this workbook.

The weighted average cost of capital (WACC) is used for a discount rate for the NPV calculations is generated on this worksheet using values in use for each given ACC update. For statewide measure packages, this should be the weighted average WACC where the weights are based on electric funding split for IOUs. For custom project/measures, the user may select the weighted average "Statewide" WACC or one of the IOU specific WACC values from this dropdown list in the 2 RACC worksheet (cell F5).

General inputs	Notes	
Refrig. Cost Basis	GHG Value from Natural Gas ACC	
Dollar Year	2022	→ Select latest ACC
GWP Time Horizon	100-yr	→ Locked to 100-yr
WACC selection	Statewide	→ Statewide for Deemed
Active WACC%	7.54%	

DEER Database Tables

Nine DEER database tables are connected to this workbook so that they are available to measure package developers and custom applications as new records are added in DEER. Since these tables are updated as warranted by new evaluation, measurement, and verification (EM&V) studies or stakeholder requests, they may require periodic refreshing. It is recommended that users sign up for alerts to the DEER database webpage within the DEER Module of the CEDARS website. Updates to these tables will be announced as they occur. If new EUL_IDs or TechTypes are needed, please email a request to DEERsupport@DNV.com.

RACC_FSC_InputTracker_DEER

This worksheet is connected to the DEER database table that shows the modifications made to the other DEER tables that are referenced by RACC_FSC.

The **Intro** worksheet, found at beginning of the RACC-FSC workbook, contains a table indicating the status of the DEER database connected tables. The DEER Table Status shows the last modification dates found in each of the connected DEER database tables currently loaded into the RACC-FSC and compares that to the last modified dates found in this RACC_FSC_InputTracker_DEER table. Additionally, there is an input cell to record the date when measure package developers and custom applications submit the RACC-FSC for review. The possible comments on status include: “DEER table is up to date”, "DEER table was current as of the date that the RACC-FSC was submitted. No further action is needed.", and "DEER table must be updated before uploading to eTRM!".

Date of RACC-FSC submission:	2024-Apr-08					
	Status	DEER Schema	DEER Table	Last Modified according to RACC_FSC_InputTracker	Last Modification According to Table Currently Loaded in RACC_FSC	Comment regarding status of DEER table
DEER Table Status	✓	applic	BldgWts	2024-Apr-01	2024-Apr-01	DEER table is up to date.
	✓	costeff	CARB_EPA_GWP_Limits	2024-Mar-22	2024-Mar-22	DEER table is up to date.
	✓	costeff	CARB_RefrigLeaks	2024-Feb-29	2024-Feb-29	DEER table is up to date.
	✓	costeff	EUL_basis	2024-Apr-02	2024-Apr-02	DEER table is up to date.
	✓	costeff	OtherRatesACC	2024-Mar-30	2024-Mar-30	DEER table is up to date.
	✓	costeff	Refrigerant	2024-Mar-25	2024-Mar-25	DEER table is up to date.
	✓	costeff	RefrigerantACC	2024-Mar-30	2024-Mar-30	DEER table is up to date.
	✓	tech	TechType	2024-Apr-02	2024-Apr-02	DEER table is up to date.

BldgWts_DEER

This worksheet is connected to the DEER database BldgWts table and contains DEER-approved building weights (BldgWts).

CARB_EPA_GWP_Limits_DEER

This worksheet is connected to a new DEER database table that contains the GWP limits established by either the California Air Resources Board or the EPA, depending upon which prevails in a given year.

CARB_RefrigLeaks_DEER

This worksheet is connected to a DEER database table that contains typical refrigerant leakage rates (annual and end-of-life) by equipment type from CARB data. The 2 RACC worksheet references this worksheet to lookup default refrigerant leakage values.

EUL_basis_DEER

This worksheet is connected to the DEER database EUL table, and contains DEER-approved EUL_IDs.

OtherRatesACC_DEER

This worksheet is connected to the DEER database table that contains natural gas heat rates, source energy rates, methane leakage rates and adders, and PA-specific capital rates established for each ACC update.

Refrigerant_DEER

This worksheet is connected to the DEER database. This table contains a list of refrigerants and their associated GWPs for 20- and 100-year horizons.

RefrigerantACC_DEER

This worksheet is connected to the DEER database Refrigerant_ACC table and contains the avoided refrigerant emission costs, electric ACCs, natural gas ACCs, and emissions rates for recent ACC updates.

TechType_DEER

This worksheet is connected to the DEER database TechType table and contains DEER-recognized technology types (TechType, a subcategory of TechGroup).

2022 RACC Worksheets

The following worksheets are taken from the 2022 Refrigerant ACC to be used for the DC RACC workbook.

ACC Inputs

This worksheet contains the GHG Adder Coefficients that monetize emissions in each given year (in nominal dollars). These coefficients are based on the $114/ton GHG abatement cost in 2021 dollars from the California Energy Commission (CEC) report. The GHG cost is escalated at the WACC rate of 7.51% due to an anticipated increase of gas or other fuel prices to calculate the total cost of GHG during the measure lifetime. The total net present value (NPV) cost accounts for a 2% inflation rate.

Refrigerant Leakage

This worksheet contains typical refrigerant leakage rates (annual and end-of-life) by equipment type from CARB data.

Refrigerant GWP

This worksheet contains the 20-year and 100-year GWP values of the refrigerants as defined by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).

RACC Change Log

This is the change log from the E3 2022 RACC tool for reference purposes.

2022 FuelSub worksheets

The following worksheets are taken from the 2022 FuelSub Calculator (version 1b updated) to be used for the RACC-FSC workbook.

Reference

This worksheet contains the conversion factors and constants used by the 3 FSC worksheet.

Annual Factors

This worksheet contains the annual source energy and emissions rates used by the 3 FSC worksheet.

Methane Leakage

This worksheet contains the methane leakage rate assumed used by the 3 FSC worksheet.

Long-run Emissions Inputs

This worksheet contains the basis for the annual source energy and emissions rates presented on the Annual Factors worksheet.

section 3

Baseline Guidance

This section covers how to determine an appropriate baseline for the applications covered in this document. This includes measure application type, measure life, leakage rates, charge level, applicable regulations, and required documentation.

APPROPRIATE BASELINES

NR measures require a standard practice baseline condition, which could either be equipment that meets code and regulation requirements or ISP equipment, whichever has greater energy efficiency. For refrigerant emissions the normal replacement baseline would be either code/regulation or ISP, whichever has a lower GWP. The normal replacement baseline is sometimes referred to as a "standard baseline".

Measures may only be categorized as accelerated replacement (AR) if the existing equipment being replaced could and would remain operation without program intervention. The baseline for the AR measure would be the existing system for the RUL period, and then a standard baseline (code/regulation, or ISP) for the remainder of the measure life. The default RUL is defined as one-third of the existing equipment's EUL. However, the default RUL period may be replaced with a custom value in cases where credible evidence is provided to support an alternative RUL value that CPUC staff can reasonably deem more credible than of the adopted default value.

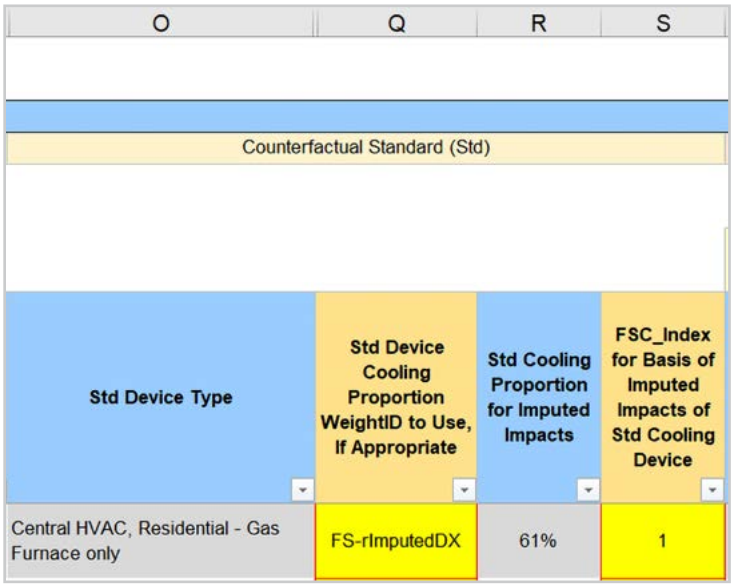
Residential Heat Pumps that Replace Natural Gas Furnaces Without Cooling

When developing fuel-substitution permutations for residential heat pumps that replace existing natural gas heating systems without either room/window air conditioning or central air conditioning, the standard practice baseline shall use an imputed cooling baseline. The 3 FSC worksheet will produce a climate-zone specific permutation when the user follows the steps described:

1. Create a permutation on the 3 FSC worksheet for a given building-type/building-vintage/building-location combination where the standard practice baseline includes space cooling.
2. Create a second permutation on the 3 FSC worksheet for the same building-type/building-vintage/building-location combination where the standard practice baseline does not include space cooling.

3. In columns Q and S of the 3 FSC worksheet:
    - Select “FS-rImputedDX” from the dropdown list in the “Std Device Cooling Proportion WeightID to Use, if Appropriate” field.
    - Indicate the corresponding FSC_Index of the relevant permutation where the standard baseline included space cooling (from Step 1). A screenshot is provided in Figure 3-1.

Figure 3-1: Appropriate baselines, imputed cooling screenshot



O	Q	R	S
Counterfactual Standard (Std)			
Std Device Type	**Std Device Cooling Proportion WeightID to Use, If Appropriate**	**Std Cooling Proportion for Imputed Impacts**	**FSC_Index for Basis of Imputed Impacts of Std Cooling Device**
Central HVAC, Residential - Gas Furnace only	FS-rImputedDX	61%	1

4. The “Std Cooling Proportion for Imputed Impacts” will be auto-populated based upon the climate zone in which the permutation will apply. This proportion will be used to interpolate between the electric energy usage for the current permutation and electric energy usage previously entered for the associated FSC_Index with cooling in the baseline. More information regarding the basis for this proportion is provided in Appendix A.
5. Interpolated values for imputed cooling are provided in the fields that follow:
    - “Imputed Std Annual Electric Usage, kWh per NormUnit”
    - “Imputed Counterfactual Refrigerant Emissions, tonne CO2e per NormUnit”
    - “Lifecycle Primary Energy Savings, MMBtu per NormUnit”
    - “Electric Lifecycle Emissions, tonne CO2e per NormUnit”
    - “Refrigerant Emissions Lifecycle Net Benefit, Dollar per NormUnit”

EUL/RUL CONSIDERATIONS

Generally, the EUL for RACC claims shall be based on default DEER database EULs where possible. These represent the median lifetimes. When the CARB average EUL does not align with DEER, a user-specified EUL in the RACC should be used to align with DEER.

However, when pursuing a custom project or site-level NMEC pathway, alternative EULs are allowed but are subject to PA review and require documentation supporting the claim. Alternative EUL and RUL should only be used if suitable EUL IDs in the DEER database do not exist. Sources must be provided for manual entries of EUL and RUL, and independently evaluated and assessed before using for claims. Sources may include project documentation, ASHRAE tables, workpapers, industry publications, etc. Alternative EULs can be used up 20 years. Anything beyond 20 years is difficult to get approved, due to an existing CPUC rule that sets a max EUL of 20 years.

LEAKAGE RATE

Normally, users of the RACC will not deviate from the CARB average annual leakage rates, and EOL leakage values. Locally defined, system/site-specific leakage rates may be used only if the rate is less than the CARB average.

REFRIGERANT CHARGE

For custom projects, site-specific charge level in lb. will be used in place of the CARB averages included in the RACC. If the measure is a NR MAT, the charge level will be determined by the manufacturer specification for the new equipment. With AR MATs with an existing system initial baseline condition, the site-specific refrigerant charge needs to be supported by adequate documentation.

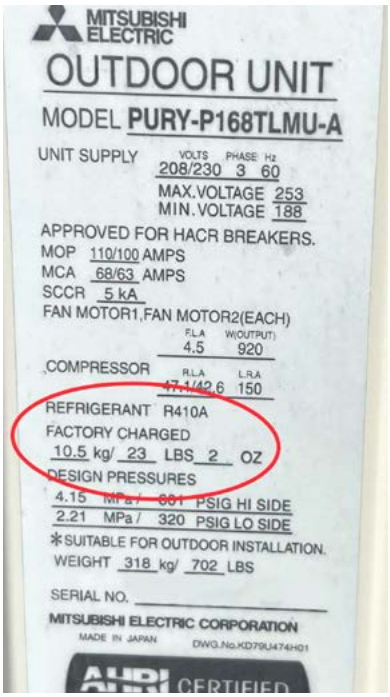
Documentation Requirements for Charge Level

If a retail food refrigeration facility is already registered in the CARB Refrigerant Management Program (RMP), then the normal operating charge should be defined and reported to CARB. This documentation can be used to support the charge levels of existing equipment for claims using the RACC.

If a retail food refrigeration facility is not already registered in the CARB RMP, then the normal operating charge can be determined using one of the following methods:

- Name plate
- Charge calculator program
- Midpoint of range
- Sum of refrigerant charged into system
- Calculated from design documents
- Equipment manual
- Recover full charge and weight back in system

To support the claimed charge from these methods, we recommend the following as example documentation: photo of nameplate, PDF or scan of equipment manual, screenshot of the design documents calculation, etc.



Example name plate

Hybrid System Measures

For hybrid measures, where systems use two different refrigerants, such as cascade refrigeration systems where the loads (low-temperature [LT] and medium-temperature [MT]) can be served by one or more systems with one refrigerant all served by a high-temperature system (HT) with another refrigerant that rejects heat through an exterior condenser. The two systems may need to be modelled separately in two different RACCs. In the case of an accelerated replacement scenario with a hybrid system with two refrigerants. For the existing system baseline, the original system charge needs to be allocated proportionally to the HT and LT/MT systems.

REFRIGERANT EMISSION POLICIES

California has consistently been at the forefront of the battle against climate change, establishing and adopting a series of progressive policies specifically designed to regulate refrigerant emissions and expedite the phase-down of HFCs, a major contributor to global warming. California Senate Bill 1383 (SB1383), signed into law in 2016, targets the reduction of short-lived climate pollutants (SLCPs), which are pollutants that, despite their relatively short lifespan in the atmosphere, are much more potent than carbon dioxide in their capacity to trap heat. HFCs are one of the three main SLCPs identified in SB1383. The bill requires a 40% reduction of HFC emissions below 2013 levels by 2030.

In 2018, California passed the California Cooling Act (SB1013) and a new CARB HFC regulation to backstop the EPA SNAP prohibitions. Under SB1013, California adopted the U.S. Environmental Protection Agency's (EPA) federal HFC regulations into state law. Following the direction set by SB1383, SB1013 established an HFC regulation by instituting multiple sector-specific measures to reduce HFC emissions. These measures apply to sectors like refrigeration and air conditioning and aim to transition these sectors to using substances with lower global warming potential.

In 2020, the CARB updated its 2018 HFC regulation to enforce limits on the GWP of refrigerants used in new air conditioning and refrigeration equipment. This update encourages industries to not just move away from refrigerants with the highest GWP, but to rapidly adopt those with the lowest GWP that are still commercially viable and technologically feasible. In addition, the update mandates companies in the retail food sector that own existing systems containing more than 50 lb. of refrigerant to cut their overall HFC emissions. This can be achieved either by reducing the company-wide weighted-average GWP or, alternatively, by lowering their total potential to emit GHGs.

Therefore, refrigeration systems in California need to follow both the EPA and CARB rules on phasing down HFCs and adopting refrigerants with low-GWP values. Those policies affect how users should choose appropriate baselines to claim avoided emissions and costs using RACC.

Table/Index of Refrigerant Emission Regulations

The CARB HFC regulation has a sector-level regulation for facilities with more than 50 lb. of refrigerant as shown in **Table 3-1** below. As can be seen, new facilities in both retail food sector and cold storage are not allowed to use refrigerants with a GWP of 150 or greater since January 1, 2022. Existing retail food facilities with existing refrigeration systems will be required to achieve company-wide HFC reductions.

Table 3-1. CARB HFC regulation for facilities with more than 50 lb. of refrigerant

Facility type	End-use	Company size	Compliance requirement	Effective date
New	Retail food refrigeration, cold storage	N/A	Refrigerants with a GWP of 150 or greater are prohibited	January 1, 2022
Existing	Retail food refrigeration	Companies owning or operating 20 or more retail food facilities in California, and national supermarket chains operating in California	Attain a company-wide weighted-average GWP of less than 2,500 or a 25% or greater reduction in GHGp below 2019 levels by December 31, 2026	December 31, 2026
			Attain a company-wide weighted-average GWP of less than 1,400 or a 55% or greater reduction in GHGp below 2019 levels	January 1, 2030
		Companies owning or operating fewer than 20 retail food facilities in California	Attain a company-wide weighted-average GWP of less than 1,400 or a 55% or greater reduction in GHGp below 2019 levels	January 1, 2030

Table 3-2. CARB HFC regulation for sector-specific prohibited refrigerants regardless of charge size

Specific end-use	Prohibited substances	Effective date
Supermarket systems (new)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Prohibited as of January 1, 2019
Supermarket systems (refrigerant retrofit)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Prohibited as of January 1, 2019
Remote condensing units (new)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Prohibited as of January 1, 2019
Remote condensing units (refrigerant retrofit)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Prohibited as of January 1, 2019
Stand-alone medium-temperature units with a compressor capacity below 2,200 Btu/hr and not containing a flooded evaporator (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03	Prohibited as of January 1, 2019
Stand-alone medium-temperature units with a compressor capacity below 2,200 Btu/hr and containing a flooded evaporator (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03	Prohibited as of January 1, 2020
Stand-alone medium-temperature units with a compressor capacity equal to or greater than 2,200 Btu/hr (new)	HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03	Prohibited as of January 1, 2020
Stand-alone low-temperature units (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 formulation)	Prohibited as of January 1, 2020
Stand-alone units (refrigerant retrofit)	R-404A, R-507A	Prohibited as of January 1, 2019
Refrigerated food processing and dispensing equipment (new)	HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 formulation)	Prohibited as of January 1, 2021
Vending machines (new)	FOR12A, FOR12B, HFC-134a, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C,	Prohibited as of January 1, 2019
Vending machines (refrigerant retrofit)	R-404A, R-507A	Prohibited as of January 1, 2019
Cold storage warehouses (new system)	HFC 227ea, R 125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R 407A, R 407B, R 410A, R 410B, R 417A, R 421A, R-421B, R 422A, R 422B, R 422C, R 422D, R 423A, R 424A, R-428A, R 434A, R 438A, R 507A, and RS 44 (2003 composition)	Unacceptable as of January 1, 2023.
Cold Storage Warehouses (new), Refrigeration equipment (new), containing more than 50 lb. refrigerant	Refrigerants with a GWP of 150 or greater	Prohibited as of January 1, 2022

In addition, the EPA Phasedown of HFCs final ruling 40 CFR Part 84, Subpart B – 10-05-2023, also listed sector specific proposed GWP limits or prohibited substances for new systems. **Table 3-3** shows the proposed HFC restrictions for stationary refrigeration.

Table 3-3. EPA proposed HFC restrictions for stationary refrigeration

Sectors and subsectors	Proposed GWP limit or prohibited substance	Compliance date
Residential and light commercial air conditioning and heat pump systems	700	January 1, 2025
Variable refrigerant flow systems	700	January 1, 2026
Chillers, industrial process refrigeration with exiting fluid below -50°C (-58°F)	Not covered	Not covered
Chillers, industrial process refrigeration with exiting fluid between -50°C (-58°F) and -30°C (-22°F)	700	January 1, 2028
Chillers, industrial process refrigeration with exiting fluid above -30°C (-22°F)	700	January 1, 2026
Chillers, comfort cooling	700	January 1, 2025
Ice rinks	700	January 1, 2025
Data centers, computer room air conditioning, and information technology equipment cooling	700	January 1, 2027
Industrial process refrigeration systems with refrigerant charge capacities of 200 lb. or greater, and refrigerant temperature entering evaporator above -30°C (-22°F), excluding high temperature cascade system	150	January 1, 2026
Industrial process refrigeration systems with refrigerant charge capacities less than 200 lb., and refrigerant temperature entering evaporator above -30°C (-22°F)	300	January 1, 2026
Industrial process refrigeration, high temperature side of cascade systems, and refrigerant temperature entering evaporator above -30°C (-22°F)	300	January 1, 2026
Industrial process refrigeration, and refrigerant temperature entering evaporator from -50°C (-58°F) to -30°C (-22°F)	700	January 1, 2028
Industrial process refrigeration, and refrigerant temperature entering evaporator below -50°C (-58°F)	Not covered	Not covered
Cold storage warehouse systems with refrigerant charge capacities of 200 lb. or greater, excluding high temperature side of cascade system	150	January 1, 2026

Sectors and subsectors	Proposed GWP limit or prohibited substance	Compliance date
Cold storage warehouse systems with refrigerant charge capacities less than 200 lb.	300	January 1, 2026
Cold storage warehouse – high temperature side of cascade system	300	January 1, 2026
Retail food refrigeration – supermarket systems with refrigerant charge capacities of 200 lb. or greater, excluding high temperature side of cascade system	150	January 1, 2027
Retail food refrigeration – supermarket systems with refrigerant charge capacities less than 200 lb.	300	January 1, 2027
Retail food refrigeration – supermarket systems, high temperature side of cascade system	300	January 1, 2027
Retail food refrigeration – remote condensing units with refrigerant charge capacities or 200 lb. or greater, excluding high temperature side of cascade system	150	January 1, 2026
Retail food refrigeration – remote condensing units with refrigerant charge capacities less than 200 lb.	300	January 1, 2026
Retail food refrigeration – remote condensing units, high temperature side of cascade system	300	January 1, 2026
Retail food – remote refrigerated food processing and dispensing equipment	R-402A, R-402B, R-404A, R-407B, R-408A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-428A, R-434A, R-438A, R-507A, R-125/290/134a/600a (55/1/42.5/1.5), RS-44 (2003 formulation), GHG-X5	January 1, 2027
Remote automatic commercial ice machines	R-402A, R-402B, R-404A, R-407B, R-408A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-428A, R-434A, R-438A, R-507A, R-125/290/134a/600a (55/1/42.5/1.5), RS-44 (2003 formulation), GHG-X5	January 1, 2027

As can be seen above, there is overlap between the EPA rule and the CARB rule, and the categorization of the sector is not the same. Given the wealth of details within these policies and the potential for misunderstandings and confusion, we will present a selection of examples to assist in making sense of and navigating these regulations.

For example, to navigate through the applicable requirement for a supermarket refrigeration system, users can follow the steps provided below in **Table 3-4**. Supermarket refrigeration system falls under the retail food sector where the CARB HFC regulation has both sector level GWP requirements and sector-specific prohibited refrigerants. At the same time, the EPA also has listed GWP limits for new systems based on charge size.

First step is to determine the facility type. If the facility type is new, and the charge size is more than 50 lb., it needs to follow the CARB GWP limit of 150. If the charge size is 50 lb. or less, it needs to meet the prohibited refrigerants requirement from CARB and the GWP limit of 300 from EPA rule.

If it is an existing facility and the measure is refrigerant swap, for charge size 50 lb. or less, it only needs to follow the prohibited refrigerants list from CARB. If the charge size is more than 50 lb., it needs to follow the company wide GWP limit rule as well.

Similarly, if the existing facility is installing a new refrigeration equipment or system, depending on the charge size, it falls under different requirements from CARB and EPA.

Table 3-4. Example supermarket refrigeration system policy walkthrough

Facility type	Charge size	System	GWP limit or prohibited refrigerants
New	>50 lb.	New	GWP limit of 150 since 1/1/2022
	50 lb. or less	New	Prohibited refrigerants since 1/1/2019 GWP limit of 300 since 1/1/2025
Existing	50 lb. or less	Swap	Prohibited refrigerants since 1/1/2019
	>50 lb.	Swap	Companywide GWP limit Prohibited refrigerants since 1/1/2019
	200 lb. or greater	New	GWP limit of 150 since 1/1/2025
	>50 and <200 lb.	New	Companywide GWP limit Prohibited refrigerants since 1/1/2019
	50 lb. or less	New	Prohibited refrigerants since 1/1/2019 GWP limit of 300 since 1/1/2025

section 4

Stationary Refrigeration Measures

COMPLETE SYSTEM REPLACEMENT WITH NATURAL REFRIGERANT SYSTEM, >50 LB. CHARGE, ACCELERATED REPLACEMENT

Measure description

This example is a complete system replacement from a two-gas cascade system consisting of the R-404A system for the med/low-temperature side and R-407A for the high-temperature side. This system will be replaced with a CO_2 system for the med/low-temperature side and a propane refrigerant system for the high-temperature side. The refrigeration system replacement is for a retail food company with 20 or more stores.

To model the refrigerant leakage emissions impact of a cascade system with multiple refrigerants the system needs to be split into two measures. The medium/low-temperature side that uses R-404A with a refrigerant charge of 1,392 lb. is modelled as a separate measure. Likewise, the high-temperature side with R-407A refrigerant with a refrigerant charge of 595 lb. is modelled as a second measure. The avoided cost result of the whole refrigeration system is the sum of the results from the two split measures in the RACC-FSC tool.

The example presented in this section is for AR application type, where the existing equipment is replaced while still operable.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge will be used for this measure.

Input Worksheet: 1 Device Builder

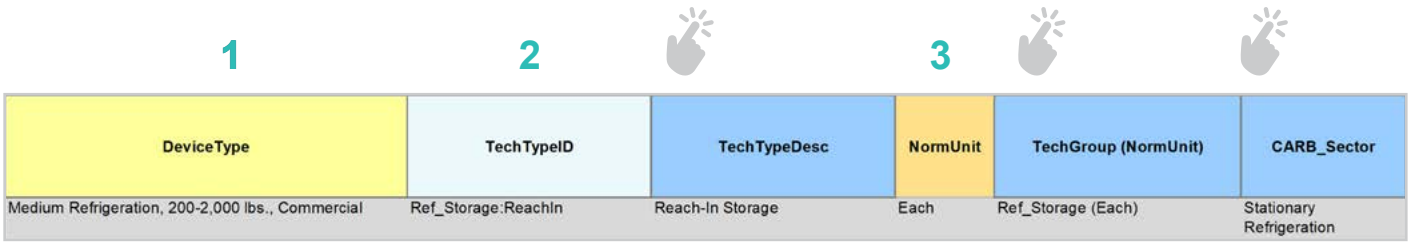
0 Refrig Research	**1 Device Builder**	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

Only a single device is required in the 1 Device Builder worksheet unless the charge size of the sides of the cascade refrigeration system fall into different CARB_DeviceType categories.

STEP 1 **Check to See if Desired Equipment is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 Add New Device



DeviceType, TechTypeID, NormUnit, CARB_Sector

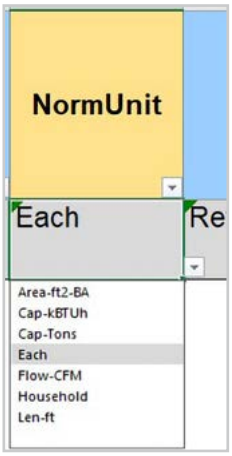
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: Medium Refrigeration, 200-2,000 lb., Commercial

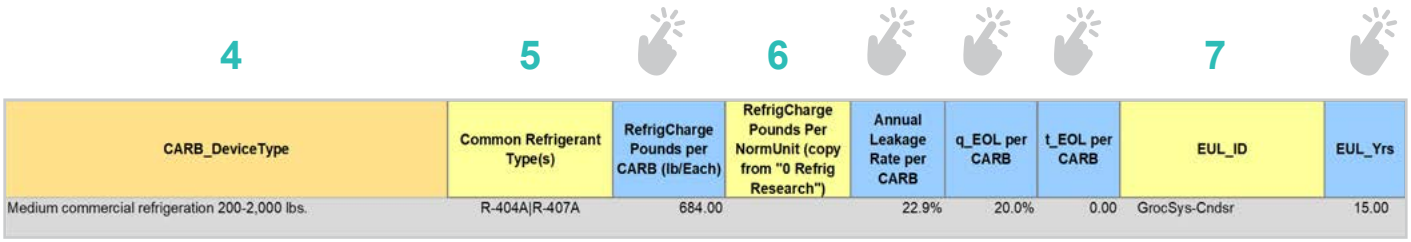
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: "Ref_Storage:ReachIn"

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Medium commercial refrigeration 200-2,000 lbs.	R-404A|R-407A	684.00		22.9%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above).

- Select the desired ***CARB_DeviceType*** from the dropdown menu.

  EXAMPLE: "Medium commercial refrigeration 200-2,000 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

  EXAMPLE: R-404A|R-407A for common refrigerants used in existing systems.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges will be entered in the 2 RACC worksheet.

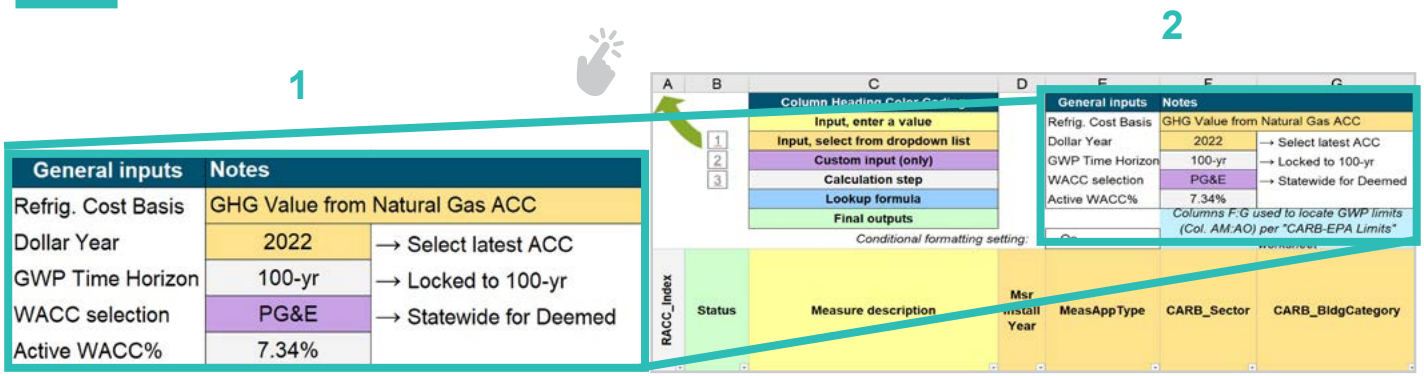
  EXAMPLE: Leave this cell blank, since this measure is custom equipment-specific charge levels will be input in the 2 RACC worksheet.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

  EXAMPLE: "GrocSys-Cndsr" is selected as the best choice of EUL for this refrigeration equipment.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Set WACC selection to “PG&E” for this measure example.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is “GHG Value from Natural Gas ACC.”

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

	1	2	3	4	5
	Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
▲	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side	2024	AR	Stationary Refrigeration	Large retail food chain (≥20 stores)
●	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side	2024	AR	Stationary Refrigeration	Large retail food chain (≥20 stores)

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

- ▲ **EXAMPLE LOW/MED TEMP SIDE:** "Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side."
- ● **EXAMPLE HIGH TEMP SIDE:** "Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side"

2 Select the ***measure installation year*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** This example is for a 2024 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

▲ ● **EXAMPLE BOTH:** AR (accelerated replacement). The existing equipment in this example would remain operation without program intervention.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** "Stationary Refrigeration"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

▲ ● **EXAMPLE BOTH:** "Large retail food chain (≥20 stores)"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

Measure case, new device (Msr)					
Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
▲ Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00
● Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

▲ ● **EXAMPLE BOTH:** For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity

1 2 3 4

Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
▲ Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00
● Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

▲ ● **EXAMPLE BOTH:** For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

1 2 3 4

	Measure Existing (Pre)						
	Counterfactual Existing (Ext)						
	Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
▲		Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00
●		Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

Note that the Pre/Existing Device input is only for AR measure applications.

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

▲ ● **EXAMPLE BOTH:** For this case, we will just model a single device and the NormUnit is left at the default value "1".

5

	Pre/Ext Install Year	Pre/Ext Install Year Basis
▲	2014	Deemed
●	2014	Deemed

5 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

▲ ● **EXAMPLE BOTH:** The Pre/Ext Install Year is unchanged from the default year. This example is appropriate for systems that may be older than the default DEER EUL for this equipment, but the owners will continue to maintain the equipment and keep it operational. Leaving this input the default assumes the default 1/3 EUL for the RUL of the existing equipment.

STEP 6 Select Refrigerant Types

1 2 3

	Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
							Refrigerant properties color coding			Refrigerant properties color coding			Refrigerant properties color coding		
							The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
										Exceeds CARB-EPA limit, if any					
	Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
▲	R-404A|R-407A	R-404A|R-407A	R-404A|R-407A	Carbon Dioxide (GWP=1	User Specified (GWP=)	R-404A (GWP=3,922)	None	2,500	None	1	0	3,922	1	150	3,922
●	R-404A|R-407A	R-404A|R-407A	R-404A|R-407A	Propane (GWP=4)	User Specified (GWP=)	R-407A (GWP=2,107)	None	2,500	None	4	0	2,107	4	150	2,107

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

- ▲ **EXAMPLE LOW/MED TEMP SIDE:** Select “Carbon Dioxide” as the measure case refrigerant.
- ● **EXAMPLE HIGH TEMP SIDE:** Select “Propane” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

- ▲ ● **EXAMPLE BOTH:** The standard baseline system would be installed in 2029 once the existing system reaches the end of it’sits RUL period. In 2029, CARB limits for new refrigeration equipment, containing more than 50 lb. of refrigerant prohibits refrigerants with 150 GWP or greater. Without a standard practice case for refrigerant less than 150 GWP in supermarket systems, the user could default to the EPA limit by selecting “User Specified” and override the Std GWP column with 150.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

- ▲ **EXAMPLE LOW/MED TEMP SIDE:** Select “R-404A” as the existing refrigerant.
- ● **EXAMPLE HIGH TEMP SIDE:** Select “R-407A” as the existing refrigerant.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)			
Msr	Std	Pre Ext	Msr	Std	Pre Ext	
Refrigerant properties color coding			*Refrigerant properties color coding*			
Value replaced formula			Value replaced formula			
Device Builder value replaced						
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**	
0.00	0.00	0.00	835.00	1,392.00	1,392.00	▲
0.00	0.00	0.00	175.00	595.00	595.00	●

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

EXAMPLE: In this example, these are zero because we will be inserting equipment specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

▲ **EXAMPLE LOW/MED TEMP SIDE:** Custom refrigerant charge is specified for this measure. The pre/existing case R-404A refrigerant charge is 1,392 lb., based on product specification. The standard case refrigerant charge is assumed to be 1,392 lb. based on picking similar equipment charged with a less than 150 GWP refrigerant that shares similar characteristics as R-404A. However, this may differ depending on the actual refrigerant used. The measure case carbon dioxide system will require a refrigerant charge of 835 lb.

● **EXAMPLE LOW/MED TEMP SIDE:** Custom refrigerant charge is specified for this measure. The pre/existing case R-407A refrigerant charge is 595 lb., based on product specification. The standard case refrigerant charge is assumed to be 595 lb. However, this may differ depending on the actual refrigerant used. The measure case propane system will require a refrigerant charge of 175 lb.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 Calculator RACC there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-2** and the total avoided cost in 2022 dollars for the medium/low-temperature side is $436,482.80, and the avoided cost for the high-temperature side is $106,831.49 for a combined avoided cost for the project of $543,314.28.

Table 4-2. User inputs for replacement with natural refrigerant system accelerated replacement

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Medium Refrigeration, 200-2,000 lb., Commercial		
	TechTypeID	Ref_Storage:ReachIn		
	NormUnit	Each		
	CARB_DeviceType	Medium commercial refrigeration 200-2,000 lb.		
	Common Refrigerant Type(s)	R-404A|R-407A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	684		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	PG&E		
	Measure Description	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side		
	Msr Install Year	2024		
	MeasAppType	AR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Large retail food chain (≥20 stores)		
	CARB_End-Use	Retail Food Refrigeration (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Medium Refrigeration, 200-2,000 lb., Commercial		
	Pre/Ext Install Year	NA	NA	2014 (auto populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	Carbon Dioxide (GWP=1)	User Specified (GWP=)	R-404A (GWP=3,922)
	GWP	Auto populated	150 (manual input)	Auto populated
	Refrigerant Charge (lb/NormUnit)	835	1,392	1,392
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		
(Inputs for the high-temperature side that differ from the med/low-temperature side)				
2 RACC (High Temperature Side)	Measure Description	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side		
	Refrigerant Type	Propane (GWP=4)	User Specified (GWP=)	R-407A (GWP=2,107)
	GWP	Auto populated	150 (manual input)	Auto populated
	Refrigerant Charge (lb/NormUnit)	175	595	595

COMPLETE SYSTEM REPLACEMENT WITH NATURAL REFRIGERANT SYSTEM, >50 LB. CHARGE SYSTEMS

Measure description

This example is a complete system replacement from a two-gas cascade system consisting of the R-404A system for the med/low-temperature side and R-407A for the high-temperature side. This example is for a NR scenario, in which the existing system has either failed or is no longer meeting the capacity needs of the facility. The new system will be a CO_2 system for the med/low-temperature side and a propane refrigerant system for the high-temperature side. The refrigeration system replacement is at an existing facility for a retail food company with 20 or more stores. The counterfactual baseline system would be required to have a refrigerant with a GWP of 150 or less based on CARB regulations at a "new facility".

NOTE: New refrigeration equipment at an existing facility may be required to meet the "New Facility" refrigeration equipment guidelines, if the existing facility has undergone replacement of 75% or more of its evaporators (by quantity/ number) and 100% of its compressor racks, condensers, and connected evaporator loads.

To model the refrigerant leakage emissions impact of a cascade system with multiple refrigerants the system needs to be split into two measures. The medium/low-temperature side with CO_2 refrigerant, and high-temperature side with propane refrigerant need to be modelled as separate measures. The avoided cost result of the whole refrigeration system is the sum of the results from the two split measures in the RACC-FSC tool.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge will be used for this measure.

Input Worksheet: 1 Device Builder

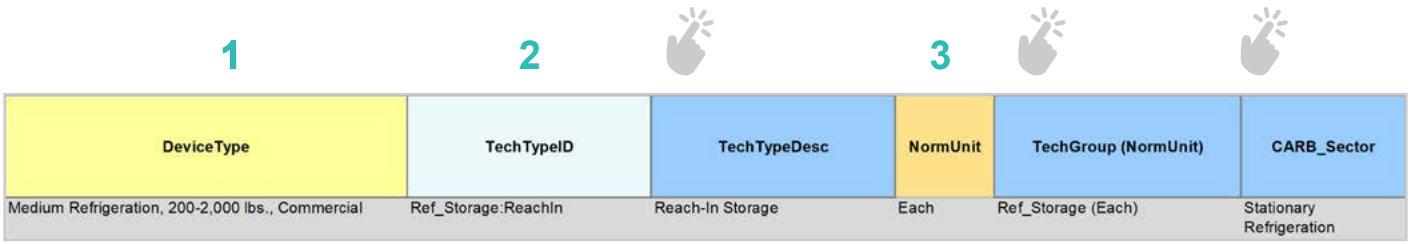
0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

Only a single device is required in the 1 Device Builder worksheet unless the charge size of the sides of the cascade refrigeration system fall into different CARB_DeviceType categories.

STEP 1 **Check to See if Desired Equipment is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

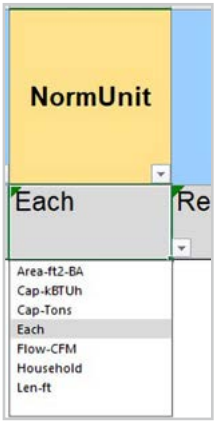
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: Medium Refrigeration, 200-2,000 lb., Commercial

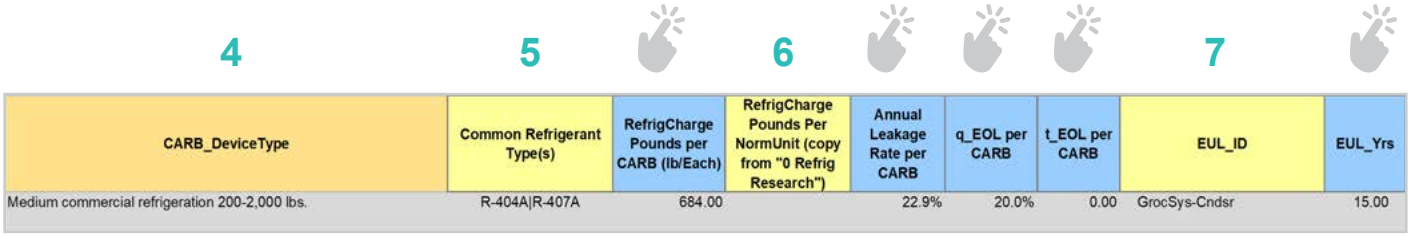
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: For this grocery store refrigeration system, we will use “Ref_Storage:ReachIn.”

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Medium commercial refrigeration 200-2,000 lbs.	R-404A|R-407A	684.00		22.9%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above).

- Select the desired ***CARB_DeviceType*** from the dropdown menu.

  EXAMPLE: "Medium commercial refrigeration 200-2,000 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

  EXAMPLE: "R-404A|R-407A" for common refrigerants used in existing systems.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges will be entered in the 2 RACC worksheet.

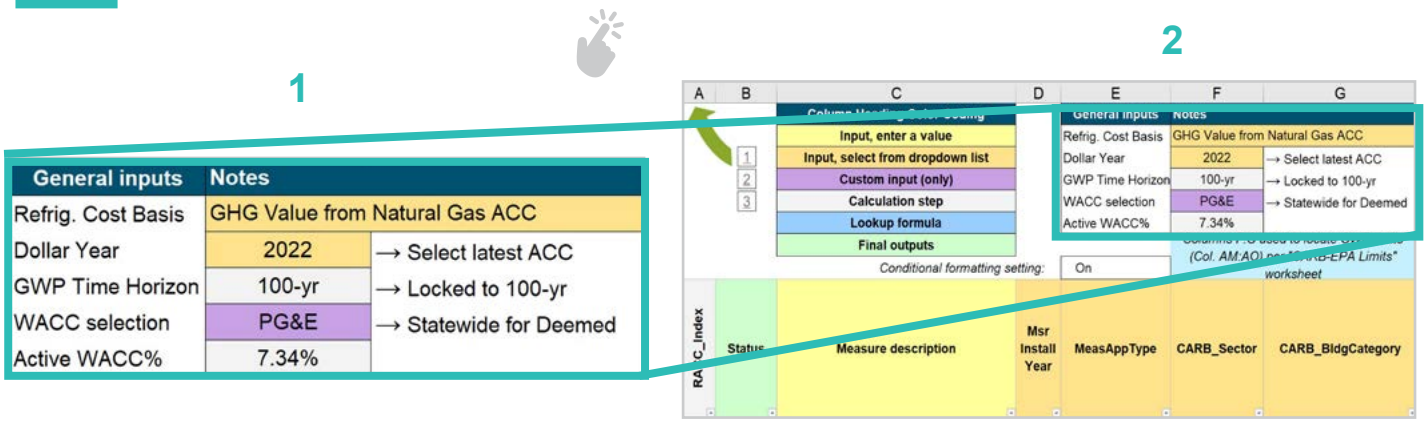
  EXAMPLE: Leave this cell blank, since this measure is custom equipment-specific charge levels will be input in the 2 RACC worksheet.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: "GrocSys-Cndsr" is selected as the best choice of EUL for this refrigeration equipment.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: This custom project example assumes "PG&E" for the WACC.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC".

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

	1	2	3	4	5
	Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
▲	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side	2024	NR	Stationary Refrigeration	Large retail food chain (≥20 stores)
●	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side	2024	NR	Stationary Refrigeration	Large retail food chain (≥20 stores)

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

- ▲ **EXAMPLE LOW/MED TEMP SIDE:** "Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side"
- ● **EXAMPLE HIGH TEMP SIDE:** "Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side"

2 Select the ***measure installation year*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** This example is for a 2024 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

▲ ● **EXAMPLE BOTH:** NR (normal replacement). The existing equipment has failed or will no longer meet facility requirements and will need to be replaced with a new system.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** "Stationary Refrigeration"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

▲ ● **EXAMPLE BOTH:** "Large retail food chain (≥20 stores)"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

1 2 3 4

Measure case, new device (Msr)					
Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
▲ Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00
● Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

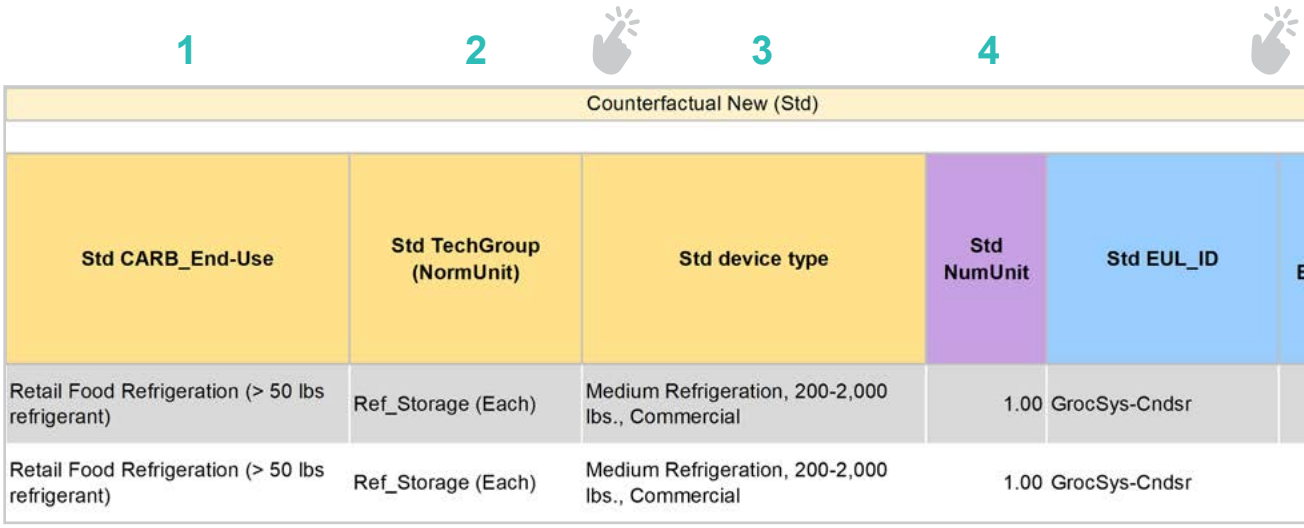
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

▲ ● **EXAMPLE BOTH:** For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

▲ ● **EXAMPLE BOTH:** For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

	Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
							Refrigerant properties color coding The CARB-EPA limit is used in calcs.			Refrigerant properties color coding Value replaced formula Exceeds CARB-EPA limit, if any			Refrigerant properties color coding Value replaced formula		
	Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
▲	R-404A|R-407A	R-404A|R-407A		Carbon Dioxide (GWP=1	User Specified (GWP=)		None	None		1	0		1	150	
●	R-404A|R-407A	R-404A|R-407A		Propane (GWP=4)	User Specified (GWP=)		None	None		4	0		4	150	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

▲ **EXAMPLE LOW/MED TEMP SIDE:** Select “Carbon Dioxide” as the measure case refrigerant.

● **EXAMPLE HIGH TEMP SIDE:** Select “Propane” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** CARB limits for new refrigeration equipment, containing more than 50 lb. of refrigerant prohibits refrigerants with 150 GWP or greater. Without a standard practice case for refrigerant less than 150 GWP in supermarket systems, the user could default to the EPA limit by selecting “User Specified” and override the Std GWP column with 150.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

▲ ● **EXAMPLE BOTH:** This is an NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)			
Msr	Std	Pre Ext	Msr	Std	Pre Ext	
Refrigerant properties color coding			*Refrigerant properties color coding*			
Value replaced formula			Value replaced formula			
Device Builder value replaced						
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**	
0.00	0.00		835.00	1,392.00		▲
0.00	0.00		175.00	595.00		●

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

▲ ● **EXAMPLE BOTH:** In this example these are zero, because we will be inserting equipment-specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

▲ **EXAMPLE LOW/MED TEMP SIDE:** Custom refrigerant charge is specified for this measure. The standard case refrigerant charge is assumed to be 1,392 lb. However, this may differ depending on the actual refrigerant used. The measure case carbon dioxide system will require a refrigerant charge of 835 lb.

● **EXAMPLE HIGH TEMP SIDE:** Custom refrigerant charge is specified for this measure. The standard case refrigerant charge is assumed to be 595 lb. However, this may differ depending on the actual refrigerant used. The measure case propane system will require a refrigerant charge of 175 lb.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-3** and the total avoided cost in 2022 dollars for the medium/low-temperature side is $49,088.71, and the avoided cost for the high-temperature side is $20,901.62, for a combined avoided cost for the project of $69,990.33.

Table 4-3. User inputs for replacement with natural refrigerant system normal replacement measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Medium Refrigeration, 200-2,000 lb.., Commercial		
	TechTypeID	Ref_Storage:ReachIn		
	NormUnit	Each		
	CARB_DeviceType	Medium commercial refrigeration 200-2,000 lb.		
	Common Refrigerant Type(s)	R-404A|R-407A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	684		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	PG&E		
	Measure Description	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, medium/low temp. side		
	Msr Install Year	2024		
	MeasAppType	NR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Large retail food chain (≥20 stores)		
	CARB_End-Use	Retail Food Refrigeration (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Medium Refrigeration, 200-2,000 lb., Commercial		
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	Carbon Dioxide (GWP=1)	User Specified (GWP=)	NA
	GWP	Auto populated	150 (manual input)	NA
	Refrigerant Charge (lb/NormUnit)	835	1,392	NA
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		
	(Inputs for the high-temperature side that differ from the med/low-temperature side)			
2 RACC (High Temperature Side)	Measure Description	Replace with natural refrig. System: Medium cascade refrigeration system, 200-2,000 lb. charge, high temp. side		
	Refrigerant Type	Propane (GWP=4)	User Specified (GWP=)	NA
	GWP	Auto populated	150 (manual input)	NA
	Refrigerant Charge (lb/NormUnit)	175	595	NA

CASCADE RETAIL FOOD PARTIAL SYSTEM REPLACEMENT WITH HYBRID REFRIGERANT SYSTEM, >50 LB. CHARGE SYSTEMS

Measure description

For two-gas systems, instead of replacing both refrigerants with natural refrigerants, retail food facility owners may seek to replace only part of the system replacing one HFC refrigerant with a natural refrigerant. Retail food companies have CARB limits on their portfolio of stores, this may be an option to lower the weighted average GWP in an existing facility and mitigate the downtime by only replacing sections of the stores systems at a given time.

This example is a system replacement of the low/medium temperature side of a two-gas cascade system. The existing low/medium temperature system contains R-404A refrigerant and will be replaced with a subcritical CO_2 system which rejects heat to the existing high-temperature system with a R-407A refrigerant type. This example is only considering the replacement of the low/medium temperature side, while additional benefit could be gained by replacing the high-temperature system refrigerant, R-407A, with a drop-in gas replacement option such as R-448A or a natural refrigerant such as example measure described in Section 4.

The example presented in this section is for AR application type, where the existing equipment is replaced while still operable.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge will be used for this measure.

Input Worksheet: 1 Device Builder

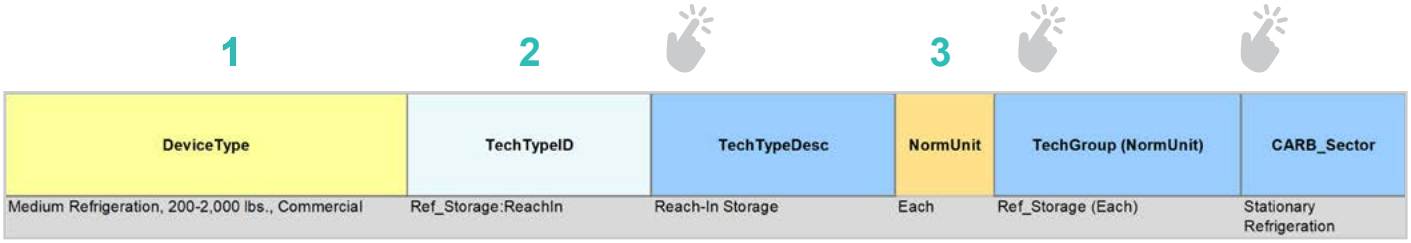
0 Refrig Research	**1 Device Builder**	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

Only a single device is required in the 1 Device Builder worksheet unless the charge size of the sides of the cascade refrigeration system fall into different CARB_DeviceType categories.

STEP 1 **Check to See if Desired Equipment is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

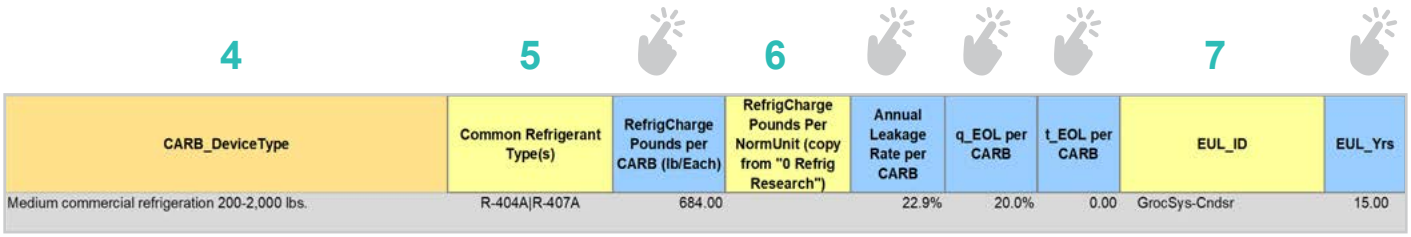
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: Medium Refrigeration, 200-2,000 lb., Commercial

2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: For this grocery store refrigeration system, we will use “Ref_Storage:ReachIn.”

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



4		5		6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Medium commercial refrigeration 200-2,000 lbs.	R-404A|R-407A	684.00		22.9%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above). Select the desired ***CARB_DeviceType*** from the dropdown menu.

EXAMPLE: "Medium commercial refrigeration 200-2,000 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

EXAMPLE: "R-404A|R-407A" for common refrigerants used in existing systems.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges will be entered in the 2 RACC worksheet.

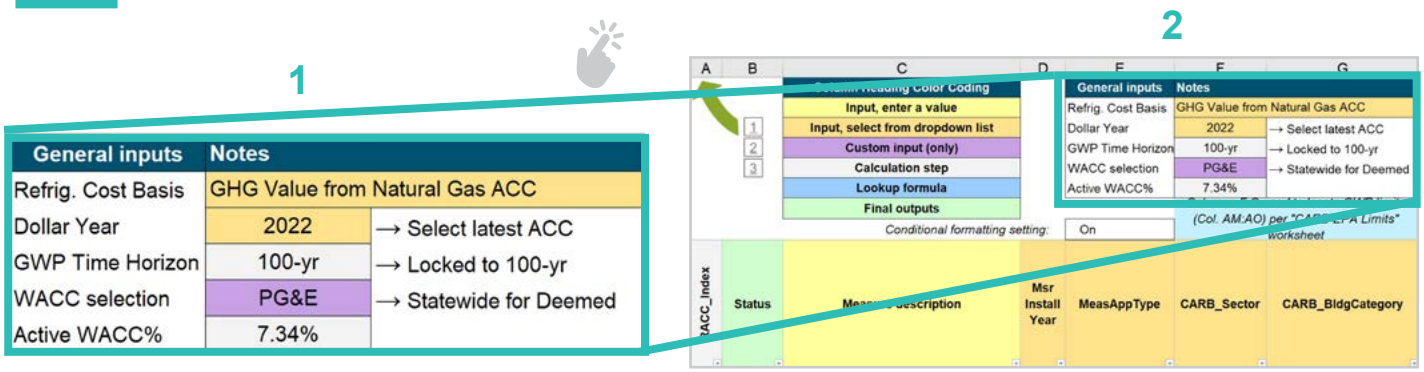
EXAMPLE: Leave this cell blank, since this measure is custom equipment-specific charge levels will be input in the 2 RACC worksheet.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: "GrocSys-Cndsr" is selected as the best choice of EUL for this refrigeration equipment.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: For this example, the custom project is within PG&E territory, so the WACC selection is "PG&E."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side	2025	AR	Stationary Refrigeration	Large retail food chain (≥20 stores)

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: AR (accelerated replacement). The existing equipment in this example would remain operation without program intervention.

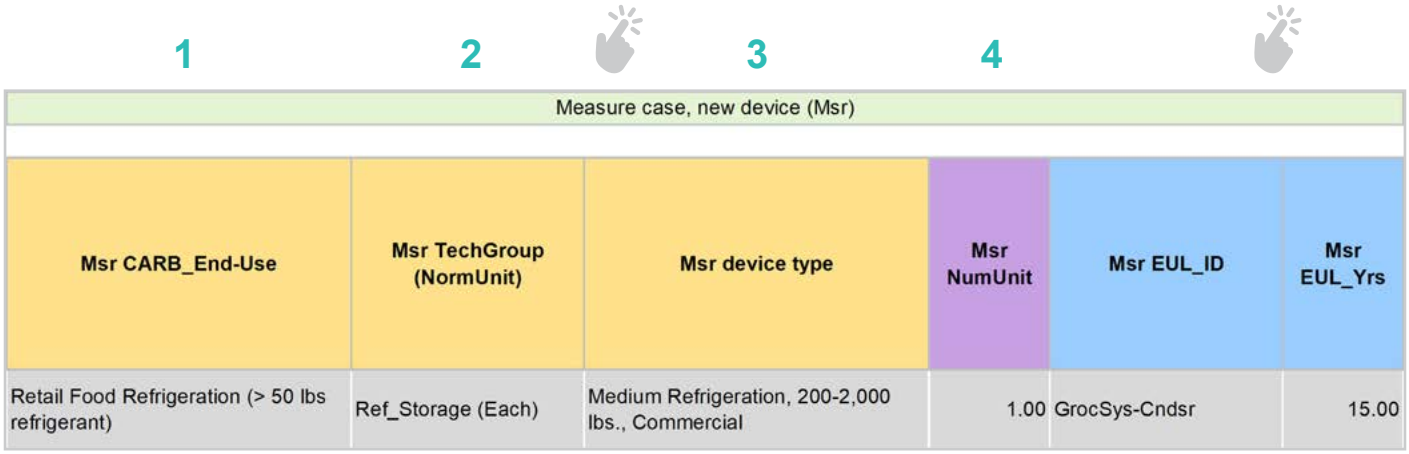
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: "Stationary Refrigeration"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE: "Large retail food chain (≥20 stores)"

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**



Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

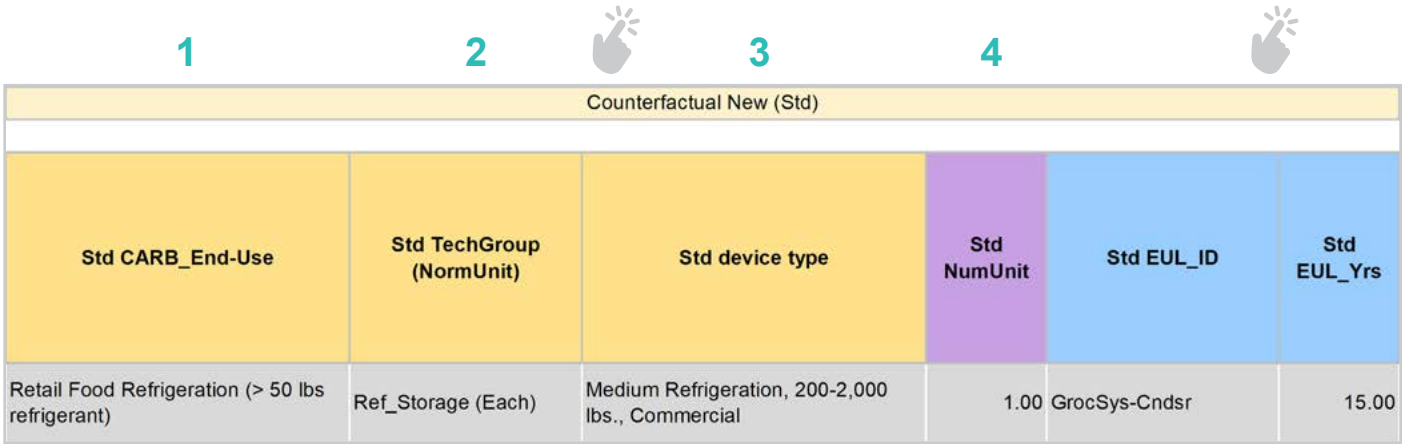
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, and Unit Quantity



1	2	3	4		
Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

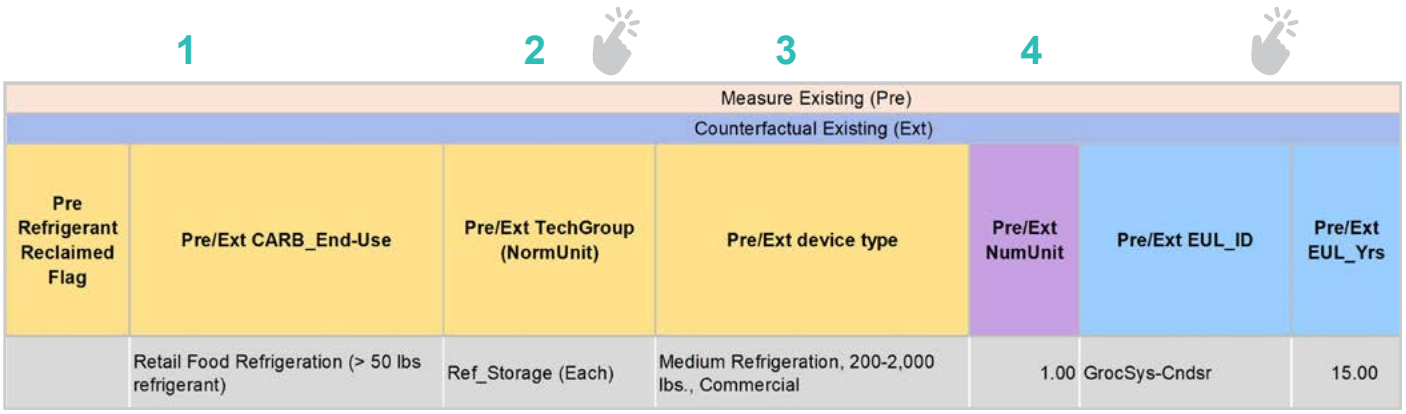
3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year



1		2	3	4		
Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

Note that the Pre/Existing Device input is only for AR measure applications.

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

5

5 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: The Pre/Ext Install Year is unchanged from the default year. This is appropriate for systems that may be older than the default DEER EUL for this equipment, but the owners will continue to maintain the equipment and keep it operational. Leaving this input the default, assumes the default 1/3 EUL for the RUL of the existing equipment.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
R-404A|R-407A	R-404A|R-407A	R-404A|R-407A	Carbon Dioxide (GWP=1	R-448A (GWP=1,386)	R-404A (GWP=3,922)	None	1,400	None	1	1,386	3,922	1	1,386	3,922

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: Select “Carbon Dioxide” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: Select “R-448A” as the standard case refrigerant. CARB requires new refrigeration equipment to have refrigerants with a GWP of 150 or less. California Code regulations define new refrigeration equipment as systems at a new facility or existing retail food facility that has replaced 75% or more of its evaporators and 100% of its compressor racks, condensers, and connected evaporator loads. This measure would not raise to the level of new refrigeration equipment. Our example measure assumes an R-448A refrigerant standard case since facility owner seeks to lower their store portfolio GWP below the 1,400 GWP limit for retail food chains.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: Select “R-404A” as the existing refrigerant.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.00	0.00	0.00	835.00	1,392.00	1,392.00

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example these are zero, because we will be inserting equipment specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** Custom refrigerant charge is specified for this measure. The pre/existing case R-404A refrigerant charge is 1,392 lb., based on product specification. The standard case R-448A refrigerant charge is assumed to be 1,392 lb. The measure case carbon dioxide system will require a refrigerant charge of 835 lb.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-4** and the total avoided cost in 2022 dollars is $754,832.17.

Table 4-4. User inputs for replacement with hybrid refrigerant system accelerated replacement measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Medium Refrigeration, 200-2,000 lb., Commercial		
	TechTypeID	Ref_Storage:ReachIn		
	NormUnit	Each		
	CARB_DeviceType	Medium commercial refrigeration 200-2,000 lb.		
	Common Refrigerant Type(s)	R-404A|R-407A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	684		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	PG&E		
	Measure Description	Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side		
	Msr Install Year	2025		
	MeasAppType	AR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Large retail food chain (≥20 stores)		
	CARB_End-Use	Retail Food Refrigeration (> 50 lbs. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Medium Refrigeration, 200-2,000 lbs., Commercial		
	Pre/Ext Install Year	NA	NA	2015 (auto populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	Carbon Dioxide (GWP=1)	R-448A (GWP=1,386)	R-404A (GWP=3,922)
	GWP	Auto populated		
	Refrigerant Charge (lb/NormUnit)	835	1,392	1,392
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

CASCADE RETAIL FOOD PARTIAL SYSTEM REPLACEMENT WITH HYBRID REFRIGERANT, >50 LB. CHARGE SYSTEMS

Measure description

For two-gas systems, instead of replacing both refrigerants with natural refrigerants, retail food facility owners may seek to replace only part of the system replacing one HFC refrigerant with a natural refrigerant. Retail food companies have CARB limits on their portfolio of stores, this may be an option to lower the weighted average GWP in an existing facility and mitigate the downtime by only replacing sections of the stores systems at a given time.

The system new system will be a subcritical CO_2 system which rejects heat to the existing high-temperature system with a R-407A refrigerant type. This example is only considering the replacement of the low/medium temperature side, while additional benefit could be gained by replacing the high-temperature system refrigerant, R-407A, with a drop-in gas replacement option such as R-448A or a natural refrigerant such as example measure described in Section 4.

This example is for an NR scenario, where the existing low/medium temperature system has either failed or is no longer meeting the capacity needs of the facility.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge will be used for this measure.

Input Worksheet: 1 Device Builder

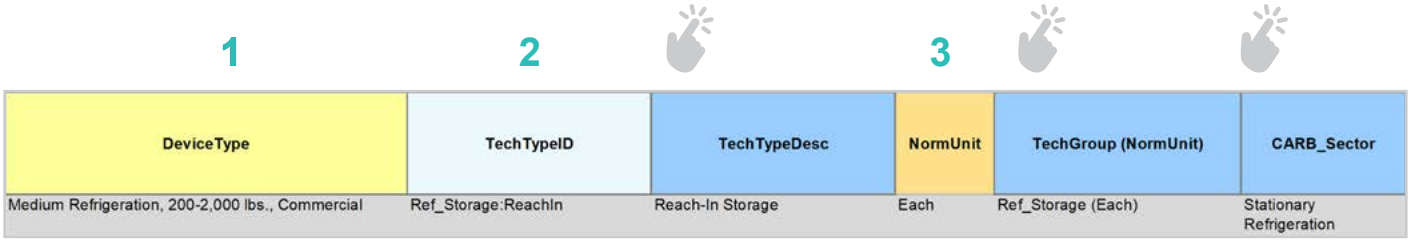
0 Refrig Research	**1 Device Builder**	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

Only a single device is required in the 1 Device Builder worksheet unless the charge size of the sides of the cascade refrigeration system fall into different CARB_DeviceType categories.

STEP 1 **Check to See if Desired Equipment is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

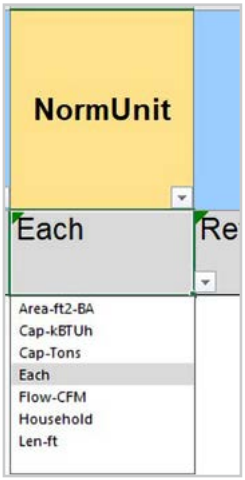
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: Medium Refrigeration, 200-2,000 lb., Commercial

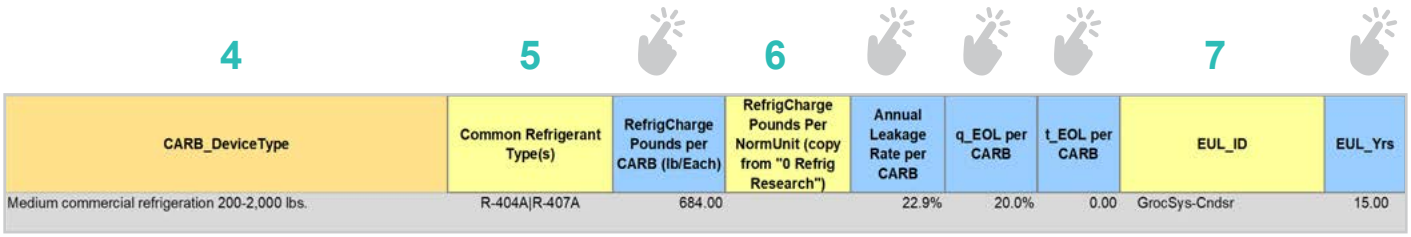
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: For this grocery store refrigeration system, we will use “Ref_Storage:ReachIn.”

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4		5		6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Medium commercial refrigeration 200-2,000 lbs.	R-404A|R-407A	684.00		22.9%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above).

- Select the desired ***CARB_DeviceType*** from the dropdown menu.

  EXAMPLE: "Medium commercial refrigeration 200-2,000 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

  EXAMPLE: R-404A|R-407A for common refrigerants used in existing systems

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges will be entered in the 2 RACC worksheet.

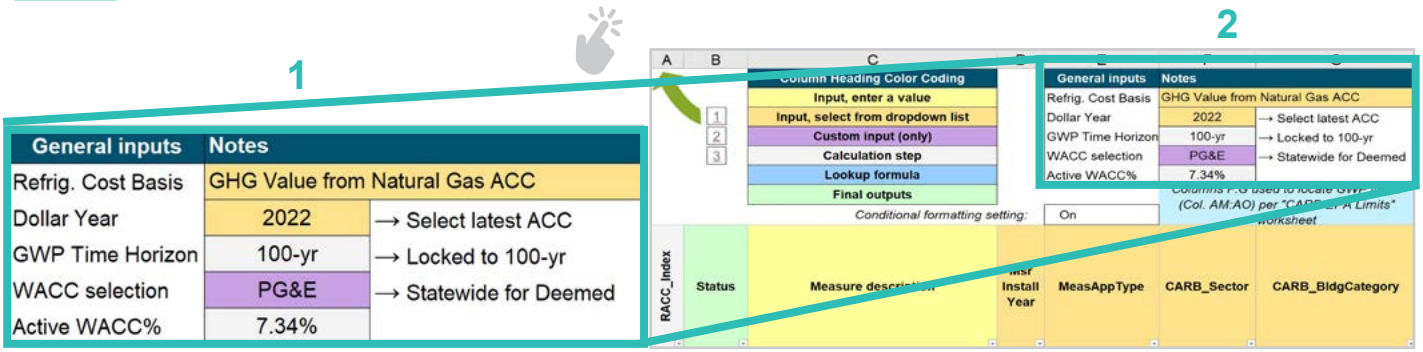
  EXAMPLE: Leave this cell blank, since this measure is custom equipment-specific charge levels will be input in the 2 RACC worksheet.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: "GrocSys-Cndsr" is selected as the best choice of EUL for this refrigeration equipment.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: For this example, the custom project is within PG&E territory, so the WACC selection is "PG&E."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side	2025	NR	Stationary Refrigeration	Large retail food chain (≥20 stores)

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: NR (normal replacement). The existing equipment has failed or will no longer meet facility requirements and will need to be replaced with a new system.

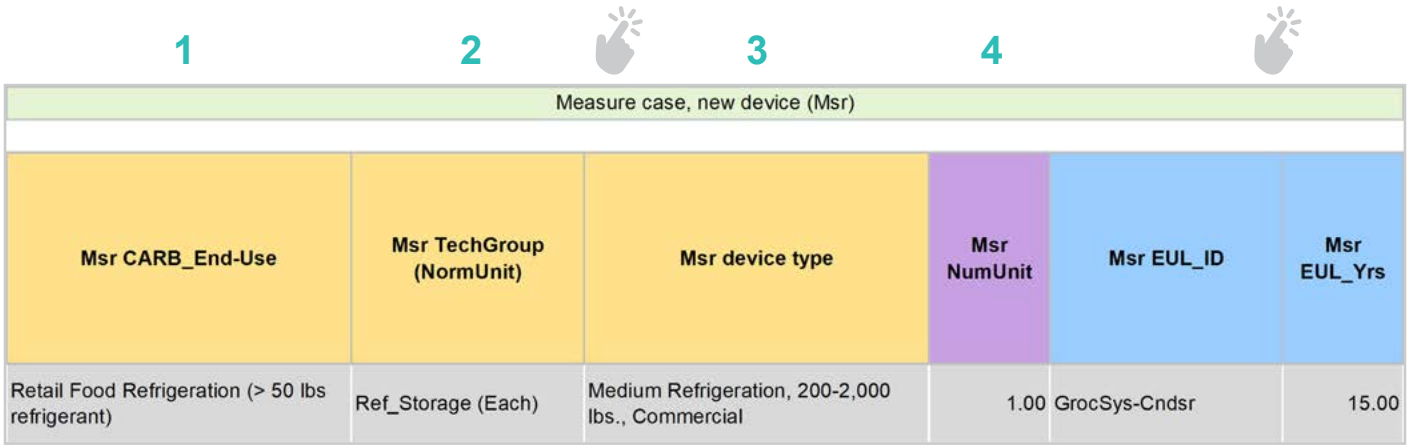
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: "Stationary Refrigeration"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the me**asure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.**

EXAMPLE: "Large retail food chain (≥20 stores)"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity



Measure case, new device (Msr)					
Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

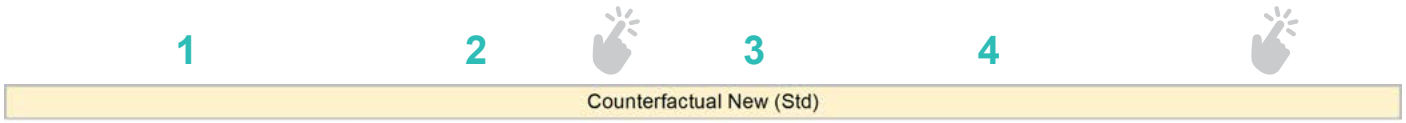
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
Retail Food Refrigeration (> 50 lbs refrigerant)	Ref_Storage (Each)	Medium Refrigeration, 200-2,000 lbs., Commercial	1.00	GrocSys-Cndsr	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the "Medium Refrigeration, 200-2,000 lb., Commercial" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
R-404A|R-407A	R-404A|R-407A		Carbon Dioxide (GWP=1	R-448A (GWP=1,386)		None	None		1	1,386		1	1,386	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: "Carbon Dioxide"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: Select "R-448A" as the standard case refrigerant. CARB requires new refrigeration equipment to have refrigerants with a GWP of 150 or less. California Code regulations define new refrigeration equipment as systems at a new facility or existing retail food facility that has replaced 75% or more of its evaporators and 100% of its compressor racks, condensers, and connected evaporator loads. This measure would not raise to the level of new refrigeration equipment. Our example measure assumes an R-448A refrigerant standard case since facility owners seek to lower their store portfolio GWP below the 1,400 GWP limit for retail food chains.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is a NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.00	0.00		835.00	1,392.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example, these are zero, because we will be inserting equipment specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** Custom refrigerant charge is specified for this measure. The standard case R-448A refrigerant charge is assumed to be 1,392 lb. The measure case carbon dioxide system will require a refrigerant charge of 835 lb.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-5** and the total avoided cost in 2022 dollars is $479,877.43.

Table 4-5. User inputs for replacement with hybrid refrigerant system natural replacement measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Medium Refrigeration, 200-2,000 lb., Commercial		
	TechTypeID	Ref_Storage:ReachIn		
	NormUnit	Each		
	CARB_DeviceType	Medium commercial refrigeration 200-2,000 lb.		
	Common Refrigerant Type(s)	R-404A|R-407A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	684		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	PG&E		
	Measure Description	Replace with hybrid system: Medium cascade system, 200-2,000 lb. charge, medium/low temp. side		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Large retail food chain (≥20 stores)		
	CARB_End-Use	Retail Food Refrigeration (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Medium Refrigeration, 200-2,000 lb., Commercial		
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	Carbon Dioxide (GWP=1)	R-448A (GWP=1,386)	NA
	GWP	Auto populated		
	Refrigerant Charge (lb/NormUnit)	835	1,392	NA
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

COMMERCIAL ICE MACHINES

For ice machines, there is no current CARB regulation in place, but EPA has established restrictions about prohibited HFCs or GWP limit and corresponding compliance dates. EPA has listed two main categories of ice machines: 1) self-contained automatic and 2) remote automatic ice machines. For self-contained ice machines, the EPA final rule in 2023 restricts the manufacture and import compliance date starting from January 1, 2026, or January 1, 2027, according to the harvest rate of the machine. For remote ice machines, the EPA final rule in 2023 lists prohibited refrigerants starting from January 1, 2027. The following sections will present examples for each category.

Small ice machines, self-contained

For batch-type ice machines with a harvest rate of up to 1,000 lb. per day and continuous-type machines with a rate of up to 1200 lb. per day, the EPA will restrict their manufacture and import beginning January 1, 2026. After this date, the GWP limit for these machines will be capped at 150.

Based on our findings on ENERGY STAR-rated small commercial ice machines, propane is the dominant alternative low-GWP refrigerant, suggesting that new small ice machines with low GWP refrigerants are likely to be charged with propane, whose 100-year GWP is only 3. Therefore, we think it would be an industry standard practice (ISP) to charge small ice machines with propane or other natural refrigerants like isobutane in the future. This foreseeable ISP will lead to negligible avoided emissions for small ice machines since the standard practice devices barely have any emissions. Therefore, there is no example presented.

Ice machines, self-contained

For batch-type ice machines with a harvest rate more than 1,000 lb. per day and continuous-type machines with a rate more than 1,200 lb. per day, the EPA will restrict their manufacture and import beginning January 1, 2027. After this date, a list of refrigerants is prohibited. Therefore, if a project takes place before 2027, it does not need to conform to the regulation. The first example under this equipment type will be replacing a failed/retired ice machine containing R-404A with a new one charged with CO_2 before 2027.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This tab needs to be filled out if this is a deemed measure based on research. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge is likely to be used for this measure. However, for the purposes of this example we will be using CARB average refrigerant charge based on the CARB_DeviceType.

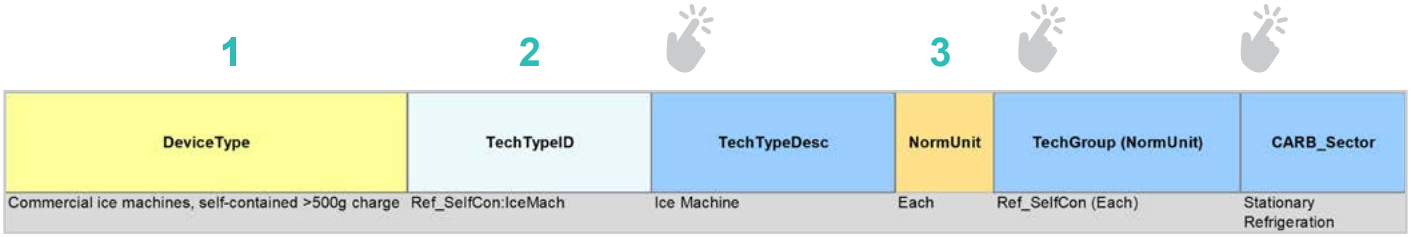
Input Worksheet: 1 Device Builder

0 Refrig Research	**1 Device Builder**	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to See if Commercial Ice Machines, Self-Contained (> 500g Charge) Equipment is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

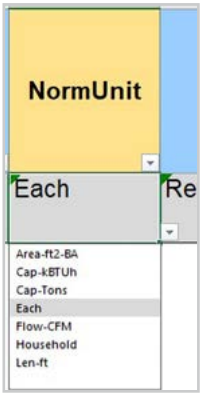
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: We entered “Commercial ice machines, self-contained > 500g charge.”

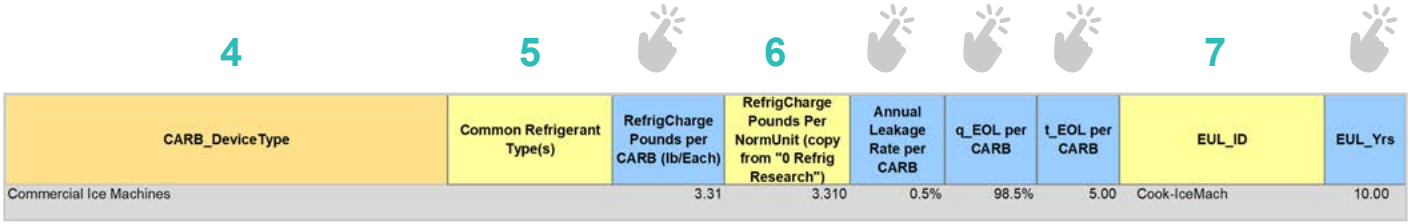
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: For commercial ice machines, we will use “Ref_SelfCon:IceMach.”

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above). Select the desired ***CARB_DeviceType*** from the dropdown menu.

EXAMPLE: "Commercial Ice Machines"

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

EXAMPLE: CARB estimates an average charge of 3.31 lb. of refrigerant for the "Commercial Ice Machines."

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges need to be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC worksheet, there is no need to enter the charge size values.

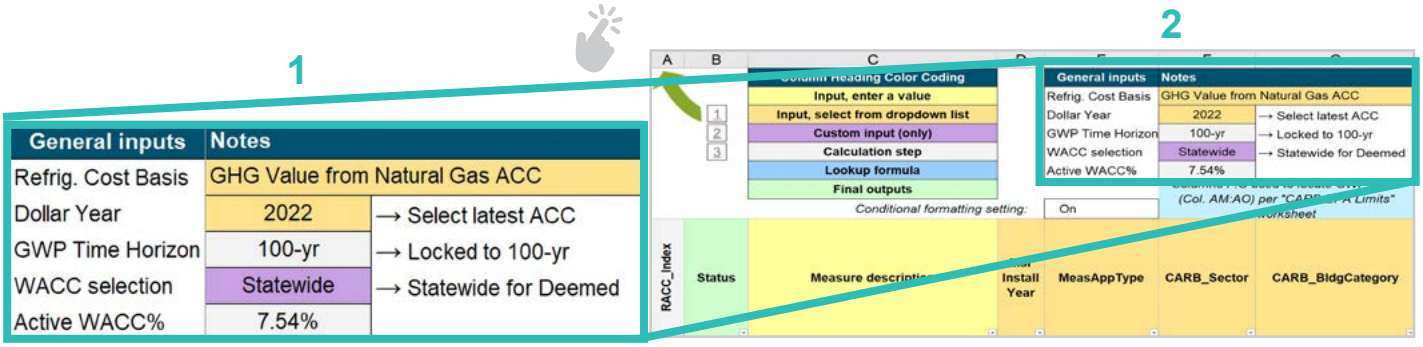
EXAMPLE: For this example, we are using the CARB default charge size for commercial ice machines. We input 3.31 lb. of refrigerant charge. This example uses the CARB referenced average charge.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: The EUL_ID selected for this example is "Cook-IceMach" as the best choice of EUL for the commercial ice machine.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: The example chooses “Statewide” for WACC selection since the example project is among dozens of projects across the state of California.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is “GHG Value from Natural Gas ACC.”

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure Description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Commercial Ice machine, self-contained >500g charge, replacement before 2025	2024	NR	Stationary Refrigeration	Unregulated

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Commercial Ice machine, self-contained >500g charge, replacement before 2025"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2024 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: NR (normal replacement) was selected for this replacement measure. The replacement of a commercial ice machine at the end of its life after equipment failure is a more likely scenario than accelerated replacement.

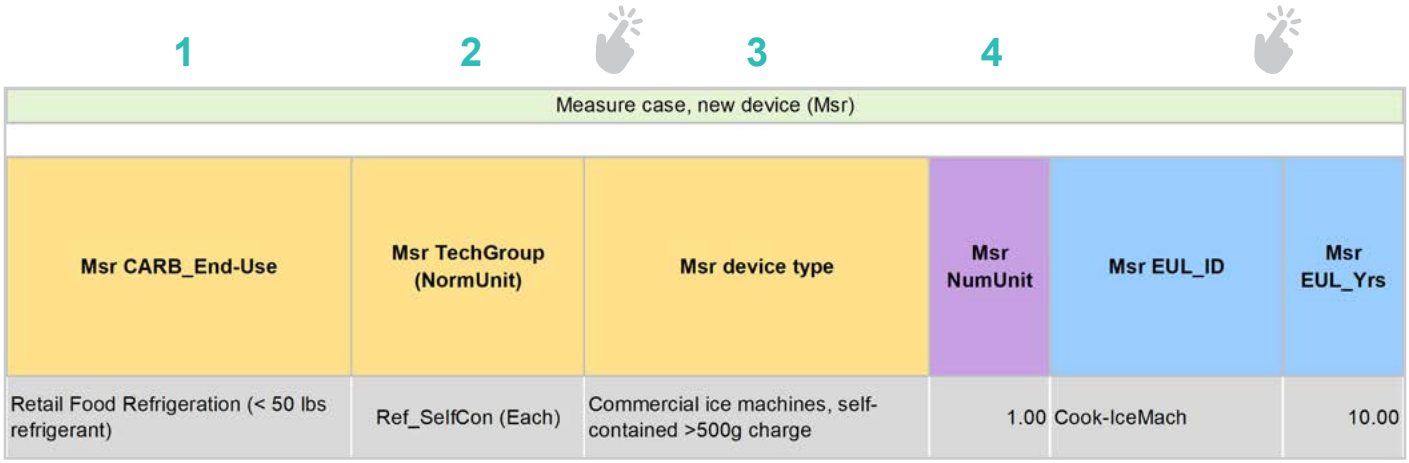
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: The CARB_Sector for this example is defined as "Stationary Refrigeration" in the 1 Device Builder worksheet.

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE: "Unregulated" was selected for this measure example. CARB and EPA refrigeration regulation specific to commercial ice machines are not built into the RACC at this time. So, users can select the most appropriate categories or select "Unregulated" and make sure the refrigerant and GWP inputs follow any appropriate regulations. A summary of CARB and EPA regulations is listed in Section 3.

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity



1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (< 50 lb. refrigerant)" was selected for this measure example.

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet. was given a TechGroup (NormUnit) parameter of "Ref_SelfCon (Each)." This represents a Tech Group of "Ref_SelfCon," and a normalizing unit of "Each."

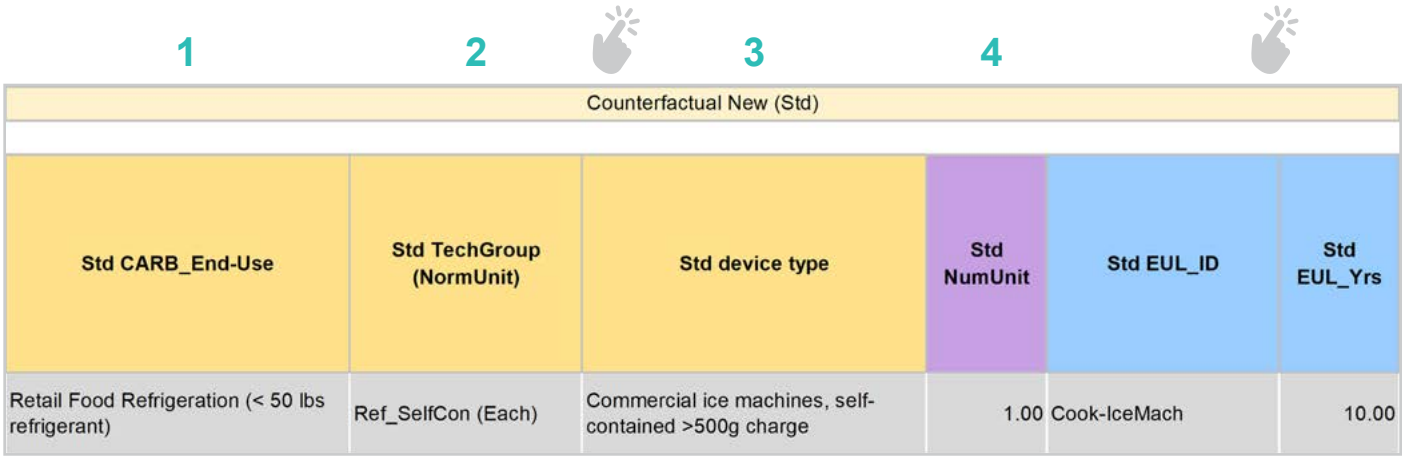
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Commercial ice machines, self-contained > 500g charge" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 **Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity**



1	2	3	4		
Counterfactual New (Std)					
Std CARB_End-Use	**Std TechGroup (NormUnit)**	**Std device type**	**Std NumUnit**	**Std EUL_ID**	**Std EUL_Yrs**
Retail Food Refrigeration (< 50 lbs refrigerant)	Ref_SelfCon (Each)	Commercial ice machines, self-contained >500g charge	1.00	Cook-IceMach	10.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (< 50 lb. refrigerant)" was selected for this measure example.

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_SelfCon (Each)." This represents a Tech Group of "Ref_SelfCon," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the same as the measure case device, "Commercial ice machines, self-contained > 500g charge."

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

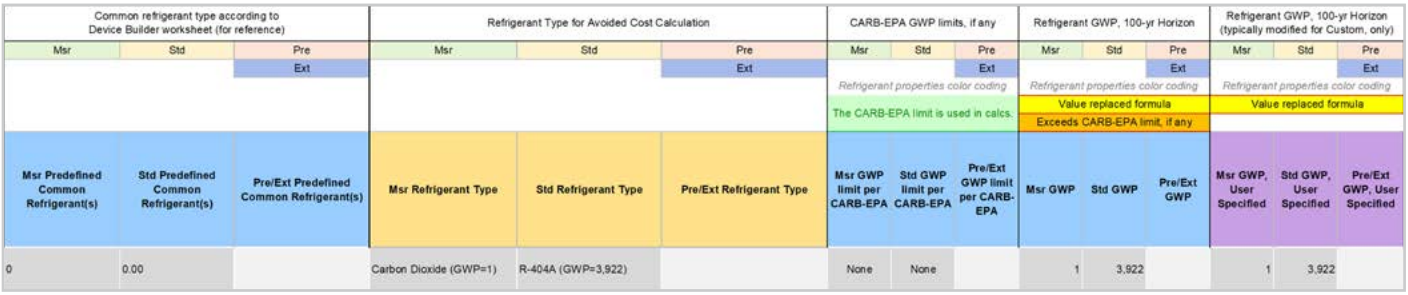
EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3



Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			Refrigerant properties color coding Value replaced formula Exceeds CARB-EPA limit, if any			Refrigerant properties color coding Value replaced formula		
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
0	0.00		Carbon Dioxide (GWP=1)	R-404A (GWP=3,922)		None	None		1	3,922		1	3,922	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For equipment replacement measure select “Carbon Dioxide” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For this measure select “R-404A,” which is the same as the existing device and it is still acceptable before 2027.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is an NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
3.31	3.31		3.31	3.31	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

EXAMPLE: In this example, the charge size and leakage rate are defaulted to the CARB average. Users can specify those values with evidence or audit values supporting user-specified inputs.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-6** and the total avoided cost in 2022 dollars are $838.82.

Table 4-6. User inputs for commercial ice machine measure example

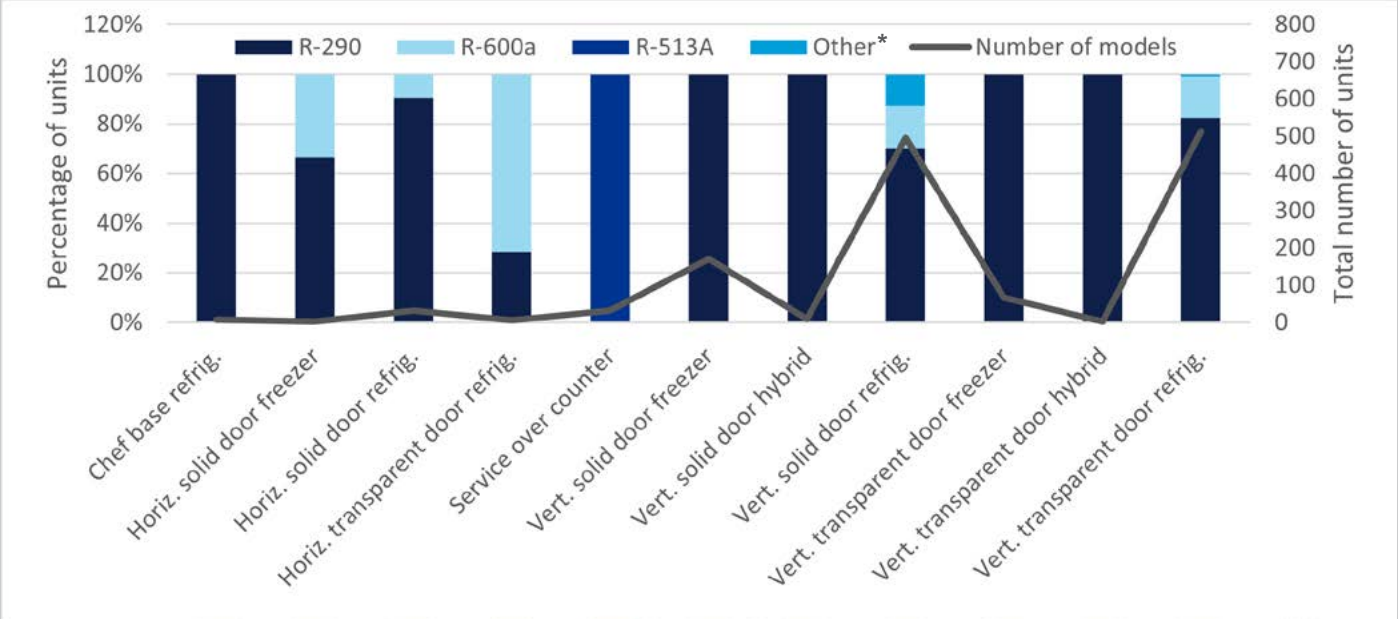
Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Commercial ice machines, self-contained >500g charge		
	TechTypeID	Ref_SelfCon:IceMach		
	NormUnit	Each		
	CARB_DeviceType	Commercial Ice Machines		
	Common Refrigerant Type(s)	Optional input for reference only		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.31		
	EUL_ID	Cook-IceMach		
2 RACC (Medium/Low-Temperature Side)	WACC selection	Statewide		
	Measure Description	Commercial Ice machine, self-contained >500g charge, replacement before 2025		
	Msr Install Year	2024		
	MeasAppType	NR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Unregulated		
	CARB_End-Use	Retail Food Refrigeration (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_SelfCon (Each)		
	Device type	Commercial ice machines, self-contained >500g charge		
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	Carbon Dioxide (GWP=1)	R-404A (GWP=3,922)	NA
	GWP	Auto populated		
	Refrigerant Charge (lb/NormUnit)	Auto populated		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

STAND-ALONE UNITS

Stand-alone units considered in this guidance document include commercial refrigerators, freezers, and reach-in coolers where all refrigeration components are integrated and fully charged at the factor and typically only require an electricity supply to begin operation. For stand-alone units, CARB provides a list of refrigerants prohibited for new units as well as refrigerant gas retrofits. However, EPA has established a GWP limit of 150 for the sale and distribution of new retail food refrigeration stand-alone units, effective January 1, 2025.

Based on our review of the ENERGY STAR certified products list, propane (R-290) and isobutane (R-600a) are the dominate alternative low-GWP refrigerant for almost all types of stand-alone units, suggesting that new stand-alone units with low-GWP are likely be charged with R-290 or R-600a, whose 100-year GWP is 4 for R-290 and 2 for R-600a. The only exception is service over counter units which are dominated by R-513A. **Figure 4-1** below presents an overview of the refrigerant used in ENERGY STAR certified stand-alone units.

Figure 4-1. Overview of Refrigerant Used in Energy Star Certified Stand-Alone Refrigeration Equipment



*Other includes units charged with R-134a, R-448A, R-449A, and R-450A refrigerant.

Because of the EPA requirement on the sale and distribution of new stand-alone units to have a GWP of 150 starting in 2025, we think it would be an ISP to charge stand-alone units with R-290 or R-600a in the future. It is possible that other alternative refrigerants could become available in stand-alone units, such as HFO blends or other A2L classified refrigerants. However, at this time the foreseeable ISP will lead to almost no avoided emissions for stand-alone units since the stand-alone unit market appears to be transitioning toward a R-290 and R-600a ISP. Therefore, there is no example presented.

REFRIGERATED FOOD PROCESSING AND DISPENSING EQUIPMENT

Measure description

Refrigerated food processing and dispensing equipment in this guidance document include but are not limited to chilled and frozen beverages (carbonated and non-carbonated, alcoholic and non-alcoholic); frozen custards, gelato, ice cream, Italian ice, sorbets, and yogurts; milkshakes, “slushies” and smoothies, and whipped cream. For equipment within this end-use category, CARB provides a list of refrigerants prohibited for new or retrofit units starting January 1, 2019. Meanwhile, EPA’s final rule in 2023 restricted the manufacture and import compliance data and installation date depending on the device type and refrigerant charge size for refrigerated food processing and dispensing equipment. The EPA’s 2023 final rule established a 150 GWP cap for manufacture and import of equipment with no more than 500g charge of refrigerant and outside scope of UL621 edition 7 starting January 1, 2027. For other self-contained units, the rule restricted the manufacture and import of equipment charged with certain refrigerants. For remote equipment, the final rule restricted the installation of devices charged with certain refrigerants starting January 1, 2027.

After we examined the prevailing manufactured products, we found that there is no distinct trend in the market’s pursuit of alternative low-GWP refrigerants. We have found that R-404A, R-134a, and R-448A are the predominant refrigerants in use but use of R-404A and R-134a will not meet the EPA’s final rule and R-448A will not be allowed in equipment with less than 500 charge. In the example below, we will model replacing a retired/failed self-contained equipment with more than 500g charge in 2025 with equipment containing CO2 refrigerant. As of 2025, the EPA’s final rule is not in effect yet. The use of R-404A is prohibited by CARB in new refrigerated food processing and dispensing units stating January 1, 2021. Therefore, for the new equipment installed in 2025 example below, the baseline will be R-134a.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This tab needs to be filled out if this is a deemed measure based on research. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge is likely to be used for this measure. However, for the purposes of this example we will be using CARB average refrigerant charge based on the CARB_DeviceType.

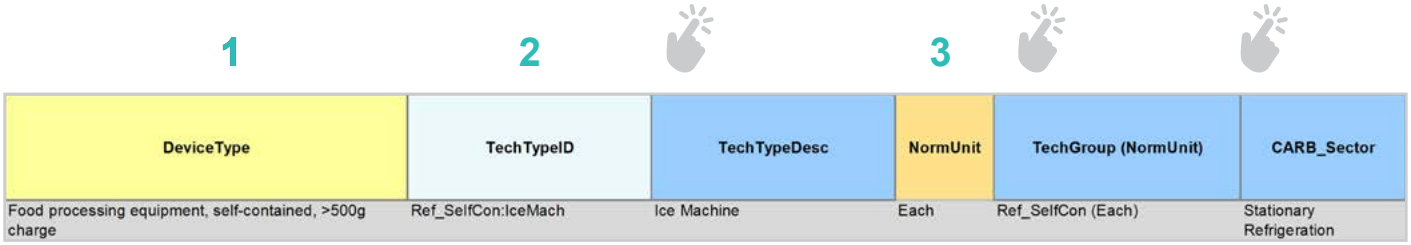
Input Worksheet: 1 Device Builder

0 Refrig Research	**1 Device Builder**	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to See if Food Processing Equipment, Self-Contained (> 500g Charge) is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

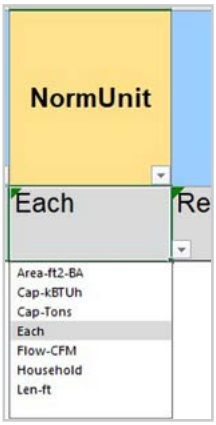
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: "Food processing equipment, self-contained, >500g charge"

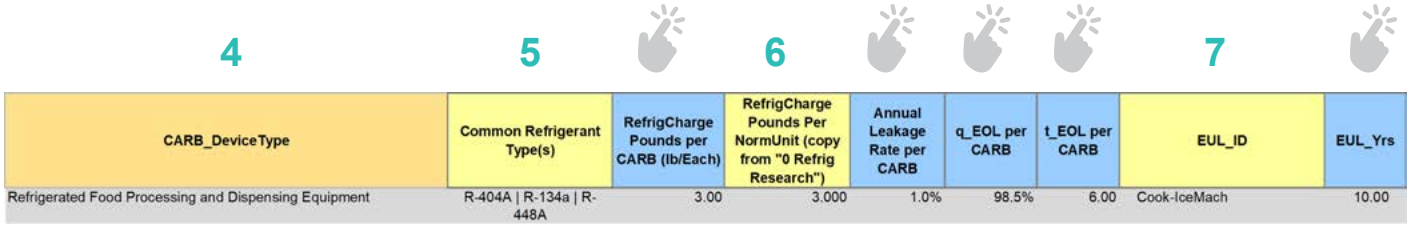
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: For this food processing and dispensing unit, we will use "Ref_SelfCon:IceMach," which is the nearest option the in TechTypeID options.

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4	5		6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Refrigerated Food Processing and Dispensing Equipment	R-404A | R-134a | R-448A	3.00	3.000	1.0%	98.5%	6.00	Cook-IceMach	10.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above).

- Select the desired ***CARB_DeviceType*** from the dropdown menu.

  EXAMPLE: "Refrigerated Food Processing and Dispensing Equipment"

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

  EXAMPLE: "R-404A | R-134a | R-448A" for common refrigerants used in existing systems.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges need to be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC worksheet, there is no need to enter the charge size values.

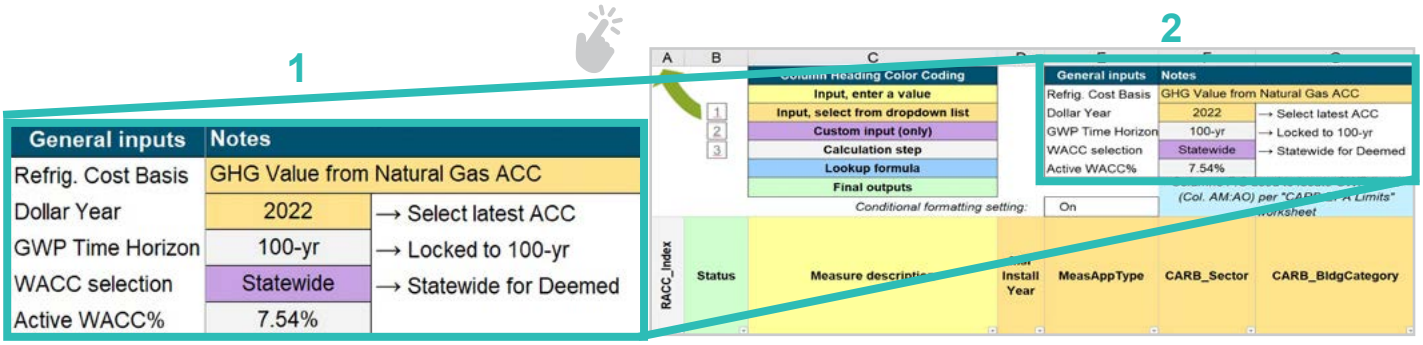
  EXAMPLE: For this example, we are using the CARB default charge size for Refrigerated Food Processing and Dispensing Equipment. Input 3.0 lb. of refrigerant charge. This example is using the CARB referenced average charge.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

  EXAMPLE: The EUL_ID selected for this example is "Cook-IceMach" as the best choice of EUL for the commercial ice machine.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: The example chooses "Statewide" for WACC selection since the example project is among dozens of projects across the state of California.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
food processing unit, replacement, self-contained >500g charge	2025	NR	Stationary Refrigeration	Retail food facility

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Food processing unit, replacement, self-contained >500g charge"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: NR (normal replacement) was selected for this measure. The existing equipment no longer operational and will be replaced with new equipment.

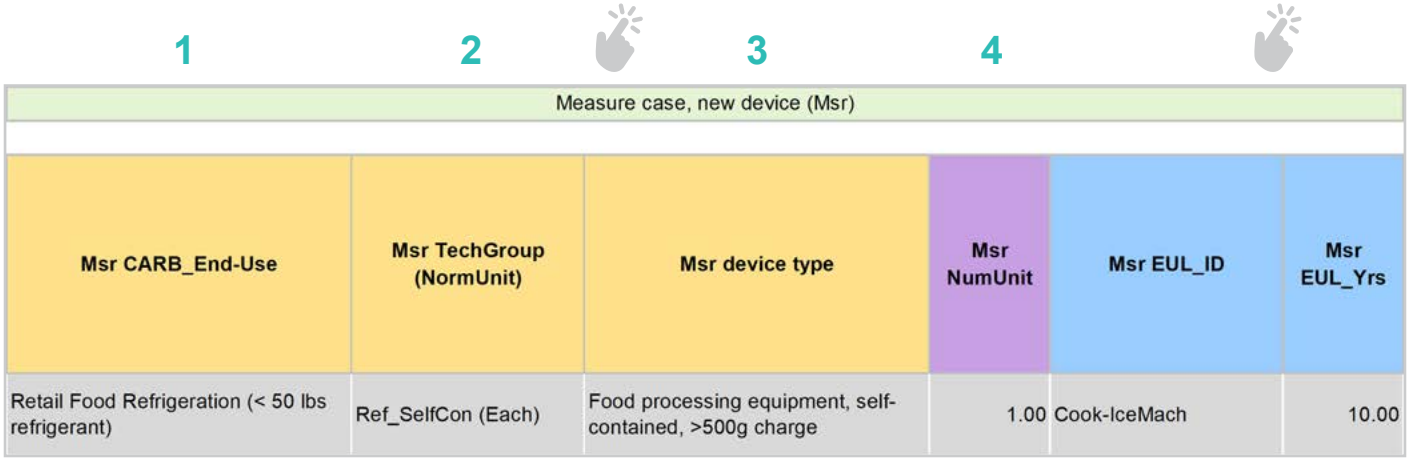
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: The CARB_Sector for this example is defined as "Stationary Refrigeration" in the 1 Device Builder worksheet.

5 Select CARB_BldgCategory from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference. There is no active CARB GWP limits for food processing and dispensing units, but CARB prohibits the use of certain refrigerants in new units starting January 1, 2021.

EXAMPLE: "Retail food facility" was selected for this measure example.

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**



1	2	3	4

Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Retail Food Refrigeration (< 50 lbs refrigerant)	Ref_SelfCon (Each)	Food processing equipment, self-contained, >500g charge	1.00	Cook-IceMach	10.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (< 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_SelfCon (Each)." This represents a Tech Group of "Ref_SelfCon," and a normalizing unit of "Each."

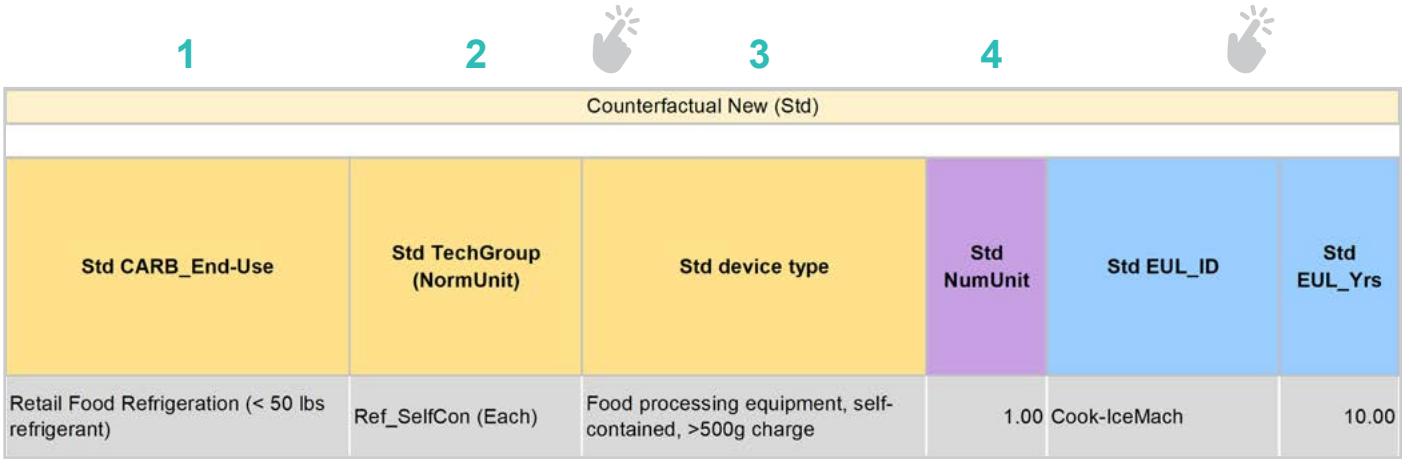
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Food processing equipment, self-contained, >500g charge" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type, and Unit Quantity



1	2	3	4

Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
Retail Food Refrigeration (< 50 lbs refrigerant)	Ref_SelfCon (Each)	Food processing equipment, self-contained, >500g charge	1.00	Cook-IceMach	10.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Retail Food Refrigeration (< 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_SelfCon (Each)." This represents a Tech Group of "Ref_SelfCon," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the same as the measure case device, "Food processing equipment, self-contained, >500g charge."

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
R-404A | R-134a | R-448A	R-404A | R-134a | R-448A		Carbon Dioxide (GWP=1)	HFC-134a (GWP=1,430)		None	None		1	1,430		1	1,430	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: "Carbon Dioxide"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: "HFC-134a," which is the same as the existing device and it is still acceptable before 2027.

NOTE: As for CARB requirements, the company owning the facility is an independent small business with refrigeration equipment containing a refrigerant charge of 50 lb. or less. CARB does not have an active regulation on such business for the refrigerant GWP cap.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is a NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
3.00	3.00		3.00	3.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

EXAMPLE: In this example, the charge size and leakage rate are defaulted to the CARB average. Users can specify those values with evidence or audit values supporting user-specified inputs.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-7** and the total avoided cost in 2022 dollars are $296.61.

Table 4-7. User inputs for refrigerated food processing and dispensing equipment measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Food processing equipment, self-contained, >500g charge		
	TechTypeID	Ref_SelfCon:IceMach		
	NormUnit	Each		
	CARB_DeviceType	Refrigerated Food Processing and Dispensing Equipment		
	Common Refrigerant Type(s)	R-404A	R-134a	R-448A
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.00		
	EUL_ID	Cook-IceMach		
2 RACC (Medium/Low-Temperature Side)	WACC selection	Statewide		
	Measure Description	Food processing unit, replacement, self-contained >500g charge		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Retail food facility		
	CARB_End-Use	Retail Food Refrigeration (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_SelfCon (Each)		
	Device type	Food processing equipment, self-contained, >500g charge		
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	Carbon Dioxide (GWP=1)	HFC-134a (GWP=1,430)	NA
	GWP	Auto populated		
	Refrigerant Charge (lb/NormUnit)	Auto populated		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

COLD STORAGE WAREHOUSE SYSTEM, 50-200 LB. (AR)

Measure description

Cold storage warehouse refrigeration includes systems installed at a refrigerated facility or warehouse used for the storage of temperature-controlled substances. Current CARB regulations on new systems within existing cold storage warehouse facilities prohibit a variety of high-GWP refrigerants (see Table 3-2), while new systems containing more than 50 lb. of refrigerant within new cold storage warehouse facilities are required to have a GWP less than 150 as of January 1, 2022.

EPA regulations differ for cold storage warehouse systems, in that starting on January 1, 2026, new systems with more than 200 lb. of refrigerant charge must have a GWP less than 150, new systems with less than 200 lb. of refrigerant must have a GWP less than 300, and the high temperature side of a new cascade system must have a GWP of less than 300. For self-contained cold storage warehouse products, the EPA final rule in 2023 restricted the manufacture and import compliance data starting January 1, 2026, for the three categories above.

Most large cold storage systems and facilities utilize ammonia refrigerant, which has a GWP of 0. Therefore, this example is a system replacement for a small cold storage refrigeration system using R-404A with charge of 150 lb. to a CO_2 (R-744) transcritical system with 90 lb. of refrigerant in 2025.

This example is for an AR cold storage measure. For refrigeration systems of cold storage warehouse with less than 200 lb. charge, the CARB lists a list of prohibited refrigerants in new systems in existing facilities starting January 1, 2023; EPA's 2023 final rule established a 300 GWP limit to cold storage warehouse system starting January 1, 2026. Therefore, if the counterfactual new equipment will be installed after January 1, 2026. The GWP cap will be 300 as the baseline GWP cap for the counterfactual.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This tab needs to be filled out if this is a deemed measure based on research. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge is likely to be used for this measure. However, for the purposes of this example we will be using CARB average refrigerant charge based on the CARB_DeviceType.

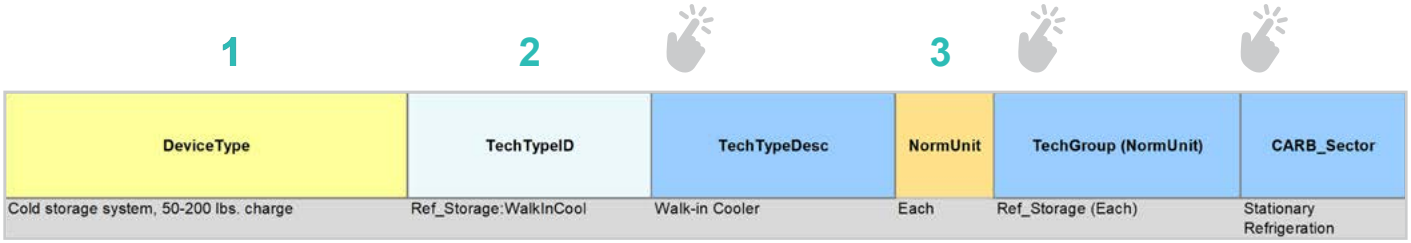
Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to See if Cold Storage System, 50-200 lb. Charge is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

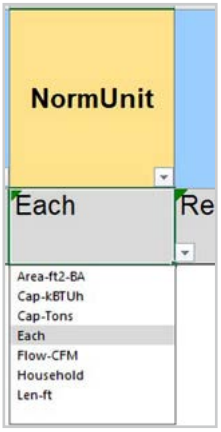
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: "Cold storage system, 50-200 lb. charge"

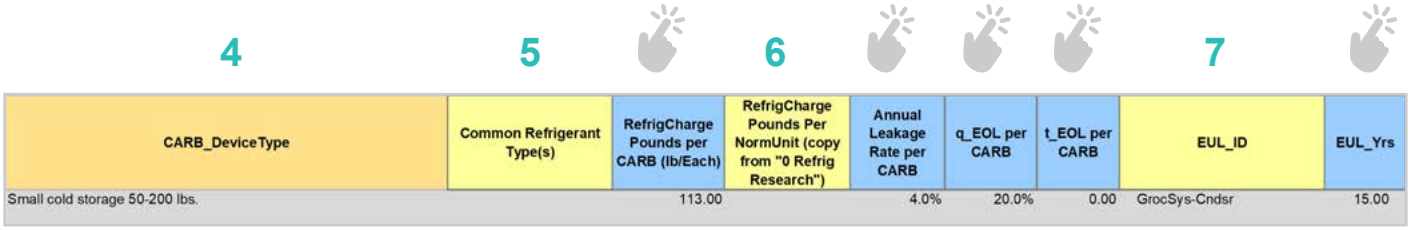
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: "Ref_Storage:WalkInCool"

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4	5		6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Small cold storage 50-200 lbs.		113.00		4.0%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above). Select the desired ***CARB_DeviceType*** from the dropdown menu.

EXAMPLE: "Small cold storage 50-200 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

EXAMPLE: "R-404A | R-134a | R-448A" for common refrigerants used in existing systems.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges need to be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC **worksheet, there is no need to enter the charge size values.**

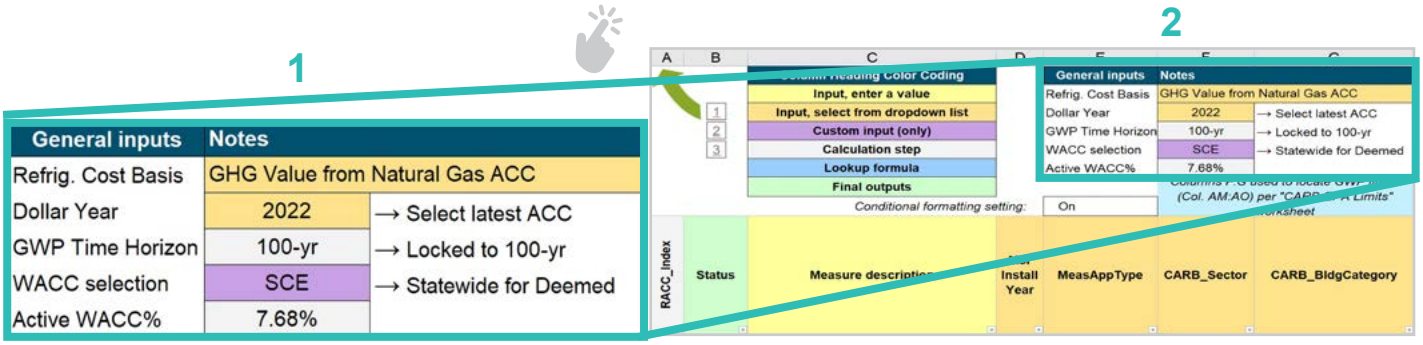
EXAMPLE: For this example, we will be using customer charge size for the small cold storage system in 2 RACC: 150 lb. for existing system and 90 lb. for the new system.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: The EUL_ID selected for this example is "GrocSys-Cndsr" as the best choice of EUL for the small cold storage system.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: The example chooses "SCE" for WACC selection since the example project is custom project with a known location within the SCE territory.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
small cold storage system, replacement 50-200 lbs. charge	2025	AR	Stationary Refrigeration	Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "small cold storage system, replacement 50-200 lb. charge"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: AR (accelerated replacement) was selected for this measure. The existing equipment in this example would remain operation without program intervention.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: The CARB_Sector for this example is defined as "Stationary Refrigeration" in the 1 Device Builder worksheet.

5 Select CARB_BldgCategory from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE: "Commercial / Industrial"

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**

Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Cold Storage Warehouse (> 50 lbs refrigerant)	Ref_Storage (Each)	Cold storage system, 50-200 lbs. charge	1.00	GrocSys-Cndsr	15.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Cold Storage Warehouse (> 50 lb. refrigerant)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

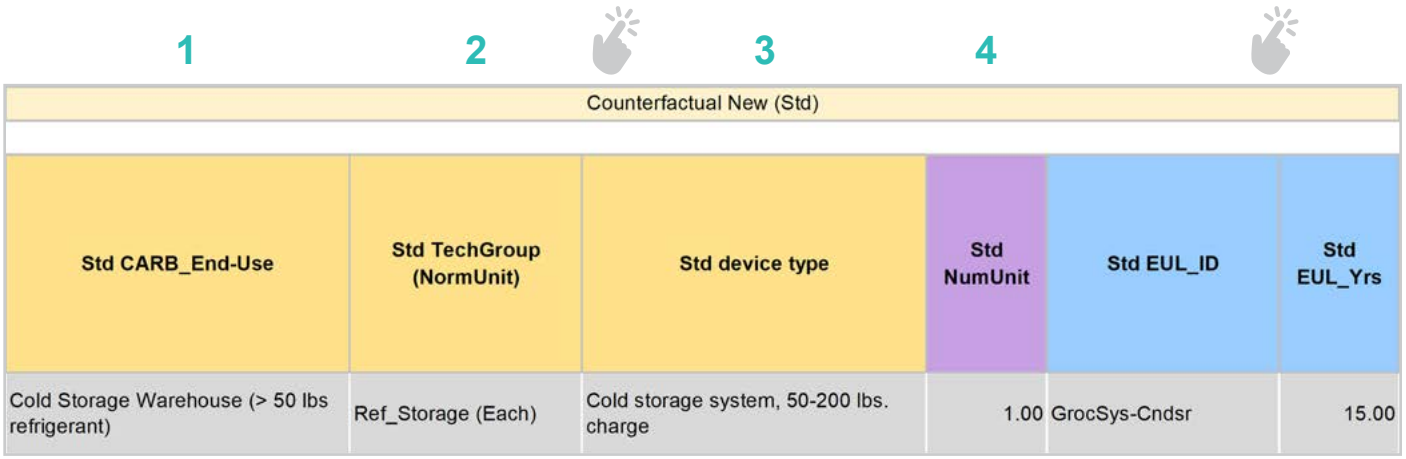
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Cold storage system, 50-200 lb. charge" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



1	2	3	4

Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
Cold Storage Warehouse (> 50 lbs refrigerant)	Ref_Storage (Each)	Cold storage system, 50-200 lbs. charge	1.00	GrocSys-Cndsr	15.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Cold Storage Warehouse (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a ***TechGroup (NormUnit)*** parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected ***TechGroup (NormUnit)*** parameter.

EXAMPLE: The standard case device is the same as the measure case device, "Cold storage system, 50-200 lb. charge."

4 For custom measures: a custom measure may also input the ***NumUnit*** or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the ***NormUnit*** is left at the default value "1".

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

1 2 3 4

Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	Cold Storage Warehouse (> 50 lbs refrigerant)	Ref_Storage (Each)	Cold storage system, 50-200 lbs. charge	1.00	GrocSys-Cndsr	15.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Cold Storage Warehouse (> 50 lb. refrigerant)"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a ***TechGroup (NormUnit)*** parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The pre/existing case device is the same as the measure and standard case devices, "Cold storage system, 50-200 lb. charge."

4 For custom measures: a custom measure may also input the ***NumUnit*** or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom m**easure.**

EXAMPLE: For this case, we will just model a single device and the ***NormUnit*** is left at the default value "1".

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

5

5 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: With this example the Pre/Ext Install Year is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding			Refrigerant properties color coding			Refrigerant properties color coding		
						The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
									Exceeds CARB-EPA limit, if any					
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
0	0.00	0	Carbon Dioxide (GWP=1)	User Specified (GWP=)	R-404A (GWP=3,922)	None	None	None	1	0	3,922	1	300	3,922
0	0.00		Carbon Dioxide (GWP=1)	R-449A (GWP=1,396)		None	None		1	1,396		1	1,396	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: "Carbon Dioxide"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For this measure, select "User Specified." This option is selected since the standard new device will be installed after the end of the EUL of the existing device in 2030 when the EPA's 300 GWP limit is in effect. Therefore, for the standard refrigerant type, we choose "User Specified" and override the std GWP column to 300.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: For this measure select "R-404A," as the refrigerant contained in the existing device.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.00	0.00	0.00	90.00	150.00	150.00
0.00	0.00		90.00	150.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

EXAMPLE: In this example, these are zero, because we will be inserting equipment specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

EXAMPLE: In this example, the charge sizes are overridden by user-specified inputs where the charge size of the CO_2 transcritical system is 90 lb. and the charge size for standard and existing is 150 lb. These estimates account for differences in refrigerant charge for each refrigerant type.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-8** and the total avoided cost in 2022 dollars are $9,642.99.

Table 4-8. User inputs for cold storage warehouse systems accelerated replacement measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Cold storage system, 50-200 lb. charge		
	TechTypeID	Ref_Storage:WalkInCool		
	NormUnit	Each		
	CARB_DeviceType	Small cold storage 50-200 lb.		
	Common Refrigerant Type(s)	NA		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	NA		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	SCE		
	Measure Description	Small cold storage system, replacement 50-200 lb. charge		
	Msr Install Year	2025		
	MeasAppType	AR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Commercial / Industrial		
	CARB_End-Use	Cold Storage Warehouse (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Cold storage system, 50-200 lb. charge		
	Pre/Ext Install Year	NA	NA	2015 (auto-populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	Carbon Dioxide (GWP=1)	User Specified (GWP=)	R-404A (GWP=3,922)
	GWP	Auto populated	300	Auto populated
	Refrigerant Charge (lb/NormUnit)	90	150	150
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

COLD STORAGE WAREHOUSE SYSTEM, 50-200 LB. (NR)

Measure description

This is a NR measure example for a new CO_2 (R-744) transcritical system with 90 lb. of refrigerant installed in 2025. For refrigeration systems of cold storage warehouse with less than 200 lb. charge, the CARB provides a list of prohibited refrigerants for new systems in existing facilities starting January 1, 2023; EPA's 2023 final rule established a 300 GWP limit to cold storage warehouse system starting January 1, 2026. If the normal replacement of the system occurs in 2025, the EPA rule is not in effect yet. The baseline refrigerant selected is R-449A, which is a low-GWP alternative for cold storage and not prohibited by CARB.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This tab needs to be filled out if this is a deemed measure based on research. This example assumes this measure will be custom where site-specific/equipment-specific refrigerant charge is likely to be used for this measure. However, for the purposes of this example we will be using CARB average refrigerant charge based on the CARB_DeviceType.

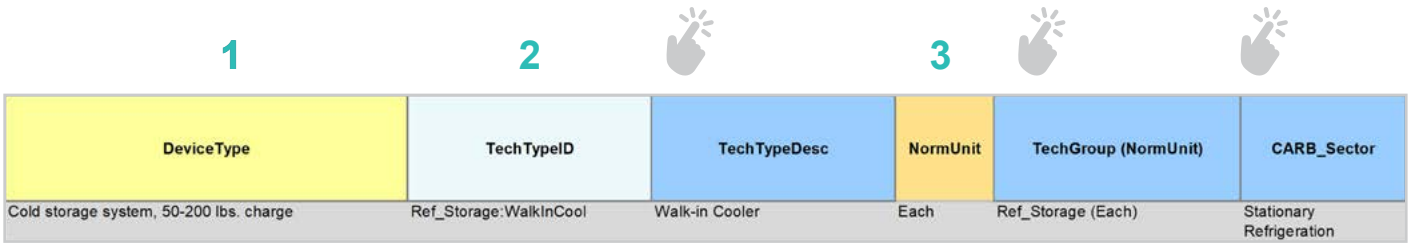
Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to See if Cold Storage System, 50-200 lb. Charge is Listed in the Device Builder Table**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**



DeviceType, TechTypeID, NormUnit, CARB_Sector

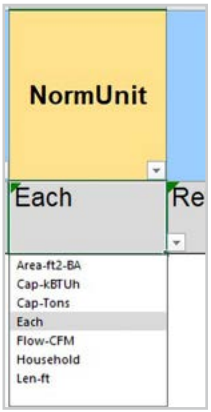
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).

EXAMPLE: "Cold storage system, 50-200 lb. charge"

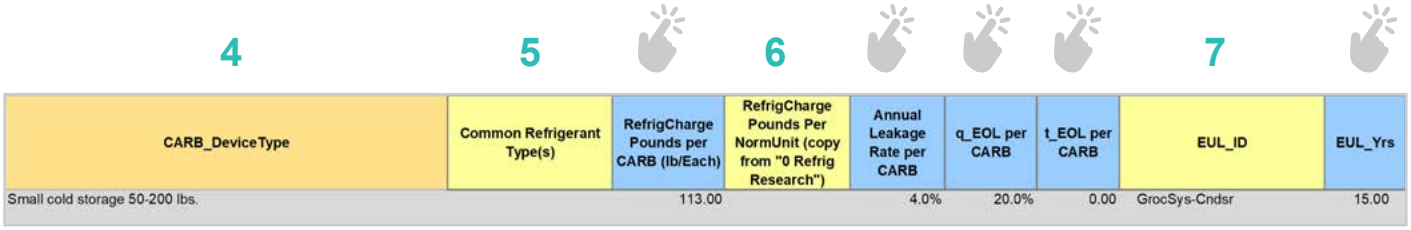
2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.

EXAMPLE: "Ref_Storage:WalkInCool"

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4	5		6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Small cold storage 50-200 lbs.		113.00		4.0%	20.0%	0.00	GrocSys-Cndsr	15.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above. Select the desired ***CARB_DeviceType*** from the dropdown menu.

EXAMPLE: "Small cold storage 50-200 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges need to be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC worksheet, there is no need to enter the charge size values.

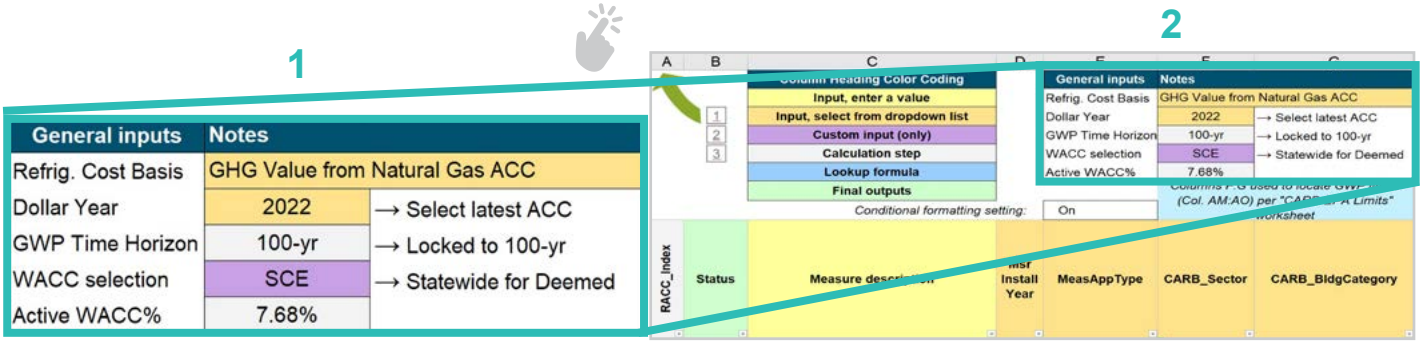
EXAMPLE: For this example, we will be using customer charge size for the small cold storage system in 2 RACC: 150 lb. for existing system and 90 lb. for the new system.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: The EUL_ID selected for this example is "GrocSys-Cndsr" as the best choice of EUL for the small cold storage system.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: The example chooses "SCE" for WACC selection since the example project is custom project with a known location within the SCE territory.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
small cold storage system, normal replacement 50-200 lbs. charge	2025	NR	Stationary Refrigeration	Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Small cold storage system, replacement 50-200 lb. charge."

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: NR (normal replacement) was selected for this measure. The existing equipment has failed or will no longer meet facility requirements and will need to be replaced with a new system.

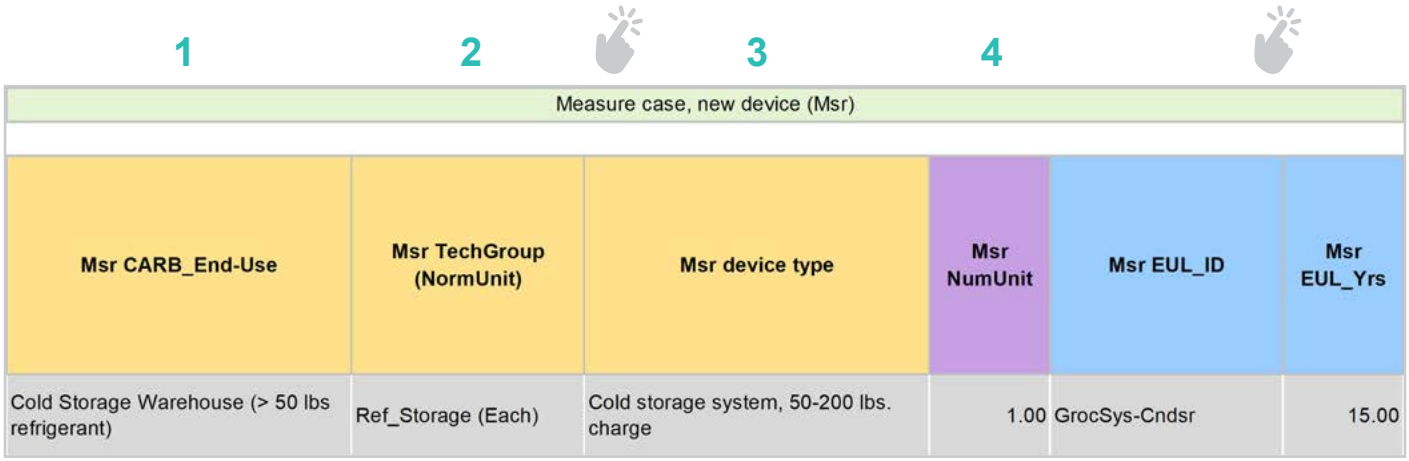
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: The CARB_Sector for this example is defined as “Stationary Refrigeration” in the 1 Device Builder worksheet.

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE: “Commercial / Industrial”

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**



Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Cold Storage Warehouse (> 50 lbs refrigerant)	Ref_Storage (Each)	Cold storage system, 50-200 lbs. charge	1.00	GrocSys-Cndsr	15.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Cold Storage Warehouse (> 50 lb. refrigerant)" was selected for this measure example.

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_SelfStorage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

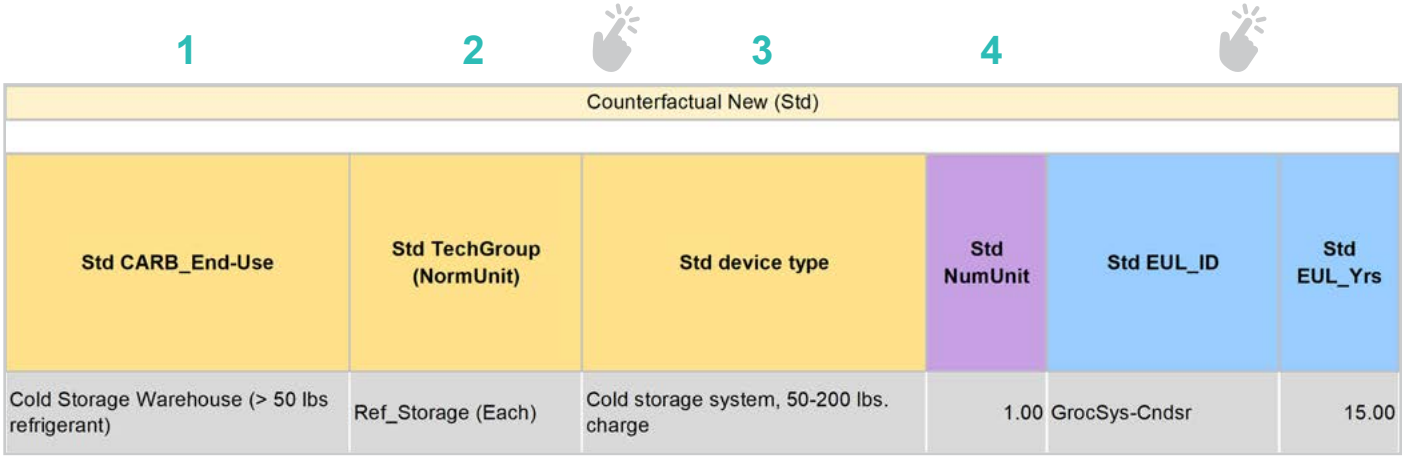
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Cold storage system, 50-200 lb. charge" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 **Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity**



Counterfactual New (Std)					
Std CARB_End-Use	**Std TechGroup (NormUnit)**	**Std device type**	**Std NumUnit**	**Std EUL_ID**	**Std EUL_Yrs**
Cold Storage Warehouse (> 50 lbs refrigerant)	Ref_Storage (Each)	Cold storage system, 50-200 lbs. charge	1.00	GrocSys-Cndsr	15.00

1 Select ***standard CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Cold Storage Warehouse (> 50 lb. refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)." This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the same as the measure case device, "Cold storage system, 50-200 lb. charge."

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
0	0.00		Carbon Dioxide (GWP=1)	R-449A (GWP=1,396)		None	None		1	1,396		1	1,396	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: Select “Carbon Dioxide” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For this measure, select “R-449A,” which is an alternative for predominant refrigerants like R-404A used in cold storage and not prohibited by CARB or EPA in 2025.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is a NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.00	0.00		90.00	150.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example these are zero, because we will be inserting equipment specific charge levels.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** In this example, the charge size is user-specified where the standard device charge size will be same as the failed system of 150 lb. and the charge size of the CO_2 transcritical system will be 90 lb.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in **Table 4-9** and the total avoided cost in 2022 dollars are $11,160.

Table 4-9. User inputs for cold storage warehouse systems accelerated replacement measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Not required for this example		
1 Device Builder	Device Type	Cold storage system, 50-200 lb. charge		
	TechTypeID	Ref_Storage:WalkInCool		
	NormUnit	Each		
	CARB_DeviceType	Small cold storage 50-200 lb.		
	Common Refrigerant Type(s)	NA		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	NA		
	EUL_ID	GrocSys-Cndsr		
2 RACC (Medium/Low-Temperature Side)	WACC selection	SCE		
	Measure Description	Small cold storage system, replacement 50-200 lb. charge		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Refrigeration		
	CARB_BldgCategory	Commercial / Industrial		
	CARB_End-Use	Cold Storage Warehouse (> 50 lb. refrigerant)		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Cold storage system, 50-200 lb. charge		
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	Carbon Dioxide (GWP=1)	R-449A (GWP=1,396)	NA
	GWP	Auto populated	Auto populated	NA
	Refrigerant Charge (lb/NormUnit)	90	150	NA
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

section 5

Stationary Air-conditioning Measures

AIR-COOLED HVAC CHILLER

Measure description

This example is a deemed measure that includes the replacement of commercial air-cooled chiller for air-conditioning with a new chiller using R-454B refrigerant in 2025. EPA's 2023 final rule established a 700 GWP limit to air-conditioning chillers starting January 1, 2025. The existing chiller system contains R-134a with a GWP of 1,430, while the counterfactual standard system will be limited to 700 GWP.

This example will model both AR and NR scenarios as separate measure offerings.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

This example assumes this measure will be deemed where a charge per normal unit Tons of refrigeration capacity is used. Since there is no established charge level per normal unit found in the 0 Refrig Research worksheet, this example assumes a 2 lb./Cap-Tons.

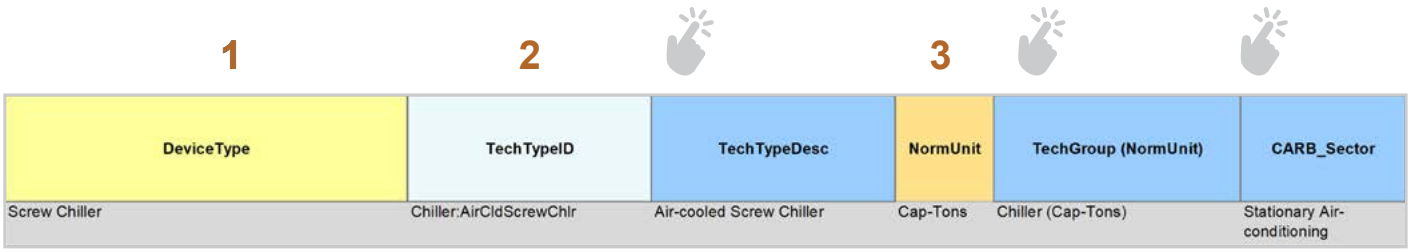
Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**

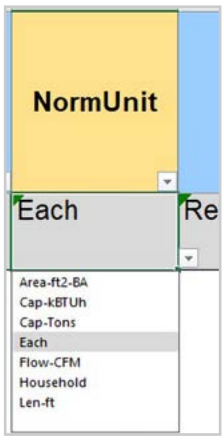


DeviceType, TechTypeID, NormUnit, CARB_Sector

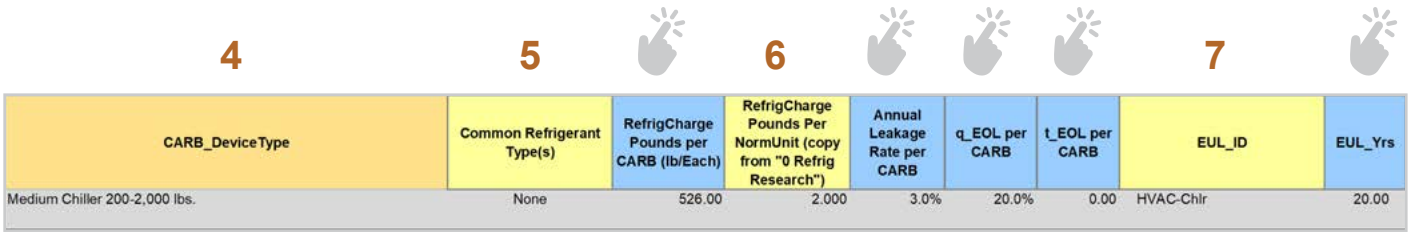
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality).
EXAMPLE: "Screw Chiller"

2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.
EXAMPLE: "Chiller:AirCldScrewChlr"

3 ***NormUnit*** is auto filled based on the TechTypeID. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4	5	6				7	
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Medium Chiller 200-2,000 lbs.	None	526.00	2.000	3.0%	20.0%	0.00	HVAC-Chlr	20.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 If needed, drag the formula down from the ***CARB_DeviceType*** column in the row above. Select the desired ***CARB_DeviceType*** from the dropdown menu.

EXAMPLE: "Medium Chiller 200-2,000 lb."

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices added here. This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges need to be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC worksheet, there is no need to enter the charge size values.

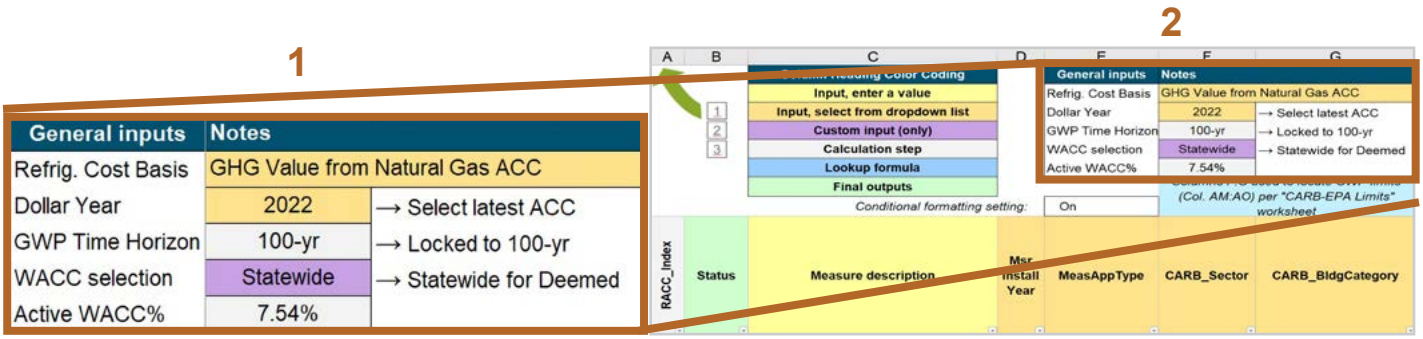
EXAMPLE: For this example, an assumed charge of 2 lb./Cap-Tons is used.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

EXAMPLE: The EUL_ID selected for this example is "HVAC-Chlr" as the best choice of EUL for the HVAC screw chiller system.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

	1	2	3	4	5
	Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
▲	Air cooled constant speed screw chiller (>= 150 tons), R-454B, NR	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial
●	Air cooled constant speed screw chiller (>= 150 tons), R-454B, AR	2025	AR	Stationary Air-conditioning	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

- ▲ **EXAMPLE NR MEASURE:** "Air cooled constant speed screw chiller (>= 150 tons), R454B, NR"
- ● **EXAMPLE AR MEASURE:** "Air cooled constant speed screw chiller (>= 150 tons), R454B, AR"

2 Select the ***measure installation year*** from the dropdown menu.

- ▲ ● **EXAMPLE BOTH:** This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

- ▲ **EXAMPLE NR MEASURE:** NR (normal replacement). The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.
- ● **EXAMPLE AR MEASURE:** AR (accelerated replacement). This measure offering is for equipment that would remain in operation without program intervention and has not exceeded the EUL.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

- ▲ ● **EXAMPLE BOTH:** "Stationary Air-conditioning"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

- ▲ ● **EXAMPLE BOTH:** "Residential / Commercial / Industrial"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

Measure case, new device (Msr)

Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
▲ Chillers - Air-Conditioning	Chiller (Cap-Tons)	Screw Chiller	1.00	HVAC-Chlr	20.00
● Chillers - Air-Conditioning	Chiller (Cap-Tons)	Screw Chiller	1.00	HVAC-Chlr	20.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Chillers – Air-Conditioning"

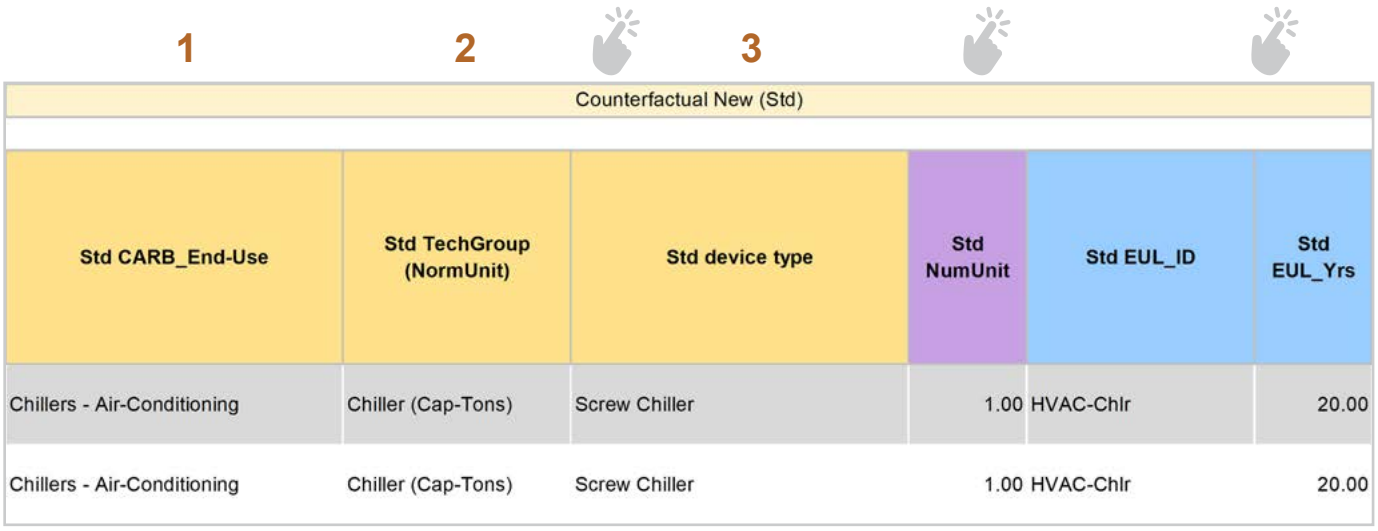
2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Chiller (Cap-Tons)". This represents a Tech Group of "Chiller," and a normalizing unit of "Cap-Tons."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Screw Chiller" device within the 1 Device Builder worksheet.

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



	Counterfactual New (Std)					
	Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
▲	Chillers - Air-Conditioning	Chiller (Cap-Tons)	Screw Chiller	1.00	HVAC-Chlr	20.00
●	Chillers - Air-Conditioning	Chiller (Cap-Tons)	Screw Chiller	1.00	HVAC-Chlr	20.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Chillers – Air-Conditioning"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

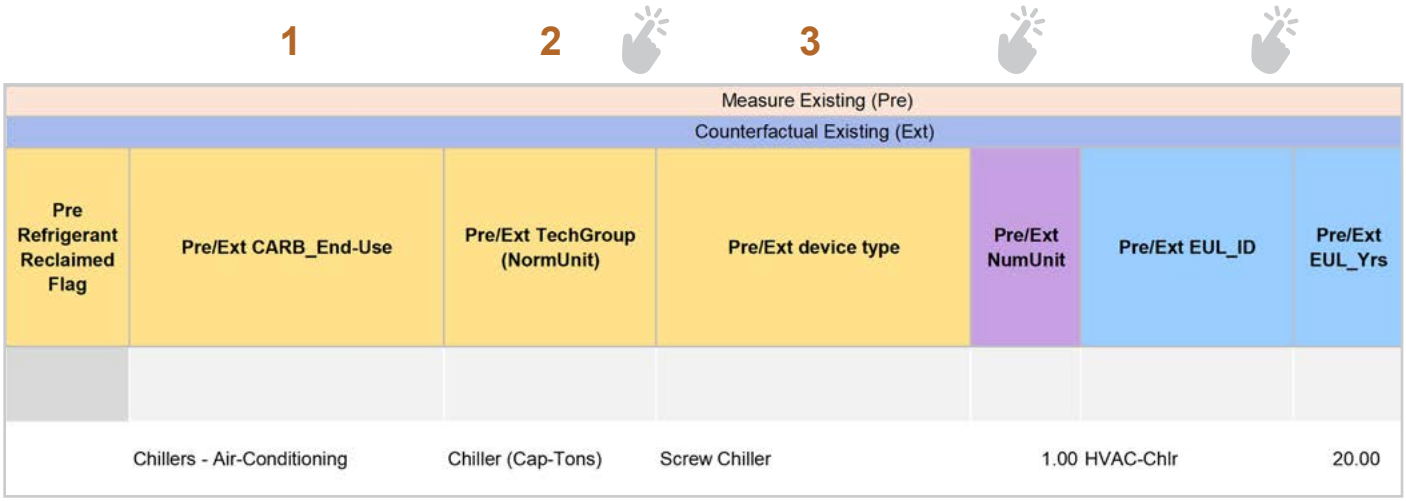
▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Chiller (Cap-Tons)." This represents a Tech Group of "Chiller," and a normalizing unit of "Cap-Tons."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Screw Chiller" device within the 1 Device Builder worksheet.

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

Note that the Pre/Existing Device input is only for AR measure applications.



1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Chillers – Air-Conditioning"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a ***TechGroup (NormUnit)*** parameter of "Chiller (Cap-Tons)." This represents a Tech Group of "Chiller," and a normalizing unit of "Cap-Tons."

3 Select the ***pre/existing device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The pre/existing case device is the "Screw Chiller" device within the 1 Device Builder worksheet.

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

4

4 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: With this example, the ***Pre/Ext Install Yea***r is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
▲ None	None		R-454B (GWP=466)	User Specified (GWP=?)		700	700		466	0		466	700	
● None	None	None	R-454B (GWP=466)	User Specified (GWP=?)	HFC-134a (GWP=1,430)	700	700	None	466	0	1,430	466	700	1,430

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** "R-454B (GWP=466)"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** The standard baseline for both AR and NR in this example is limited by EPA's 2023 final rule limiting the GWP of these system to 700 GWP or less. With a standard practice case for refrigerant less than 700 GWP, the user could default to the EPA limit by selecting "User Specified" and override the Std GWP column with 700.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

● **EXAMPLE AR ONLY:** "HFC-134a (GWP=1,430)"

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
▲ 2.00	2.00		2.00	2.00	
● 2.00	2.00	2.00	2.00	2.00	2.00

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

▲ ● **EXAMPLE BOTH:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

▲ ● **EXAMPLE BOTH:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in Table 5 1 and the total avoided cost in 2022 dollars for the NR measure is $25.24/Cap-Ton and $45.87/Cap-Ton for the AR measure offering.

Table 5-1. User inputs for commercial air-cooled chiller for air conditioning with R-454B measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into the charge amount per normalizing unit is required for this measure. This example assumes a normal charge of 2 lb./Ton.		
1 Device Builder	Device Type	Screw Chiller		
	TechTypeID	Chiller:AirCldScrewChlr		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Medium Chiller 200-2,000 lb.		
	Common Refrigerant Type(s)	None		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	2		
	EUL_ID	HVAC-Chlr		
2 RACC (NR measure)	WACC Selection	Statewide		
	Refrig. Cost Basis	GHG Value from Natural Gas ACC		
	Measure Description	Air cooled constant speed screw chiller (>= 150 tons), R-454b, NR		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Chillers - Air-Conditioning	Chillers - Air-Conditioning	NA
	TechGroup (NormUnit)	Chiller (Cap-Tons)	Chiller (Cap-Tons)	NA
	Device type	Screw Chiller	Screw Chiller	NA
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	R-454B (GWP=466)	User Specified (GWP=)	NA
	GWP	Auto populated	700 (manual input)	NA
	Refrigerant Charge (lb/NormUnit)	2 (auto-populated)		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
(Inputs for the AR measure that differ from the NR measure)				
2 RACC (AR measure)	CARB_End-Use	Chillers - Air-Conditioning	Chillers - Air-Conditioning	Chillers - Air-Conditioning
	TechGroup (NormUnit)	Chiller (Cap-Tons)	Chiller (Cap-Tons)	Chiller (Cap-Tons)
	Device type	Screw Chiller	Screw Chiller	Screw Chiller
	Pre/Ext Install Year	NA	NA	2012 (auto-populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	R-454B (GWP=466)	User Specified (GWP=)	HFC-134a (GWP=1,430)
	GWP	Auto populated	700 (manual input)	Auto populated

UNITARY AIR-COOLED AC AND GAS FURNACE, RTU WITH R-32, COMMERCIAL

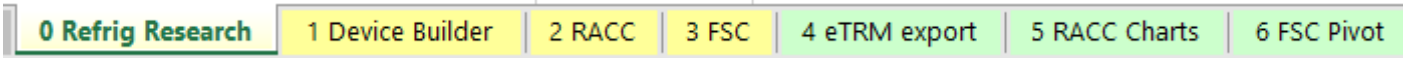
Measure description

This example is a deemed measure that includes the replacement of commercial air-cooled unitary AC with gas furnace rooftop unit with a new unitary AC with R-32 refrigerant in 2025. EPA's 2023 final rule established a 700 GWP limit to air-conditioning equipment starting January 1, 2025. The existing unitary AC equipment contains R-410A with a GWP of 2,088, while the counterfactual standard system will be limited to 700 GWP.

This example will model both AR and NR scenarios as separate measure offerings.

Measure input walkthrough

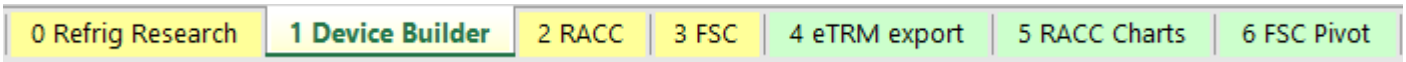
Input worksheet: 0 Refrig Research



This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

This example assumes this measure will be deemed where a charge per normal unit Tons of refrigeration capacity is used. A nominal charge level per normal unit found in the 0 Refrig Research worksheet for this equipment is 3.2 lb./ Cap-Tons.

Input Worksheet: 1 Device Builder



Only a single device is required in the 1 Device Builder worksheet unless the charge size of the sides of the cascade refrigeration system fall into different CARB_DeviceType categories.

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

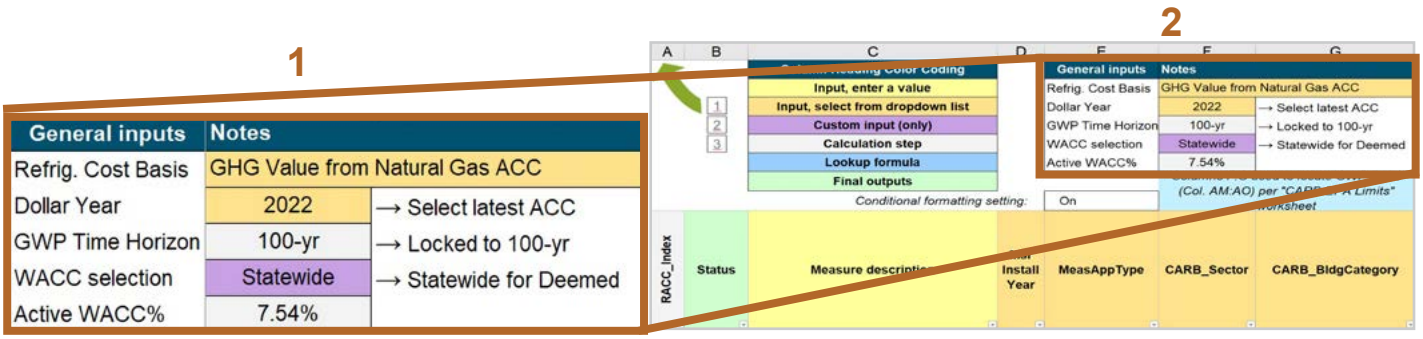
Note: The device required for this measure example already exists in the 1 Device Builder worksheet: "Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)."

STEP 2 **Add New Device**

The device required for this measure already exists; skip the add new device step.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

	1	2	3	4	5
	Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
▲	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh), with R-32	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial
●	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh), with R-32	2025	AR	Stationary Air-conditioning	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

▲ ● **EXAMPLE BOTH:** "Unitary Air-Cooled HVAC, Commercial – AC and Gas Furnace (>= 135 kBTUh), with R-32"

2 Select the ***measure installation year*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

▲ **EXAMPLE NR MEASURE:** NR (normal replacement). The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

● **EXAMPLE AR MEASURE:** AR (accelerated replacement). This measure offering is for equipment that would remain in operation without program intervention and has not exceeded the EUL.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** "Stationary Air-conditioning"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

▲ ● **EXAMPLE BOTH:** "Residential / Commercial / Industrial"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

1 2 3

Measure case, new device (Msr)					
Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
▲ Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)	1.00	HVAC-airAC	15.00
● Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)	1.00	HVAC-airAC	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Other Air-Conditioning Equipment (residential and non-residential)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)" device within the 1 Device Builder worksheet.

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity

Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
▲ Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)	1.00	HVAC-airAC	15.00
● Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)	1.00	HVAC-airAC	15.00

1 Select CARB_End-Use from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Other Air-Conditioning Equipment (residential and non-residential)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

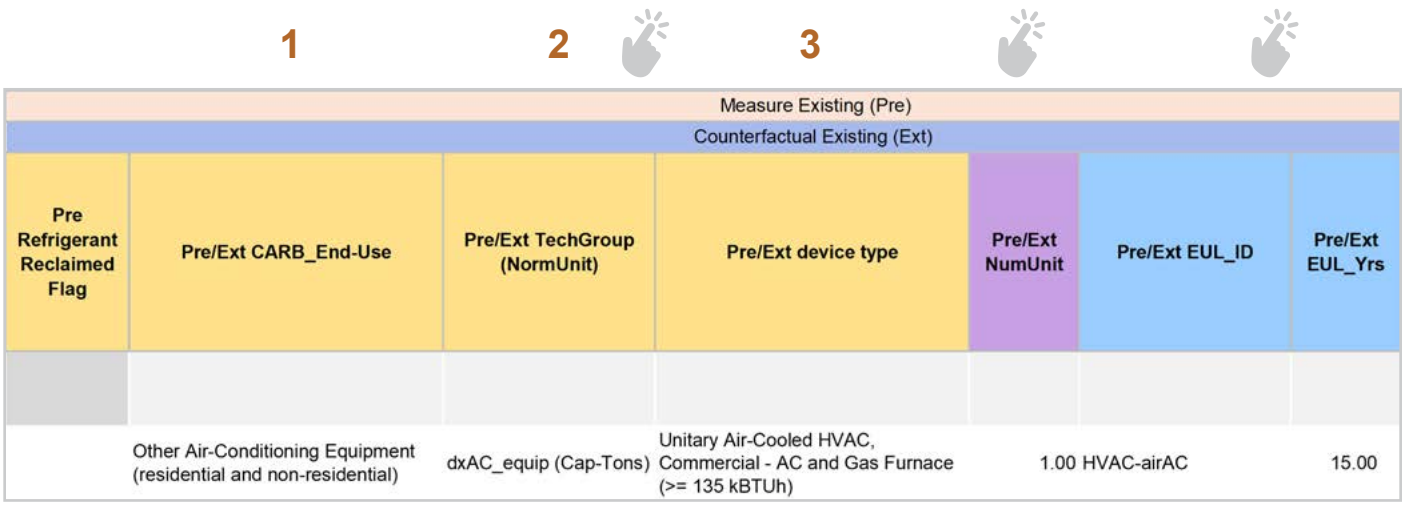
▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)" device within the 1 Device Builder worksheet.

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

Note that the Pre/Existing Device input is only for AR measure applications.



Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)	1.00	HVAC-airAC	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Other Air-Conditioning Equipment (residential and non-residential)"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a ***TechGroup (NormUnit)*** parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."

3 Select the ***pre/existing device type*** from the dropdown menu. Device types are associated with the selected ***TechGroup (NormUnit)*** parameter.

EXAMPLE: The pre/existing case device is the "Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>= 135 kBTUh)" device within the 1 Device Builder worksheet.

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

4

4 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: The ***Pre/Ext Install Year*** is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre / Ext	Msr	Std	Pre / Ext	Msr	Std	Pre / Ext	Msr	Std	Pre / Ext	Msr	Std	Pre / Ext
						Refrigerant properties color coding			Refrigerant properties color coding			Refrigerant properties color coding		
						The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
									Exceeds CARB-EPA limit, if any					
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
▲ R-410A	R-410A		HFC-32 (GWP=675)	User Specified (GWP=?)		700	700		675	0		675	700	
● R-410A	R-410A	R-410A	HFC-32 (GWP=675)	User Specified (GWP=?)	R-410A (GWP=2,088)	700	700	None	675	0	2,088	675	700	2,088

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** "HFC-32 (GWP=675)"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** The standard baseline for both AR and NR in this example is limited by EPA's 2023 final rule limiting the GWP of these system to 700 GWP or less. With a standard practice case for refrigerant less than 700 GWP, the user could default to the EPA limit by selecting "User Specified" and override the Std GWP column with 700.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

● **EXAMPLE AR ONLY:** "R-410A (GWP=2,088)"

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
▲ 3.20	3.20		3.20	3.20	
● 3.20	3.20	3.20	3.20	3.20	3.20

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

▲ ● **EXAMPLE BOTH:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the **RefrigCharge Pounds Per NormUnit** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

▲ ● **EXAMPLE BOTH:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in Table 5-2 and the total avoided cost in 2022 dollars for the NR measure is $6.74/Cap-Ton, and $111.56/Cap-Ton for the AR measure offering.

Table 5-2. User inputs for commercial unitary air-cooled AC with R-32 measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into the charge amount per normalizing unit is required for this measure. This example assumes a nominal charge of 3.2 lb./Cap-Tons.		
1 Device Builder	Device Type	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>=135 kBTUh)		
	TechTypeID	dxAC_equip:pkgEER		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Commercial Unitary AC 50-200 lb., > 135,000 BTUh size		
	Common Refrigerant Type(s)	R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.2		
	EUL_ID	HVAC-airAC		
2 RACC (Medium/Low-Temperature Side)	WACC Selection	Statewide		
	Refrig. Cost Basis	GHG Value from Natural Gas ACC		
	Measure Description	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>=135 kBTUh)		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)		NA
	TechGroup (NormUnit)	dxAC_equip (Cap-Tons)		NA
	Device type	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (> 135 kBTUh)		NA
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	HFC-32 (GWP=675)	R-410A (GWP=2,088)	NA
	GWP	Auto populated	Auto populated	NA
	Refrigerant Charge (lb/ NormUnit)	3.2 (auto-populated)		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		
(Inputs for the AR measure that differ from the NR measure)				
2 RACC (AR measure)	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)		
	TechGroup (NormUnit)	dxAC_equip (Cap-Tons)		
	Device type	Unitary Air-Cooled HVAC, Commercial - AC and Gas Furnace (>=135 kBTUh)		
	Pre/Ext Install Year	NA	NA	2015 (auto-populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	HFC-32 (GWP=675)	User Specified (GWP=)	R-410A (GWP=2,088)
	GWP	Auto populated	700 (manual input)	Auto populated

CENTRAL HEAT PUMP REPLACING RESIDENTIAL GAS FURNACE AND WEIGHTED BASELINE AC COOLING

Measure description

This example is a deemed measure that includes the replacement of residential AC and gas furnace central HVAC systems with a central heat pump system with R-454B for the refrigerant type. The measure year will be for 2025. EPA's 2023 final rule established a 700 GWP limit to stationary air conditioning and heat pump systems starting January 1, 2025. Both R-454B and R-32 (HFC-32) are the most likely refrigerants to satisfy this regulation. The existing AC system contains R-410A with a GWP of 2,088, while the counterfactual standard system will be limited to 700 GWP.

This example will model both AR and NR scenarios as separate measure offerings.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

There are several default refrigerant charge per normalizing unit values included in the RACC. These are not intended to be used as a default for measure packages. Users should conduct research into estimating charge levels for measure package development. For this example, we will use the default number in the worksheet for the "Central HVAC, Residential - Heat Pump" and "Residential Unitary AC" devices. These devices have a normalized refrigerant charge 3.5 lb./Cap-Tons and 3.2 lb./Cap-Tons, respectively.

Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

Note: The devices required for this measure example already exist in the 1 Device Builder worksheet.

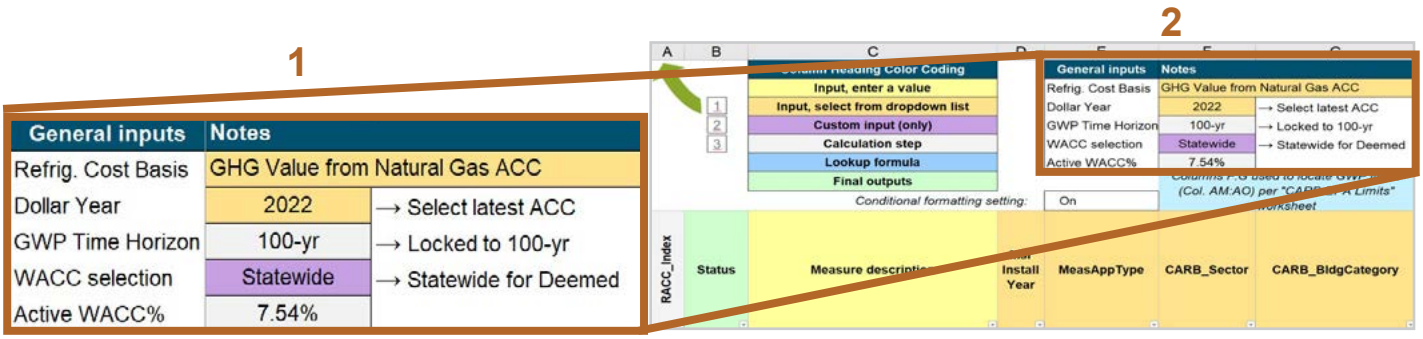
- Measure case device: "Central HVAC, Residential – Heat Pump"
- Standard, Pre/Ext device: "Central HVAC, Residential – AC and Gas Furnace"

STEP 2 **Add New Device**

The device required for this measure already exists; skip the add new device step.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current refrigerant emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Residential central heat pump, R-454B, replacing AC and gas furnace	2025	AR	Stationary Air-conditioning	Residential / Commercial / Industrial
Residential central heat pump, R-454B, replacing AC and gas furnace	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial
Residential central heat pump, R-454B, replacing gas furnace only	2025	AR	Stationary Air-conditioning	Residential / Commercial / Industrial
Residential central heat pump, R-454B, replacing gas furnace only	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Residential central heat pump, R-454B, replacing AC and gas furnace", one AR and one NR example.

EXAMPLE: "Residential central heat pump, R-454B, replacing gas furnace only", one AR and one NR example.

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE ALL: This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE AR MEASURES: This measure offering is for equipment that would remain in operation without program intervention and has not exceeded the EUL.

EXAMPLE NR MEASURE: The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE ALL: "Stationary Air-conditioning"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE BOTH: "Residential / Commercial / Industrial"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

1 2 3

Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Other Air-Conditioning Equipment (residential and non-residential)	dxHP_equip (Cap-Tons)	Central HVAC, Residential - Heat Pump	1.00	HV-ResHP	15.00
Other Air-Conditioning Equipment (residential and non-residential)	dxHP_equip (Cap-Tons)	Central HVAC, Residential - Heat Pump	1.00	HV-ResHP	15.00
Other Air-Conditioning Equipment (residential and non-residential)	dxHP_equip (Cap-Tons)	Central HVAC, Residential - Heat Pump	1.00	HV-ResHP	15.00
Other Air-Conditioning Equipment (residential and non-residential)	dxHP_equip (Cap-Tons)	Central HVAC, Residential - Heat Pump	1.00	HV-ResHP	15.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE ALL: "Other Air-Conditioning Equipment (residential and non-residential)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE ALL: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxHP_equip (Cap-Tons)". This represents a Tech Group of "dxHP_equip," and a normalizing unit of "Cap-Tons."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE ALL: The measure case device is the "Central HVAC, Residential – Heat Pump" device within the 1 Device Builder worksheet.

STEP 4 **Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity**

Counterfactual New (Std)					
Std CARB_End-Use	**Std TechGroup (NormUnit)**	**Std device type**	**Std NumUnit**	**Std EUL_ID**	**Std EUL_Yrs**
Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Central HVAC, Residential - AC and Gas Furnace	1.00	HVAC-airAC	15.00
Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Central HVAC, Residential - AC and Gas Furnace	1.00	HVAC-airAC	15.00
None (no refrigerant)	SpaceHtg_eq (Cap-kBTUh)	Central HVAC, Residential - Gas Furnace only	1.00	HV-EffFurn	20.00
None (no refrigerant)	SpaceHtg_eq (Cap-kBTUh)	Central HVAC, Residential - Gas Furnace only	1.00	HV-EffFurn	20.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Other Air-Conditioning Equipment (residential and non-residential)" for the AC and gas furnace offerings.

EXAMPLE: "None (no refrigerant)" for the gas furnace only offerings.

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: For replacing AC and gas furnace offerings the device from the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."

EXAMPLE: For replacing gas furnace only offerings the device from the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "SpaceHtg_eq (Cap-kBTUh)." This represents a Tech Group of "SpaceHtg_eq," and a normalizing unit of "Cap-kBTUh."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: For replacing AC and gas furnace offerings the standard case device is the "Central HVAC, Residential – AC and Gas Furnace" device within the 1 Device Builder worksheet.

EXAMPLE: For replacing furnace only offerings the standard case device is the "Central HVAC, Residential – Gas Furnace only" device within the 1 Device Builder worksheet.

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

Note that the Pre/Existing Device input is only for AR measure applications.

Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	Other Air-Conditioning Equipment (residential and non-residential)	dxAC_equip (Cap-Tons)	Central HVAC, Residential - AC and Gas Furnace	1.00	HVAC-airAC	15.00
	None (no refrigerant)	SpaceHtg_eq (Cap-kBTUh)	Central HVAC, Residential - Gas Furnace only	1.00	HV-EffFurn	20.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: For replacing AC and gas furnace offerings, "Other Air-Conditioning Equipment (residential and non-residential)".

EXAMPLE: For replacing gas furnace only offerings, "None (no refrigerant"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: For replacing AC and gas furnace offerings the device from the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."

EXAMPLE: For replacing gas furnace only offerings the device from the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "SpaceHtg_eq (Cap-kBTUh)." This represents a Tech Group of "SpaceHtg_eq," and a normalizing unit of "Cap-kBTUh."

3 Select the ***pre/existing device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: For replacing AC and gas furnace offerings the standard case device is the "Central HVAC, Residential – AC and Gas Furnace" device within the 1 Device Builder worksheet.

EXAMPLE: For replacing gas furnace only offerings the standard case device is the "Central HVAC, Residential – Gas Furnace only" device within the 1 Device Builder worksheet.

4

		EULs and RUL are rounded to nearest whole number to calculate costs of refrigerant leakage			
		Msr	Std	Pre	
				Ext	
Pre/Ext Install Year	**Pre/Ext Install Year Basis**	**Msr EUL, Rounded**	**Std EUL, Rounded**	**Pre/Ext EUL, Rounded**	**Pre/Ext RUL, Rounded**
2015	Deemed	15	15	15	5
		15	15		
2012	Deemed	15	20	20	7
		15	20		

4 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: The ***Pre/Ext Install Year*** is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
R-410A	R-410A	R-410A	R-454B (GWP=466)	R-454B (GWP=466)	R-410A (GWP=2,088)	700	700	None	466	466	2,088	466	466	2,088
R-410A	R-410A		R-454B (GWP=466)	R-454B (GWP=466)		700	700		466	466		466	466	
R-410A	None	None	R-454B (GWP=466)	None	None	700		None	466	0	0	466	0	0
R-410A	None		R-454B (GWP=466)	None		700			466	0		466	0	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE ALL: Select “R-454B (GWP=466)” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For replacing AC and gas furnace offerings select “R-454B (GWP=466)” as the standard case refrigerant. This example is limited by EPA’s 2023 final rule limiting the GWP of these systems to 700 GWP or less. Since no single alternative refrigerant ISP has been established. We recommend selecting R-454B as the standard case to match the measure case.

EXAMPLE: For replacing gas furnace only offerings, select “None”.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: For replacing AC and gas furnace offerings select “R-410A” as the existing refrigerant.

EXAMPLE: For replacing gas furnace only offerings select “None” as the existing refrigerant.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
3.50	3.20	3.20	3.50	3.20	3.20
3.50	3.20		3.50	3.20	
3.50	0.00	0.00	3.50	0.00	0.00
3.50	0.00		3.50	0.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

A sample of measure permutations were selected for this walkthrough of the 3 FSC worksheet. The sample of example permutations is sourced from the SWHC045-02 Heat Pump HVAC, Residential, Fuel Substitution measure package.

For deemed measures, all information for all permutations of a measure package must be entered into the 3 FSC worksheet.

STEP 1 Input Measure Offering Classifications

				1	2	3	4	5
FSC_Index	RACC_Index	Overall Result	RACC_Measure Description	Offering ID Description	Sector	BldgType	BldgVint	BldgLoc
1	1	PASS	1: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (AR)	SWHC045-02-AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	Res	SFm	Ex	CZ06
2	2	PASS	2: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (NR)	SWHC045-02-AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	Res	SFm	Ex	CZ06
3	3	PASS	3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)	SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	Res	SFm	Ex	CZ06
4	4	PASS	4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)	SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	Res	SFm	Ex	CZ06
5	3	PASS	3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)	SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING	Res	SFm	Ex	CZ06
6	4	PASS	4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)	SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING	Res	SFm	Ex	CZ06

1 Enter in the ***offering ID description***. Users may input statewide measure offering ID(s), or a measure offering description to clearly identify the offering in each row.

EXAMPLE: "SWHC045-02-AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace"

EXAMPLE: "SWHC045-02-AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace"

EXAMPLE: "SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only"

EXAMPLE: "SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only"

EXAMPLE: "SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING"

EXAMPLE: "SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING"

2 Select the ***Sector*** for the measure offering from the dropdown list or copy (as text) all sector permutations from the permutations table.

EXAMPLE: "Res", for all permutations in this example.

3 Select the ***BldgType*** for the measure offering from the dropdown list or copy (as text) all BldgType permutations from the permutations table.

EXAMPLE: "SFm", for all permutations in this example.

4 Select the ***BldgVint*** for the measure offering from the dropdown list or copy (as text) all BldgVint permutations from the permutations table.

EXAMPLE: "Ex", for all permutations in this example.

5 Select the ***BldgLoc*** for the measure offering from the dropdown list or copy (as text) all BldgLoc permutations from the permutations table.

EXAMPLE: "CZ06", for all permutations in this example.

6

FSC_Index	RACC_Index	Overall Result	RACC_Measure Description	Offering ID Description	Sector	BldgType	BldgVint	BldgLoc
1	1	PASS	1: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (AR)	SWHC045-02-AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	Res	SFm	Ex	CZ06
2	2	PASS	2: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (NR)	SWHC045-02-AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	Res	SFm	Ex	CZ06
3	3	PASS	3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)	SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	Res	SFm	Ex	CZ06
4	4	PASS	4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)	SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	Res	SFm	Ex	CZ06
5	3	PASS	3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)	SWHC045-02-BK: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING	Res	SFm	Ex	CZ06
6	4	PASS	4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)	SWHC045-02-BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only-WITH IMPUTED COOLING	Res	SFm	Ex	CZ06

6 Assign the refrigerant emissions calculation associated with each offering by selecting a ***RACC_Measure Description*** from the dropdown list. Each item in the dropdown list corresponds to a completed calculation row in the 2 RACC worksheet. This field assigns which avoided refrigerant emissions should be used for each measure offering for the fuel-substitution calculations. This is also how the offering(s) MeasAppType is assigned to each offering in the 3 FSC worksheet.

EXAMPLE: Assign “1: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (AR)” to any replacing AC and gas furnace AR offerings.

EXAMPLE: Assign “2: Residential central heat pump, R-454B, replacing AC and gas furnace in 2025 (NR)” to any replacing AC and gas furnace NR offerings.

EXAMPLE: Assign “3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)” to any replacing gas furnace only AR offerings.

EXAMPLE: Assign “4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)” to any replacing gas furnace only NR offerings.

EXAMPLE: Assign “3: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (AR)” for AR offerings that will be including imputed cooling.

EXAMPLE: Assign “4: Residential central heat pump, R-454B, replacing gas furnace only in 2025 (NR)” for NR offerings that will be including imputed cooling.

STEP 2 Imputed Impacts of Standard Cooling Device Analysis

1 2

Measure case, new device (Msr)	Counterfactual Standard (Std)				Measure Existing (Pre)			
						Counterfactual Existing (Ext)		
					AR/NR only	AOE, AR, and--when existing Refrigerant reclamation documentation is provided--NR		
Msr Device Type	Std Device Type	Std Device Cooling Proportion WeightID to Use, If Appropriate	Std Cooling Proportion for Imputed Impacts	FSC_Index for Basis of Imputed Impacts of Std Cooling Device	Pre Refrigerant Reclaimed Flag	Pre/Ext Device Type	Pre/Ext Install Year	Pre/Ext Install Year Basis
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - AC and Gas Furnace	None	None			Central HVAC, Residential - AC and Gas Furnace	2015	Deemed
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - AC and Gas Furnace	None	None				-	-
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - Gas Furnace only	None	None			Central HVAC, Residential - Gas Furnace only	2012	Deemed
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - Gas Furnace only	None	None				-	-
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - Gas Furnace only	FS-rImputedDX	72%	1		Central HVAC, Residential - Gas Furnace only	2012	Deemed
Central HVAC, Residential - Heat Pump	Central HVAC, Residential - Gas Furnace only	FS-rImputedDX	72%	2			-	-

1 Assign the ***Std Device Cooling Proportion WeightID to Use, If Appropriate*** for the appropriate building weight ID corresponding to the measure.

EXAMPLE: "None", for rows not calculating imputed cooling.

EXAMPLE: "FS-rImputedDX", for rows where imputed cooling will be calculated.

2 Select the ***FSC_Index for Basis of Imputed Impacts of Std Cooling Device*** for the appropriate 3 FSC calculation row matching the offering with cooling in the Std device case.

EXAMPLE: Leave blank for rows not calculating imputed cooling.

EXAMPLE: Select "1", corresponding to the replacing AC and gas furnace AR FSC calculation on row 1 of the FSC table to tell the calculator to interpolate energy savings impacts between the replacing AC and gas furnace AR offering row and the replacing gas furnace only AR offering row found here.

EXAMPLE: Select "2", corresponding to the replacing AC and gas furnace NR FSC calculation on row 2 of the FSC table to tell the calculator to interpolate energy savings impacts between the replacing AC and gas furnace NR offering row and the replacing gas furnace only NR offering row found here.

STEP 3 Annual Energy Usage by Case

1 2 3

Annual Energy Usage by Case						Imputed	Annual Energy Savings by Fuel & Baseline			
Msr		Std		Pre		Std	If space cooling is imputed for the Std case (counterfactual new equipment), the imputed energy usage is taken into account in these columns.			
Note: At rows being used to create imputed-cooling permutations for space-conditioning, fuel-substitution measures, these Msr/Std/Pre/Ext fields should contain the annual energy usage values without cooling.				Ext						
				AR, only					AR, only	
Msr Annual Electric Usage, kWh per NormUnit	Msr Annual Natural Gas Usage, Therm per NormUnit	Std Annual Electric Usage, kWh per NormUnit	Std Annual Natural Gas Usage, Therm per NormUnit	Pre/Ext Annual Electric Usage, kWh per NormUnit	Pre/Ext Annual Natural Gas Usage, Therm per NormUnit	Imputed Std Annual Electric Usage, kWh per NormUnit	1st Baseline Annual Electric Savings, kWh per NormUnit	1st Baseline Annual Natural Gas Savings, Therm per NormUnit	2nd Baseline Annual Electric Savings, kWh per NormUnit	2nd Baseline Annual Natural Gas Savings, Therm per NormUnit
1,850.00	46.900	1,700.00	75.600	1,700.00	75.600		-150.00	28.700	-150.00	28.700
1,850.00	46.900	1,700.00	75.600				-150.00	28.700		
1,850.00	46.900	1,460.00	75.600	1,460.00	75.600		-390.00	28.700	-390.00	28.700
1,850.00	46.900	1,460.00	75.600				-390.00	28.700		
1,850.00	46.900	1,460.00	75.600	1,460.00	75.600	1,632.56	-390.00	28.700	-217.44	28.700
1,850.00	46.900	1,460.00	75.600			1,632.56	-217.44	28.700		

1 Input the measure device kWh usage in the ***Msr annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

2 Input the measure device kWh usage in the ***Msr annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

3 Input the measure device kWh usage in the ***Std annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

STEP 3 Annual Energy Usage by Case, continued

4 5 6

Annual Energy Usage by Case						Imputed	Annual Energy Savings by Fuel & Baseline			
Msr		Std		Pre Ext		Std	If space cooling is imputed for the Std case (counterfactual new equipment), the imputed energy usage is taken into account in these columns.			
Note: At rows being used to create imputed-cooling permutations for space-conditioning, fuel-substitution measures, these Msr/Std/Pre/Ext fields should contain the annual energy usage values without cooling.				AR, only					AR, only	
Msr Annual Electric Usage, kWh per NormUnit	Msr Annual Natural Gas Usage, Therm per NormUnit	Std Annual Electric Usage, kWh per NormUnit	Std Annual Natural Gas Usage, Therm per NormUnit	Pre/Ext Annual Electric Usage, kWh per NormUnit	Pre/Ext Annual Natural Gas Usage, Therm per NormUnit	Imputed Std Annual Electric Usage, kWh per NormUnit	1st Baseline Annual Electric Savings, kWh per NormUnit	1st Baseline Annual Natural Gas Savings, Therm per NormUnit	2nd Baseline Annual Electric Savings, kWh per NormUnit	2nd Baseline Annual Natural Gas Savings, Therm per NormUnit
1,850.00	46.900	1,700.00	75.600	1,700.00	75.600		-150.00	28.700	-150.00	28.700
1,850.00	46.900	1,700.00	75.600				-150.00	28.700		
1,850.00	46.900	1,460.00	75.600	1,460.00	75.600		-390.00	28.700	-390.00	28.700
1,850.00	46.900	1,460.00	75.600				-390.00	28.700		
1,850.00	46.900	1,460.00	75.600	1,460.00	75.600	1,632.56	-390.00	28.700	-217.44	28.700
1,850.00	46.900	1,460.00	75.600			1,632.56	-217.44	28.700		

4 Input the measure device kWh usage in the ***Std annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

5 Input the measure device kWh usage in the ***Pre/Ext annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: AR measure only. This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

6 Input the measure device kWh usage in the ***Pre/Ext annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures this information is required for the permutations table.

EXAMPLE: AR measures only. This example sources energy usage values from SWHC045-02, see screenshot for specific example values.

Summary

User inputs of this example are summarized in Table 5-3 and the total avoided cost in 2022 dollars for the heat pump replacing AC and gas furnace offerings an AR measure refrigerant benefit is $69.64/Cap-Ton and NR results in additional refrigerant costs of $17.64/Cap-Ton. While the heat pump replacing gas furnace only offerings result in additional refrigerant costs of $161.41/Cap-Ton for both AR and NR measures.

Table 5-3. User inputs for residential central heat pump, with R-454B, replacing AC and gas furnace measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into charge amount per normalizing unit is required for this measure. This example assumes default values built into the sheet.		
1 Device Builder (Heat Pump)	Device Type	Central HVAC, Residential - Heat Pump		
	TechTypeID	dxHP_equip:spltSEER		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Residential Heat Pumps		
	Common Refrigerant Type(s)	R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.5		
	EUL_ID	HV-ResHP		
1 Device Builder (AC and Gas Furnace)	Device Type	Central HVAC, Residential - AC and Gas Furnace		
	TechTypeID	dxAC_equip:spltSEER		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Residential Unitary AC		
	Common Refrigerant Type(s)	R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.2		
	EUL_ID	HVAC-airAC		
1 Device Builder (Furnace Only)	Device Type	Central HVAC, Residential – Gas Furnace only		
	TechTypeID	SpaceHtg_eq:GasFurnace		
	NormUnit	Cap-kBTUh		
	CARB_DeviceType	Eqmt. w/o refrigerant		
	Common Refrigerant Type(s)	None		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	0.00		
	EUL_ID	HV-EffFurn		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
2 RACC (Baseline: AC and Gas Furnace)	WACC Selection	Statewide		
	Measure Description	Residential central heat pump, R-454B, replacing AC and gas furnace		
	Msr Install Year	2025		
	MeasAppType	AR or NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)	Other Air-Conditioning Equipment (residential and non-residential)	for AR: Other Air-Conditioning Equipment (residential and non-residential); for NR: NA
	TechGroup (NormUnit)	dxHP_equip (Cap-Tons)	dxAC_equip (Cap-Tons)	For AR: dxAC_equip (Cap-Tons), for NR: NA
	Device type	Central HVAC, Residential - Heat Pump	Central HVAC, Residential - AC and Gas Furnace	for AR: Central HVAC, Residential - AC and Gas Furnace; for NR: NA
	Pre/Ext Install Year	NA	NA	for AR: 2015 (auto-populated); for NR: NA
	Pre/Ext Install Year Basis	NA	NA	for AR: Deemed; for NR: NA
	Refrigerant Type	R-454B (GWP=466)	R-454B (GWP=466)	for AR: R-410A (GWP=2,088); for NR: NA
	GWP	Auto populated	Auto populated	for AR: Auto populated; for NR: NA
	Refrigerant Charge (lb/ NormUnit)	Auto populated		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
2 RACC (Baseline: Furnace Only)	WACC Selection	Statewide		
	Measure Description	Residential central heat pump, R-454B, replacing gas furnace only		
	Msr Install Year	2025		
	MeasAppType	AR or NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)	None (no refrigerant)	for AR: None (no refrigerant); for NR: NA
	TechGroup (NormUnit)	dxHP_equip (Cap-Tons)	SpaceHtg_eq (Cap-kBTUh)	for AR: SpaceHtg_eq (Cap-kBTUh); for NR: NA
	Device type	Central HVAC, Residential - Heat Pump	Central HVAC, Residential – Gas Furnace only	for AR: Central HVAC, Residential – Gas Furnace only; for NR: NA
	Pre/Ext Install Year	NA	NA	for AR: 2012; for NR: NA
	Pre/Ext Install Year Basis	NA	NA	for AR: Deemed; for NR: NA
	Refrigerant Type	R-454B (GWP=466)	None	for AR: None; for NR: NA
	GWP	Auto populated	NA	NA
	Refrigerant Charge (lb/ NormUnit)	Auto populated	NA	NA
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

DUCTLESS HEAT PUMP REPLACING RESIDENTIAL GAS FURNACE AND WEIGHTED BASELINE AC COOLING

Measure description

This example is a deemed measure that includes the installation of residential mini-split or multi-split ductless HP systems to replace either a window AC and wall furnace or wall furnace only. A sample of permutations is presented in this example based around a 2025 measure installation year, CZ01, and single-family building type. The existing and measure refrigerant type, when applicable, is assumed to be R-32 which adheres do the 700 GWP refrigerant limit in CARB and EPA regulations.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

There are several default refrigerant charge per normalizing unit values included in the RACC. These are not intended to be used as a default for measure packages. Users should conduct research into estimating charge levels for measure package development. For this example, we will use the default number in the worksheet for the “Ductless HVAC, Residential – Heat Pump” and “Window/Room/Wall AC and Packaged Terminal AC (PTAC) Units, residential” devices. These devices have a normalized refrigerant charge 3.5 lb/Cap-Tons and 1.54 lb/Cap-Tons, respectively.

Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

Note: The devices required for this measure example already exist in the 1 Device Builder worksheet.

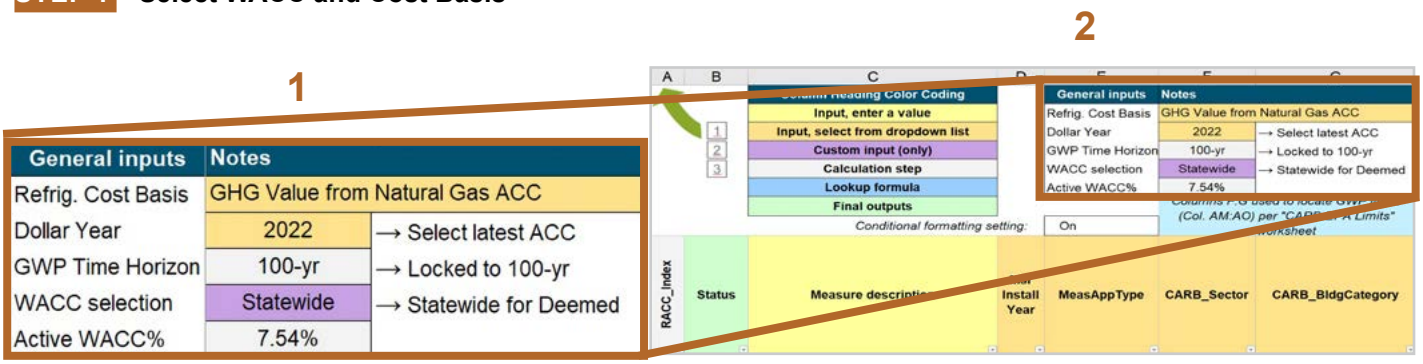
- Measure case device: “Ductless HVAC, Residential – Heat Pump”
- Standard, Pre/Ext device: “Ductless HVAC, Residential – Window AC and Wall Furnace”

STEP 2 **Add New Device**

The device required for this measure already exists; skip the add new device step.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current refrigerant emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

		1	2	3	4	5
	RACC_Index	Status	Measure description	Msr Install Year	MeasAppType	CARB_Sector	CARB_BldgCategory
▲	5	OK	Heat pump to replace gas furnace and AC	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial
●	6	OK	Heat pump to replace gas furnace	2025	NR	Stationary Air-conditioning	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

▲ **EXAMPLE:** "Heat pump to replace gas furnace and AC"

● **EXAMPLE:** "Heat pump to replace gas furnace"

2 Select the ***measure installation year*** from the dropdown menu

▲ ● **EXAMPLE BOTH:** 2025

3 Select the ***MeasAppType (MAT)*** from the dropdown menu

▲ ● **EXAMPLE NR measure:** The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

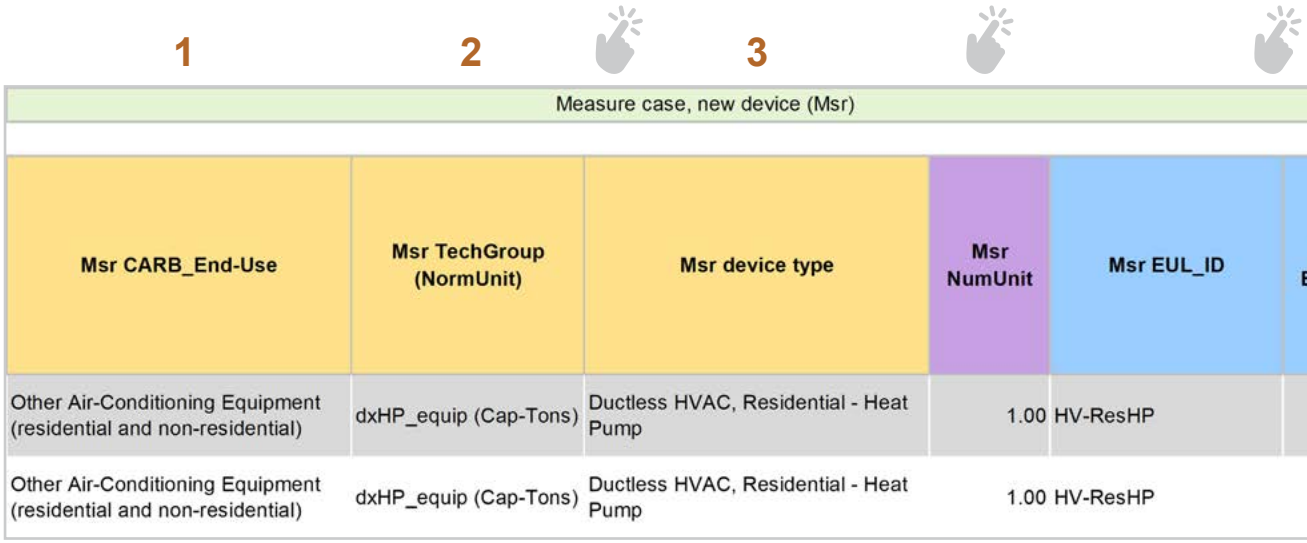
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** "Stationary Air-conditioning"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

▲ ● **EXAMPLE BOTH:** "Residential / Commercial / Industrial"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity



1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Other Air-Conditioning Equipment (residential and non-residential)"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxHP_equip (Cap-Tons)". This represents a Tech Group of "dxHP_equip," and a normalizing unit of "Cap-Tons."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Ductless HVAC, Residential – Heat Pump" device within the 1 Device Builder worksheet.

STEP 4 **Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity**

1 2 3

	Counterfactual New (Std)					
	Std CARB_End-Use	**Std TechGroup (NormUnit)**	**Std device type**	**Std NumUnit**	**Std EUL_ID**	**Std EUL_Yrs**
▲	Room/Wall/Window Air-Conditioning, PTACs, PTHPs, Portable Air-Conditioning, and Residential Dehumidifiers	dxAC_equip (Cap-Tons)	Ductless HVAC, Residential - Window AC and Wall Furnace	1.00	HV-RAC-ES	9.00
●	None (no refrigerant)	SpaceHtg_eq (Cap-kBTUh)	Ductless HVAC, Residential - Wall Furnace	1.00	HV-EffFurn	20.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

- ▲ **EXAMPLE:** "Room/Wall/Window Air-Conditioning, PTACs, PTHPs, Portable Air-Conditioning, and Residential Dehumidifiers"
- ● **EXAMPLE:** "None (no refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

- ▲ **EXAMPLE (AC and furnace):** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "dxAC_equip (Cap-Tons)." This represents a Tech Group of "dxAC_equip," and a normalizing unit of "Cap-Tons."
- ● **EXAMPLE (furnace only):** The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "SpaceHtg_eq (Cap-kBTUh)." This represents a Tech Group of "SpaceHtg_eq" and a normalizing unit of "Cap-kBTUh."

3 Select the ***standard device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

- ▲ **EXAMPLE (AC and furnace):** The standard case device is the "Ductless HVAC, Residential Window AC and Wall Furnace" device within the 1 Device Builder worksheet.
- ● **EXAMPLE (furnace only):** The standard case device is the "Ductless HVAC< Residential – Wall Furnace" device within the 1 Device Builder worksheet.

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding			*Refrigerant properties color coding*			*Refrigerant properties color coding*		
						The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
									Exceeds CARB-EPA limit, if any					
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
R-410A	R-410A		HFC-32 (GWP=675)	HFC-32 (GWP=675)		700	700		675	675		675	675	
R-410A	None		HFC-32 (GWP=675)	None		700			675	0		675	0	

▲ ●

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** Select "HFC-32 (GWP=675)" as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

▲ **EXAMPLE (AC and furnace):** The standard baseline in this example is limited by EPA's 2023 final rule limiting the GWP of these system to 700 GWP or less, which supersedes CARBs GWP limit of 750 GWP effective starting in 2023. This example assumes a standard refrigerant of HFC-32 matching the measure device refrigerant and meets refrigerant GWP regulations.

● **EXAMPLE (furnace only):** "None"

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is an NR measure, no input for the Pre/Ext system is required.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
3.50	1.54		3.50	1.54	
3.50	0.00		3.50	0.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** In this example, the refrigerant charge per Cap-Tons is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

A sample of measure permutations were selected for this walkthrough of the 3 FSC worksheet. The sample of example permutations is based on the SWHC044-03 Ductless HVAC, Residential, Fuel Substitution measure package. This example depicts how to input imputed cooling savings accounting for a mixed standard baseline where a proportion of the population would install window AC unit where none existing before.

For deemed measures, all information for all permutations of a measure package must be entered into the 3 FSC worksheet.

STEP 1 Input Measure Offering Classifications

FSC_Index	RACC_Index	Overall Result	RACC_Measure Description	Offering ID Description	Sector	BldgType	BldgVint	BldgLoc
887	5	PASS	5: Heat pump to replace gas furnace and AC in 2025 (NR)	SWHC044-03-AV: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing window AC and wall furnace	Res	SFm	Ex	CZ03
1,334	6	PASS	6: Heat pump to replace gas furnace in 2025 (NR)	SWHC044-03-AT: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing wall furnace	Res	SFm	Ex	CZ03
2,174	6	PASS	6: Heat pump to replace gas furnace in 2025 (NR)	SWHC044-03-AT: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing wall furnace-WITH IMPUTED COOLING	Res	SFm	Ex	CZ03

1 Enter in the ***offering ID description***. Users may input statewide measure offering ID(s), or a measure offering description to clearly identify the offering in each row.

EXAMPLE: "SWHC044-03-AV: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing window AC and wall furnace"

EXAMPLE: "SWHC044-03-AT: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing wall furnace"

EXAMPLE: "SWHC044-03-AT: Mini-split or multi-split ductless HP, SEER2 >= 15.2 and HSPF2 >= 7.8, replacing wall furnace-WITH IMPUTED COOLING"

2 Select the ***sector*** for the measure offering from the dropdown list or copy (as text) all sector permutations from the permutations table.

EXAMPLE: "Res", for all permutations in this example.

3 Select the ***BldgType*** for the measure offering from the dropdown list or copy (as text) all BldgType permutations from the permutations table.

EXAMPLE: This example depicts single family "SFm" building type permutations.

4 Select the **BldgVint** for the measure offering from the dropdown list or copy (as text) all BldgVint permutations from the permutations table.

EXAMPLE: "Ex", for all permutations in this example.

5 Select the ***BldgLoc*** for the measure offering from the dropdown list or copy (as text) all BldgLoc permutations from the permutations table.

EXAMPLE: This example depicts climate zone "CZ03" permutations.

6 Assign the refrigerant emissions calculation associated with each offering by selecting a ***RACC_Measure Description*** from the dropdown list. Each item in the dropdown list corresponds to a completed calculation row in the 2 RACC worksheet. This field assigns which avoided refrigerant emissions should be used for each measure offering for the fuel-substitution calculations. This is also how the offering(s) ***MeasAppType*** is assigned to each offering in the 3 FSC worksheet.

EXAMPLE (AC and furnace): Select "5: Heat pump to replace gas furnace and AC in 2025 (NR)".

EXAMPLE (furnace only, and furnace with imputed cooling): Select "6: Heat pump to replace gas furnace in 2025 (NR)".

STEP 2 Imputed Impacts of Standard Cooling Device Analysis

1 2

Measure case, new device (Msr)	Counterfactual Standard (Std)				Measure Existing (Pre)			
					Counterfactual Existing (Ext)			
					AR/NR only	AOE, AR, and--when existing refrigerant reclamation documentation is provided--NR		
Msr device type	Std device type	Std Device Cooling Proportion WeightID to Use, If Appropriate	Std Cooling Proportion for Imputed Impacts	FSC_Index for Basis of Imputed Impacts of Std Cooling Device	Pre Refrigerant Reclaimed Flag	Pre/Ext device type	Pre/Ext Install Year	Pre/Ext Install Year Basis
Ductless HVAC, Residential - Heat Pump	Ductless HVAC, Residential - Window AC and Wall Furnace	None	None		FALSE		-	-
Ductless HVAC, Residential - Heat Pump	Ductless HVAC, Residential - Wall Furnace	None	None		FALSE		-	-
Ductless HVAC, Residential - Heat Pump	Ductless HVAC, Residential - Wall Furnace	FS-rImputedDX	39%	887	FALSE		-	-

1 Assign the ***Std Device Cooling Proportion WeightID to Use, If Appropriate*** for the appropriate building weight ID corresponding to the measure.

EXAMPLE (furnace with imputed cooling): "FS-rImputedDX", not applicable for this measure.

2 Select the ***FSC_Index for Basis of Imputed Impacts of Std Cooling Device*** for the appropriate 3 FSC calculation row matching the offering with cooling in the Std device case.

EXAMPLE (furnace with imputed cooling): Select tow "887", which is the row associated with the "AC and furnace" counterpart to this "furnace only" calculation.

STEP 3 Annual Energy Usage by Case

1 2 3 4 5 6

Annual Energy Usage by Case						Imputed	Annual Energy Savings by Fuel & Baseline			
Msr		Std		Pre Ext		Std	If space cooling is imputed for the Std case (counterfactual new equipment), the imputed energy usage is taken into account in these columns.			
Note: At rows being used to create imputed-cooling permutations for space-conditioning, fuel-substitution measures, these Msr/Std/Pre/Ext fields should contain the annual energy usage values without cooling.				AR, only					AR, only	
Msr Annual Electric Usage, kWh per NormUnit	Msr Annual Natural Gas Usage, Therm per NormUnit	Std Annual Electric Usage, kWh per NormUnit	Std Annual Natural Gas Usage, Therm per NormUnit	Pre/Ext Annual Electric Usage, kWh per NormUnit	Pre/Ext Annual Natural Gas Usage, Therm per NormUnit	Imputed Std Annual Electric Usage, kWh per NormUnit	1st Baseline Annual Electric Savings, kWh per NormUnit	1st Baseline Annual Natural Gas Savings, Therm per NormUnit	2nd Baseline Annual Electric Savings, kWh per NormUnit	2nd Baseline Annual Natural Gas Savings, Therm per NormUnit
2,070.00	55.600	1,910.00	120.000				-160.00	64.400		
2,070.00	55.600	1,680.00	120.000				-390.00	64.400		
2,070.00	55.600	1,680.00	120.000			1,770.16	-299.84	64.400		

1 Input the measure device kWh usage in the ***Msr annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC044-03, see screenshot for specific example values.

2 Input the measure device kWh usage in the ***Msr annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC044-03, see screenshot for specific example values.

3 Input the measure device kWh usage in the ***Std annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC044-03, see screenshot for specific example values.

4 Input the measure device kWh usage in the Std annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWHC044-03, see screenshot for specific example values.

5 Input the measure device kWh usage in the Pre/Ext annual electric usage, kWh per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measure only.

6 Input the measure device kWh usage in the Pre/Ext annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measures only.

Summary

User inputs of this example are summarized in Table 5-4 and the total NPV net refrigerant cost in 2022 dollars is $125.34/Cap-Tons for the AC and furnace baseline measure offering and $233.80/CAP-Tons for the furnace only baseline measure offering.

Table 5-4. User inputs for mini-split or multi-split ductless HP, residential measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into charge amount per normalizing unit is required for this measure. This example assumes default values built into the sheet.		
1 Device Builder (Heat Pump)	Device Type	Ductless HVAC, Residential - Heat Pump		
	TechTypeID	dxHP_equip:spltSEER		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Residential Heat Pumps		
	Common Refrigerant Type(s)	R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	3.5		
	EUL_ID	HV-ResHP		
1 Device Builder (AC and Gas Furnace)	Device Type	Ductless HVAC, Residential - Window AC and Wall Furnace		
	TechTypeID	dxAC_equip:RoomAC		
	NormUnit	Cap-Tons		
	CARB_DeviceType	Window/Room/Wall AC and Packaged Terminal AC (PTAC) Units, residential		
	Common Refrigerant Type(s)	R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	1.54		
	EUL_ID	HV-RAC-ES		
1 Device Builder (Furnace Only)	Device Type	Ductless HVAC, Residential - Wall Furnace		
	TechTypeID	SpaceHtg_eq:GasFurnace		
	NormUnit	Cap-kBTUh		
	CARB_DeviceType	Eqmt. w/o refrigerant		
	Common Refrigerant Type(s)	None		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	0.00		
	EUL_ID	HV-EffFurn		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
2 RACC (Baseline: AC and Gas Furnace)	WACC Selection	Statewide		
	Measure Description	Heat pump to replace gas furnace and AC		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)	Room/Wall/ Window Air-Conditioning, PTACs, PTHPs, Portable Air-Conditioning, and Residential Dehumidifiers	NA
	TechGroup (NormUnit)	dxHP_equip (Cap-Tons)	dxAC_equip (Cap-Tons)	SpaceHtg_eq (Cap-kBTUh)
	Device type	Ductless HVAC, Residential - Heat Pump	Ductless HVAC, Residential - Window AC and Wall Furnace	Ductless HVAC, Residential - Wall Furnace
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	HFC-32 (GWP=675)	HFC-32 (GWP=675)	NA
	GWP	Auto populated	Auto populated	Auto populated
	Refrigerant Charge (lb/ NormUnit)	Auto populated		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
2 RACC (Baseline: Furnace Only)	WACC Selection	Statewide		
	Measure Description	Heat pump to replace gas furnace		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Stationary Air-conditioning		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Other Air-Conditioning Equipment (residential and non-residential)	None (no refrigerant)	NA
	TechGroup (NormUnit)	dxHP_equip (Cap-Tons)	SpaceHtg_eq (Cap-kBTUh)	NA
	Device type	Ductless HVAC, Residential - Heat Pump	Ductless HVAC, Residential - Wall Furnace	NA
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	HFC-32 (GWP=675)	None	NA
	GWP	Auto populated	Auto populated	NA
	Refrigerant Charge (lb/ NormUnit)	Auto populated	NA	NA
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

section 6

Appliance Measures

HEAT PUMP WATER HEATER, RESIDENTIAL, FUEL-SUBSTITUTION

Measure description

This example is a deemed measure that includes the replacement of residential natural gas storage water heater with a heat pump water heater (HPWH). Currently, there is no regulation by CARB or the EPA on HPWH refrigerants. This may change in the future, however for this example we assume a HPWH with R-134a as the refrigerant type.

This example will model both AR and NR scenarios as separate measure offerings.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

This example is based on an existing measure package, SWWH025-06, and uses the researched charge level of 2.4 lb. per device (each).

Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

Note: The devices required for this measure example already exist in the 1 Device Builder worksheet.

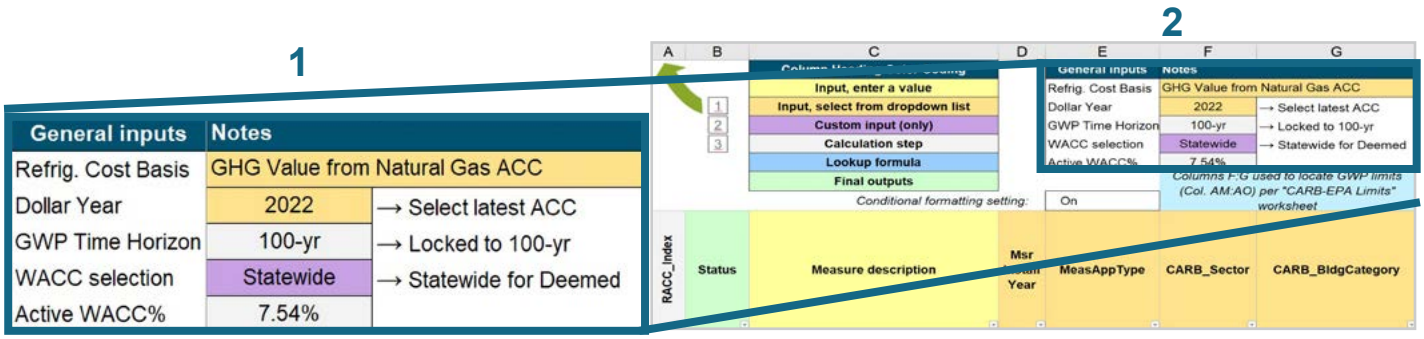
- Measure case device: “Water Heater, Residential – Heat Pump”
- Standard, Pre/Ext device: “Water Heater, Residential – Natural Gas”

STEP 2 **Add New Device**

The device required for this measure already exists; skip the add new device step.

Input Worksheet: 2 RACC

STEP 1 Select WACC and Cost Basis



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

	1	2	3	4	5
	Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
▲	Water Heater, Residential - Heat Pump	2025	NR	Appliance	Residential / Commercial / Industrial
●	Water Heater, Residential - Heat Pump	2025	AR	Appliance	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

▲ ● **EXAMPLE BOTH:** "Water Heater, Residential – Heat Pump"

2 Select the ***measure installation year*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** This example is for a 2025 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

▲ **EXAMPLE NR MEASURE:** NR (normal replacement). The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

● **EXAMPLE AR MEASURE:** AR (accelerated replacement). This measure offering is for equipment that would remain in operation without program intervention and has not exceeded the EUL.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** "Appliance"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

▲ ● **EXAMPLE BOTH:** "Residential / Commercial / Industrial"

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**

Measure case, new device (Msr)					
Msr CARB_End-Use	Msr TechGroup (NormUnit)	Msr device type	Msr NumUnit	Msr EUL_ID	Msr EUL_Yrs
▲ Heat Pump Water Heaters	WaterHtg_eq (Each)	Water Heater, Residential - Heat Pump	1.00	WtrHt-HtPmp	10.00
● Heat Pump Water Heaters	WaterHtg_eq (Each)	Water Heater, Residential - Heat Pump	1.00	WtrHt-HtPmp	10.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "Heat Pump Water Heaters"

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

▲ ● **EXAMPLE BOTH:** The measure device, "Water Heater, Residential – Heat Pump," found in the 1 Device Builder worksheet has a TechGroup (NormUnit) parameter of "WaterHtg_eq (each)." This represents a Tech Group of "WaterHtg_eq," and a normalizing unit of "each."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The measure case device is the "Water Heater, Residential – Heat Pump" device within the 1 Device Builder worksheet.

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity

Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
▲ None (no refrigerant)	WaterHtg_eq (Each)	Water Heater, Residential - Natural Gas	1.00	WtrHt-Res-Gas	11.00
● None (no refrigerant)	WaterHtg_eq (Each)	Water Heater, Residential - Natural Gas	1.00	WtrHt-Res-Gas	11.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

▲ ● **EXAMPLE BOTH:** "None (no refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

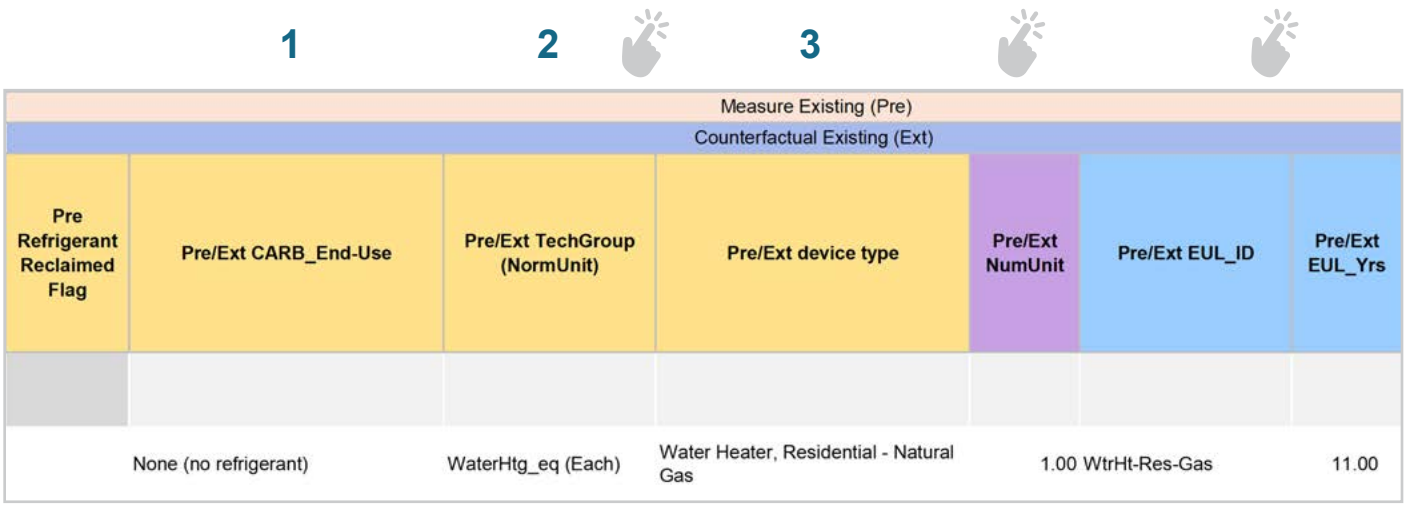
▲ ● **EXAMPLE BOTH:** The standard case device, "Water Heater, Residential – Natural Gas," found in the 1 Device Builder worksheet has a TechGroup (NormUnit) parameter of "WaterHtg_eq (each)." This represents a Tech Group of "WaterHtg_eq," and a normalizing unit of "each."

3 Select the ***standard case device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

▲ ● **EXAMPLE BOTH:** The standard case device is the "Water Heater, Residential – Natural Gas" device within the 1 Device Builder worksheet.

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

Note that the Pre/Existing Device input is only for AR measure applications.



Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	None (no refrigerant)	WaterHtg_eq (Each)	Water Heater, Residential - Natural Gas	1.00	WtrHt-Res-Gas	11.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "None (no refrigerant)"

2 Assign ***pre/existing case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The pre/existing case device, "Water Heater, Residential – Natural Gas," found in the 1 Device Builder worksheet has a TechGroup (NormUnit) parameter of "WaterHtg_eq (each)." This represents a Tech Group of "WaterHtg_eq," and a normalizing unit of "each."

3 Select the ***pre/existing device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The pre/existing case device is the "Water Heater, Residential – Natural Gas" device within the 1 Device Builder worksheet.

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

4

4 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: The ***Pre/Ext Install Year*** is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

	Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
							Refrigerant properties color coding The CARB-EPA limit is used in calcs.			Refrigerant properties color coding Value replaced formula Exceeds CARB-EPA limit, if any			Refrigerant properties color coding Value replaced formula		
	Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
▲	HFC-134A|R-410A	None		HFC-134a (GWP=1,430)	None		None			1,430	0		1,430	0	
●	HFC-134A|R-410A	None	None	HFC-134a (GWP=1,430)	None	None	None		None	1,430	0	0	1,430	0	0

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** Select “HFC-134a (GWP=1,430)” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

▲ ● **EXAMPLE BOTH:** The standard baseline for both NR and AR in this example is for a natural gas water heater, for non-refrigerant equipment select “None.”

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

● **EXAMPLE AR ONLY:** Select “None” as the existing refrigerant.

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
▲ 2.40	0.00		2.40	0.00	
● 2.40	0.00	0.00	2.40	0.00	0.00

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

▲ ● **EXAMPLE BOTH:** In this example the refrigerant charge per each is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

▲ ● **EXAMPLE BOTH:** In this example the refrigerant charge per each is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

A sample of measure permutations were selected for this walkthrough of the 3 FSC worksheet. The sample of example permutations is sourced from the SWWH025-06 Heat Pump Water heater, Residential, Fuel Substitution measure package.

For deemed measures, all information for all permutations of a measure package must be entered into the 3 FSC worksheet.

STEP 1 Input Measure Offering Classifications

		6		1	2	3	4	5
FSC_Index	RACC_Index	Overall Result	RACC_Index Description	Offering ID	Sector	BldgType	BldgVint	BldgLoc
1	1	PASS	1: Water Heater, Residential - Heat Pump in 2025 (NR)	SWWH025-06-AA: Heat pump water heater, > 55 to <= 75 gal, UEF = 3.50 replacing storage natural gas water heater, 60 gal, UEF = 0.61	Res	SFm	Ex	CZ16
2	1	PASS	1: Water Heater, Residential - Heat Pump in 2025 (NR)	SWWH025-06-AA: Heat pump water heater, > 55 to <= 75 gal, UEF = 3.50 replacing storage natural gas water heater, 60 gal, UEF = 0.61	Res	MFm	Ex	CZ16
4	2	PASS	2: Water Heater, Residential - Heat Pump in 2025 (AR)	SWWH025-06-AA: Heat pump water heater, > 55 to <= 75 gal, UEF = 3.50 replacing storage natural gas water heater, 60 gal, UEF = 0.61	Res	SFm	Ex	CZ12
5	2	PASS	2: Water Heater, Residential - Heat Pump in 2025 (AR)	SWWH025-06-AA: Heat pump water heater, > 55 to <= 75 gal, UEF = 3.50 replacing storage natural gas water heater, 60 gal, UEF = 0.61	Res	MFm	Ex	CZ12

1 Enter in the ***offering ID***. Users may input statewide measure offering ID(s), or a measure offering description to clearly identify the offering in each row.

EXAMPLE: All of the sampled permutations are for offering ID "AA" of measure package SWWWH025-06, or "Heat pump water heater, >55 to <=75 gal, UE = 3.50 replacing storage natural gas water heater, 60 gal, UEF = 0.61".

2 Select the ***sector*** for the measure offering from the dropdown list or copy (as text) all ***sector*** permutations from the permutations table.

EXAMPLE: "Res", for all permutations in this example.

3 Select the ***BldgType*** for the measure offering from the dropdown list or copy (as text) all ***BldgType*** permutations from the permutations table.

EXAMPLE: This example depicts single family "SFm", and multifamily "MFm" building type permutations.

4 Select the **BldgVint** for the measure offering from the dropdown list or copy (as text) all ***BldgVint*** permutations from the permutations table.

EXAMPLE: "Ex", for all permutations in this example.

5 Select the ***BldgLoc*** for the measure offering from the dropdown list or copy (as text) all ***BldgLoc*** permutations from the permutations table.

EXAMPLE: This example depicts climate zone "CZ12" and "CZ16" permutations.

6 Assign the refrigerant emissions calculation associated with each offering by selecting a ***RACC_Measure Description*** from the dropdown list. Each item in the dropdown list corresponds to a completed calculation row in the 2 RACC worksheet. This field assigns which avoided refrigerant emissions should be used for each measure offering for the fuel-substitution calculations. This is also how the offering(s) ***MeasAppType*** is assigned to each offering in the 3 FSC worksheet.

EXAMPLE: Two NR and two AR measure offering are depicted in this example which correspond to "1: Water Heater, Residential - Heat Pump in 2025 (NR)" and "2: Water Heater, Residential – Heat Pump in 2025 (AR)".

STEP 2 Imputed Impacts of Standard Cooling Device Analysis

1 2

Measure case, new device (Msr)	Counterfactual Standard (Std)				Measure Existing (Pre)			
						Counterfactual Existing (Ext)		
					AR/NR only	AOE, AR, and--when existing refrigerant reclamation documentation is provided--NR		
Msr device type	Std device type	Std Device Cooling Proportion WeightID to Use, If Appropriate	Std Cooling Proportion for Imputed Impacts	FSC_Index for Basis of Imputed Impacts of Std Cooling Device	Pre Refrigerant Reclaimed Flag	Pre/Ext device type	Pre/Ext Install Year	Pre/Ext Install Year Basis
Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	None	None				-	-
Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	None	None				-	-
Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	None	None			Water Heater, Residential - Natural Gas	2018	Deemed
Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	None	None			Water Heater, Residential - Natural Gas	2018	Deemed

1 Assign the ***Std Device Cooling Proportion WeightID to Use, If Appropriate*** for the appropriate building weight ID corresponding to the measure.

EXAMPLE: "None", not applicable for this measure.

2 Select the ***FSC_Index for Basis of Imputed Impacts of Std Cooling Device*** for the appropriate 3 FSC calculation row matching the offering with cooling in the Std device case.

EXAMPLE: Not applicable for this measure.

STEP 3 Annual Energy Usage by Case

1 2 3 4 5 6

Annual Energy Usage by Case					
Msr		Std		Pre	
				Ext	
Note: At rows being used to create imputed-cooling permutations for space-conditioning, fuel-substitution measures, these Msr/Std/Pre/Ext fields should contain the annual energy usage values without cooling.				AR, only	
Msr annual usage, kWh per NormUnit	Msr annual usage, therm per NormUnit	Std annual usage, kWh per NormUnit	Std annual usage, therm per NormUnit	Pre/Ext annual usage, kWh per NormUnit	Pre/Ext annual usage, therm per NormUnit
2,360.00	0.000	0.00	240.000		
1,360.00	0.000	0.00	202.000		
1,500.00	0.000	0.00	214.000	0.00	61.143
1,150.00	0.000	0.00	186.000	0.00	53.143

1 Input the measure device kWh usage in the ***Msr annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

2 Input the measure device kWh usage in the ***Msr annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

3 Input the measure device kWh usage in the ***Std annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

4 Input the measure device kWh usage in the Std annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

5 Input the measure device kWh usage in the Pre/Ext annual electric usage, kWh per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measure only. This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

6 Input the measure device kWh usage in the Pre/Ext annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measures only. This example sources energy usage values from SWWWH025-06, see screenshot for specific example values.

Summary

User inputs of this example are summarized in Table 6-1 and the total NPV net refrigerant cost in 2022 dollars for AR and NR offerings is $222.20/each device.

Table 6-1. User inputs for residential heat pump water heater, replacing storage natural gas water heater measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into the charge amount per normalizing unit is required for this measure. This example assumes a nominal charge of 2.40 lb. per residential HPWH.		
1 Device Builder	Device Type	Water Heater, Residential - Heat Pump		
	TechTypeID	WaterHtg_eq:HP_UEF		
	NormUnit	Each		
	CARB_DeviceType	Heat Pump Water Heaters		
	Common Refrigerant Type(s)	HFC-134A|R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	2.4		
	EUL_ID	WtrHt-HtPmp		
2 RACC (NR measure)	WACC Selection	Statewide		
	Refrig. Cost Basis	GHG Value from Natural Gas ACC		
	Measure Description	Water Heater, Residential - Heat Pump, NR		
	Msr Install Year	2025		
	MeasAppType	NR		
	CARB_Sector	Appliance		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Heat Pump Water Heaters	None (no refrigerant)	N/A
	TechGroup (NormUnit)	WaterHtg_eq (Each)	WaterHtg_eq (Each)	N/A
	Device type	Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	N/A
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	HFC-134a (GWP=1,430)	None	None
	GWP	Auto populated	0	0
	Refrigerant Charge (lb/ NormUnit)	2.4 (auto-populated)		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
(Inputs for the AR measure that differ from the NR measure)				
2 RACC (AR measure)	CARB_End-Use	Heat Pump Water Heaters	None (no refrigerant)	None (no refrigerant)
	TechGroup (NormUnit)	WaterHtg_eq (Each)	WaterHtg_eq (Each)	WaterHtg_eq (Each)
	Device type	Water Heater, Residential - Heat Pump	Water Heater, Residential - Natural Gas	Water Heater, Residential - Natural Gas
	Pre/Ext Install Year	NA	NA	2012 (auto-populated)
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	HFC-134a (GWP=1,430)	None	None
	GWP	Auto populated	0	0

HEAT PUMP CLOTHES DRYER, RESIDENTIAL, FUEL-SUBSTITUTION

Measure description

This example is a deemed measure that includes the replacement of residential natural gas clothes dryer with a heat pump clothes dryer. Currently, there is no regulation by CARB or the EPA on heat pump clothes dryer refrigerants. This may change in the future, however for this example we assume the proposed equipment is using R-134a as the refrigerant type.

This example will model only NR scenarios.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. Users should input the researched charge per normal unit values, specific to a particular refrigerant type, for the device(s) when developing a measure package.

This example is based on an existing measure package, SWAP014-03, and uses the researched charge level of 0.882 lb. per device (each).

Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if desired equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

Note: The devices required for this measure example already exist in the 1 Device Builder worksheet.

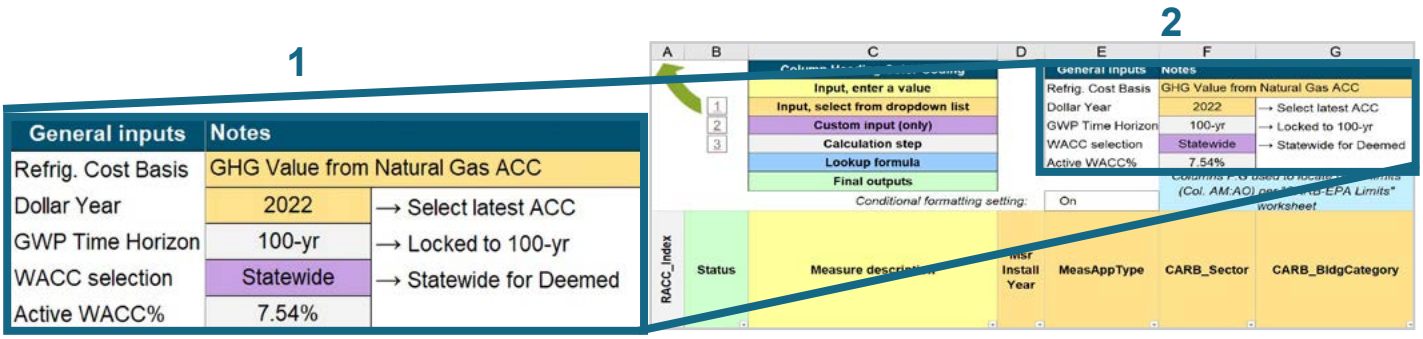
- Measure case device: “Clothes Dryer, Residential - Heat Pump”
- Standard device: “Clothes Dryer, Residential - Conventional Gas”

STEP 2 **Add New Device**

The device required for this measure already exists; skip the add new device step.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: Since this example is for a deemed measure, the WACC selection must be set to "Statewide."

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Heat pump clothes dryer, residential, replacing conventional gas clothes dryer	2024	NR	Appliance	Residential / Commercial / Industrial

1 Enter in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE: "Heat pump clothes dryer, residential, replacing conventional gas clothes dryer"

2 Select the ***measure installation year*** from the dropdown menu.

EXAMPLE: This example is for a 2024 install year.

3 Select the ***MeasAppType*** (MAT) from the dropdown menu.

EXAMPLE: The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

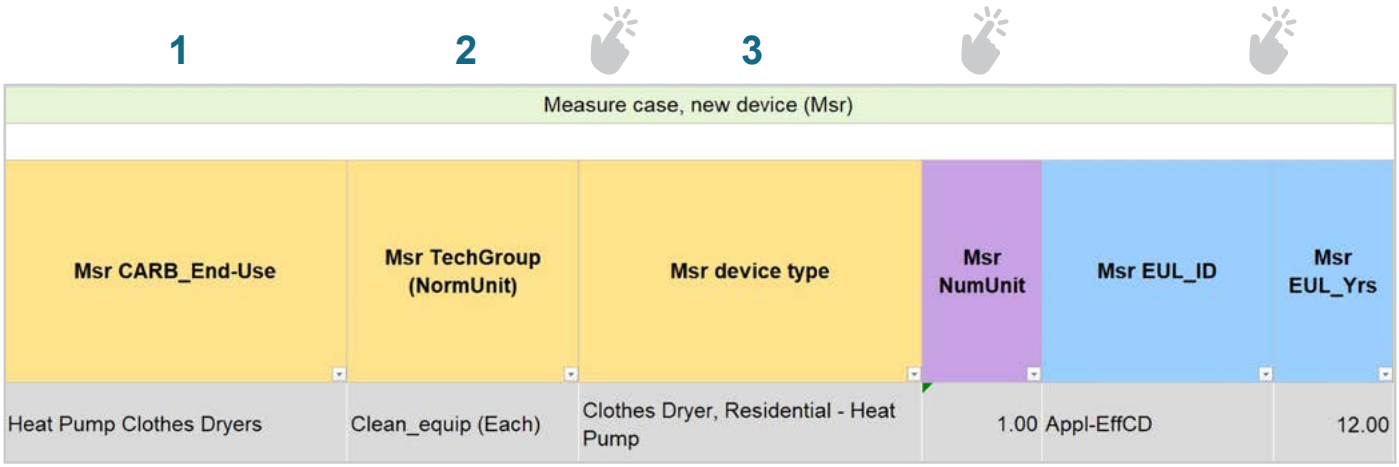
4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE: "Appliance"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet.

EXAMPLE: "Residential / Commercial / Industrial"

STEP 3 **Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity**



1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Heat Pump Water Heaters"

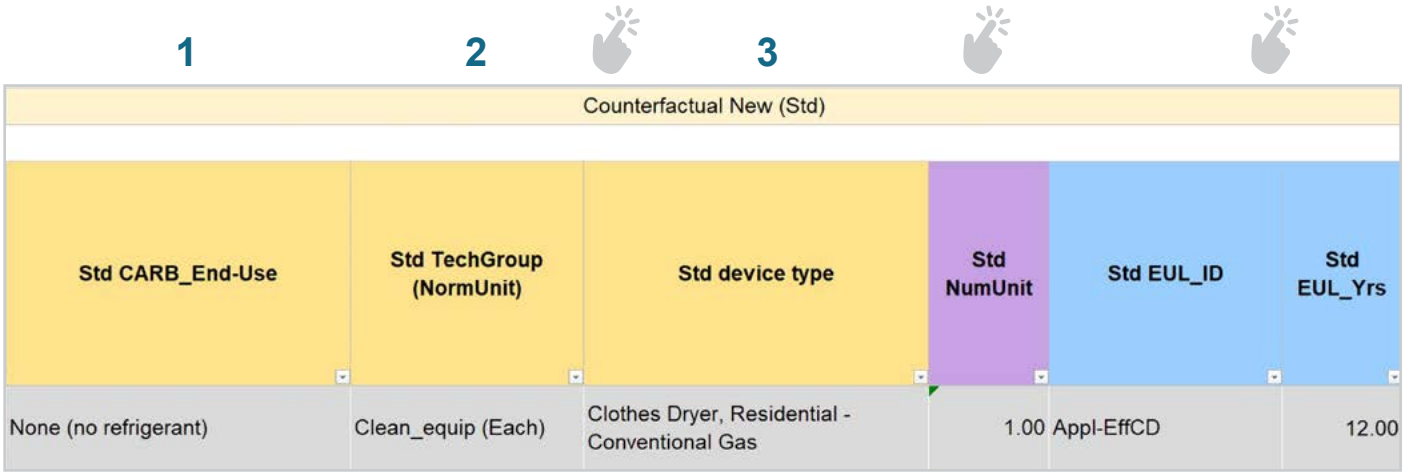
2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device found in the 1 Device Builder worksheet has a TechGroup (NormUnit) parameter of "Clean_equip (Each)." This represents a Tech Group of "Clean_equip" and a normalizing unit of "each."

3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Clothes Dryer, Residential - Heat Pump" device within the 1 Device Builder worksheet.

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
None (no refrigerant)	Clean_equip (Each)	Clothes Dryer, Residential - Conventional Gas	1.00	Appl-EffCD	12.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "None (no refrigerant)"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device found in the 1 Device Builder worksheet has a TechGroup (NormUnit) parameter of "Clean_equip (Each)." This represents a Tech Group of "Clean_equip" and a normalizing unit of "each."

3 Select the ***standard case device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the "Clothes Dryer, Residential - Conventional Gas" device within the 1 Device Builder worksheet.

STEP 5 Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year

Note that the Pre/Existing Device input is only for AR measure applications. No input is required since this is an NR measure.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding The CARB-EPA limit is used in calcs.			*Refrigerant properties color coding* Value replaced formula Exceeds CARB-EPA limit, if any			*Refrigerant properties color coding* Value replaced formula		
Msr Predefined Common Refrigerant(s)	**Std Predefined Common Refrigerant(s)**	**Pre/Ext Predefined Common Refrigerant(s)**	**Msr Refrigerant Type**	**Std Refrigerant Type**	**Pre/Ext Refrigerant Type**	**Msr GWP limit per CARB-EPA**	**Std GWP limit per CARB-EPA**	**Pre/Ext GWP limit per CARB-EPA**	**Msr GWP**	**Std GWP**	**Pre/Ext GWP**	**Msr GWP, User Specified**	**Std GWP, User Specified**	**Pre/Ext GWP, User Specified**
R-134A|R-407C|R-410A	None		HFC-134a (GWP=1,430)	None		None			1,430	0		1,430	0	

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: Select “HFC-134a (GWP=1,430)” as the measure case refrigerant.

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: The standard baseline for both NR and AR in this example is for a natural gas clothes dryer, for non-refrigerant equipment select “None.”

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: This is a NR measure; no input for the Pre/Ext system is required.

STEP 7 **Input Refrigerant Charge**

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.88	0.00		0.88	0.00	

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

> **EXAMPLE:** In this example the refrigerant charge per each is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the **RefrigCharge Pounds Per NormUnit** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

> **EXAMPLE:** In this example the refrigerant charge per each is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 ACC worksheet.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

A sample of measure permutations were selected for this walkthrough of the 3 FSC worksheet. The sample of example permutations is sourced from the SWAP014-02 Heat Pump Clothes Dryer, Residential, Fuel Substitution measure package.

For deemed measures, all information for all permutations of a measure package must be entered into the 3 FSC worksheet.

STEP 1 Input Measure Offering Classifications

			6	1	2	3	4	5
FSC_Index	RACC_Index	Overall Result	RACC_Index Description	Offering ID	Sector	BldgType	BldgVint	BldgLoc
1	1	PASS	1: Heat pump clothes dryer, residential, replacing conventional gas clothes dryer in 2024 (NR)	SWAP014-02-H: Compact size heat pump clothes dryer, 240 volt, vented, dwelling	Res	SFm	Ex	CZ01
2	1	PASS	1: Heat pump clothes dryer, residential, replacing conventional gas clothes dryer in 2024 (NR)	SWAP014-02-H: Compact size heat pump clothes dryer, 240 volt, vented, dwelling	Res	MFm	Ex	CZ01
3	1	PASS	1: Heat pump clothes dryer, residential, replacing conventional gas clothes dryer in 2024 (NR)	SWAP014-02-H: Compact size heat pump clothes dryer, 240 volt, vented, dwelling	Res	DMo	Ex	CZ01

1 Enter in the ***offering ID***. Users may input statewide measure offering ID(s), or a measure offering description to clearly identify the offering in each row.

EXAMPLE: All of the sampled permutations are for offering ID "H" of measure package SWAP014-02, or "Compact size heat pump clothes dryer, 240 volt, vented, dwelling".

2 Select the ***sector*** for the measure offering from the dropdown list or copy (as text) all ***sector*** permutations from the permutations table.

EXAMPLE: "Res", for all permutations in this example.

3 Select the ***BldgType*** for the measure offering from the dropdown list or copy (as text) all ***BldgType*** permutations from the permutations table.

EXAMPLE: This example depicts single family "SFm", and multi-family "MFm" and Mobile Home "DMo" building type permutations.

4 Select the **BldgVint** for the measure offering from the dropdown list or copy (as text) all ***BldgVint*** permutations from the permutations table.

EXAMPLE: "Ex", for all permutations in this example.

5 Select the ***BldgLoc*** for the measure offering from the dropdown list or copy (as text) all ***BldgLoc*** permutations from the permutations table.

EXAMPLE: This example depicts climate zone "CZ01" permutations.

6 Assign the refrigerant emissions calculation associated with each offering by selecting a ***RACC_Measure Description*** from the dropdown list. Each item in the dropdown list corresponds to a completed calculation row in the 2 RACC worksheet. This field assigns which avoided refrigerant emissions should be used for each measure offering for the fuel-substitution calculations. This is also how the offering(s) ***MeasAppType*** is assigned to each offering in the 3 FSC worksheet.

EXAMPLE: All offering use "1: Heat pump clothes dryer, residential, replacing conventional gas clothes dryer in 2024 (NR)".

STEP 2 Imputed Impacts of Standard Cooling Device Analysis

1 2

Measure case, new device (Msr)	Counterfactual Standard (Std)				Measure Existing (Pre)			
						Counterfactual Existing (Ext)		
					AR/NR only	AOE, AR, and--when existing refrigerant reclamation documentation is provided--NR		
Msr device type	Std device type	Std Device Cooling Proportion WeightID to Use, If Appropriate	Std Cooling Proportion for Imputed Impacts	FSC_Index for Basis of Imputed Impacts of Std Cooling Device	Pre Refrigerant Reclaimed Flag	Pre/Ext device type	Pre/Ext Install Year	Pre/Ext Install Year Basis
Clothes Dryer, Residential - Heat Pump	Clothes Dryer, Residential - Conventional Gas	None	None				-	-
Clothes Dryer, Residential - Heat Pump	Clothes Dryer, Residential - Conventional Gas	None	None				-	-
Clothes Dryer, Residential - Heat Pump	Clothes Dryer, Residential - Conventional Gas	None	None				-	-

1 Assign the ***Std Device Cooling Proportion WeightID to Use, If Appropriate*** for the appropriate building weight ID corresponding to the measure.

EXAMPLE: "None", not applicable for this measure.

2 Select the ***FSC_Index for Basis of Imputed Impacts of Std Cooling Device*** for the appropriate 3 FSC calculation row matching the offering with cooling in the Std device case.

EXAMPLE: Not applicable for this measure.

STEP 3 **Annual Energy Usage by Case**

1 2 3 4 5 6

Annual Energy Usage by Case					
Msr		Std		Pre	
Note: At rows being used to create imputed-cooling permutations for space-conditioning, fuel-substitution measures, these Msr/Std/Pre/Ext fields should contain the annual energy usage values without cooling.				Ext	
				AR, only	
Msr annual usage, kWh per NormUnit	Msr annual usage, therm per NormUnit	Std annual usage, kWh per NormUnit	Std annual usage, therm per NormUnit	Pre/Ext annual usage, kWh per NormUnit	Pre/Ext annual usage, therm per NormUnit
105.00	-0.424	52.40	13.600		
105.00	-0.424	52.40	13.600		
105.00	-0.424	52.40	13.600		

1 Input the measure device kWh usage in the ***Msr annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

2 Input the measure device kWh usage in the ***Msr annual natural gas usage, Therm per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

3 Input the measure device kWh usage in the ***Std annual electric usage, kWh per NormUnit*** column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

4 Input the measure device kWh usage in the Std annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

5 Input the measure device kWh usage in the Pre/Ext annual electric usage, kWh per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measure only. This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

6 Input the measure device kWh usage in the Pre/Ext annual natural gas usage, Therm per NormUnit column for each offering. For deemed measures, this information is required for the permutations table.

EXAMPLE: AR measures only. This example sources energy usage values from SWAP014-02, see screenshot for specific example values.

Summary

User inputs of this example are summarized in Table 6-2 and the total avoided cost in 2022 dollars for this NR offering is $79.06/each device.

Table 6-2. User inputs for residential heat pump clothes dryer, replacing a conventional gas heated clothes dryer measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into the charge amount per normalizing unit is required for this measure. This example assumes a nominal charge of 0.882 lb. per residential HP Clothes Dryer.		
1 Device Builder	Device Type	Clothes Dryer, Residential - Heat Pump		
	TechTypeID	Clean_equip:ClothesDry-HP		
	NormUnit	Each		
	CARB_DeviceType	Heat Pump Clothes Dryers		
	Common Refrigerant Type(s)	R-134A|R-407C|R-410A		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	0.882		
	EUL_ID	Appl-EffCD		
2 RACC (NR measure)	WACC Selection	Statewide		
	Refrig. Cost Basis	GHG Value from Natural Gas ACC		
	Measure Description	Heat pump clothes dryer, residential, replacing conventional gas clothes dryer		
	Msr Install Year	2024		
	MeasAppType	NR		
	CARB_Sector	Appliance		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Heat Pump Clothes Dryers	None (no refrigerant)	NA
	TechGroup (NormUnit)	Clean_equip (Each)	Clean_equip (Each)	NA
	Device type	Clothes Dryer, Residential - Heat Pump	Clothes Dryer, Residential - Conventional Gas	NA
	Pre/Ext Install Year	NA	NA	NA
	Pre/Ext Install Year Basis	NA	NA	NA
	Refrigerant Type	HFC-134a (GWP=1,430)	None	None
	GWP	Auto populated	0	0
	Refrigerant Charge (lb/ NormUnit)	0.882 (auto-populated)		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		

RESIDENTIAL REFRIGERATOR, FREEZER

Measure description

Residential refrigerators and freezers are regulated by both EPA and CARB. In the October 2023 Final Rule EPA establishes refrigerant limit of 150 GWP, effective starting January 1, 2025. CARB on the other hand prohibits the use of certain refrigerants from all residential consumer refrigeration products by 2023. The residential refrigerator and freezer market appears to be transitioning to natural refrigerants on its own, with refrigerants like isobutane (R-600a) becoming a common refrigerant in use by many OEMs. The existing devices with higher-GWP refrigerants is still subject to the emissions from EOL leakage when replacing these units.

The example described here is for a residential refrigerator device with R-600a refrigerant as the measure and standard cases, and R-134a as the pre-existing refrigerant. Two scenarios are explored, the first is an accelerator replacement of the R-134a refrigerator for an R-600a refrigerator, and the second is a normal replacement measure where the measure and standard cases are both R-600a and the failed existing equipment refrigerant is reclaimed avoiding EOL emissions.

Measure input walkthrough

Input worksheet: 0 Refrig Research

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This worksheet is used to document refrigerant charge per normal unit for Deemed Measure Package development. This tab needs to be filled out if this is a deemed measure based on research.

For the purposes of this example, we will be assuming the CARB average refrigerant charge levels for household refrigerators and freezers.

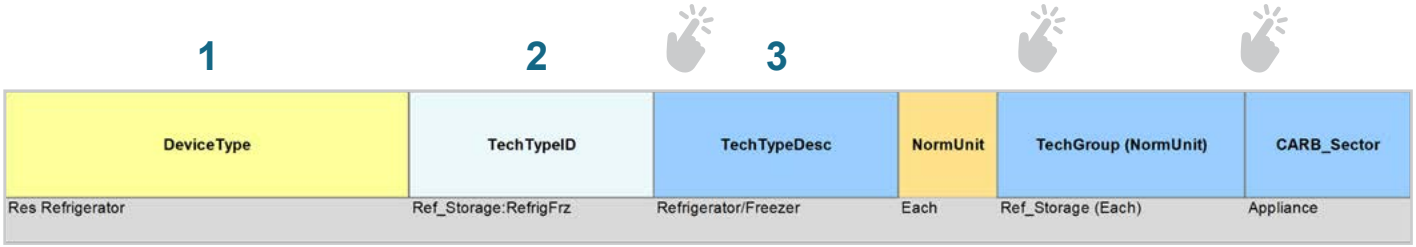
Input Worksheet: 1 Device Builder

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

STEP 1 **Check to see if Commercial ice machines, self-contained (> 500g charge) equipment is listed in the Device Builder table.**

- If yes, continue to the 2 RACC worksheet.
- If no, add new device to the end of the table.

STEP 2 **Add New Device**

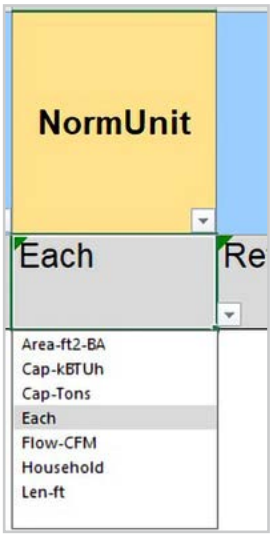


DeviceType, TechTypeID, NormUnit, CARB_Sector

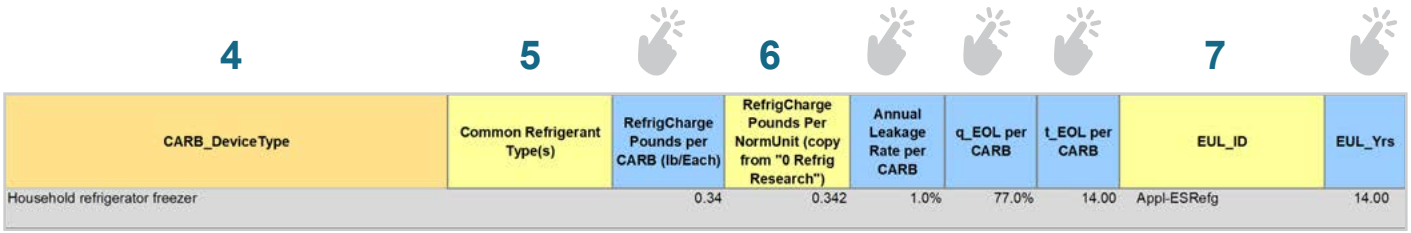
1 Start by adding a unique ***DeviceType*** name below the last row (this is required for lookup functionality)
- **EXAMPLE:** We entered "Res Refrigerator"

2 Select the appropriate ***TechTypeID*** from the dropdown menu in the next column. When an exact match is not available, use the best available TechTypeID.
- **EXAMPLE:** For residential refrigerators, we will use "Ref_Storage:RefrigFrz."

3 NormUnit is auto filled based on the ***TechTypeID***. If a different normal unit is required, override NormUnit by selecting from the dropdown menu in this cell.



STEP 2 **Add New Device, continued**



4	5	6			7		
CARB_DeviceType	Common Refrigerant Type(s)	RefrigCharge Pounds per CARB (lb/Each)	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	Annual Leakage Rate per CARB	q_EOL per CARB	t_EOL per CARB	EUL_ID	EUL_Yrs
Household refrigerator freezer		0.34	0.342	1.0%	77.0%	14.00	Appl-ESRefg	14.00

CARB_DeviceType, Refrigerant Charge, Leakage Rates, EUL

4 Drag the formula down from the ***CARB_DeviceType*** column in the row above).

- Select the desired ***CARB_DeviceType*** from the dropdown menu.

  EXAMPLE: "Household refrigerator freezer"

5 (Optional) Input ***Common Refrigerant Type(s)*** used in the devices you are entering.

- This is for reference purposes to understand what the current standard practice is for existing equipment. This does not affect the calculations in any way. Actual refrigerant types for the measure, standard, and pre/existing cases are defined in the 2 RACC worksheet.

  EXAMPLE: CARB estimates an average charge of 0.34 lb. of refrigerant for the "Household refrigerator freezer" device.

6 The ***RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")*** column is to enter the refrigerant charge per normal unit for the new DeviceType. This value is used in the 2 RACC worksheet estimate avoided emissions.

- For **Deemed Measure Packages**, users would want to input the refrigerant charge per normal unit that is documented in the 0 Refrig Research worksheet for this device.
- For **Custom Measures**, this can be left blank, and the equipment-specific charges will be entered in the 2 RACC worksheet. This cell can be filled with equipment-specific charges and in the 2 RACC worksheet, there is no need to enter the charge size values.

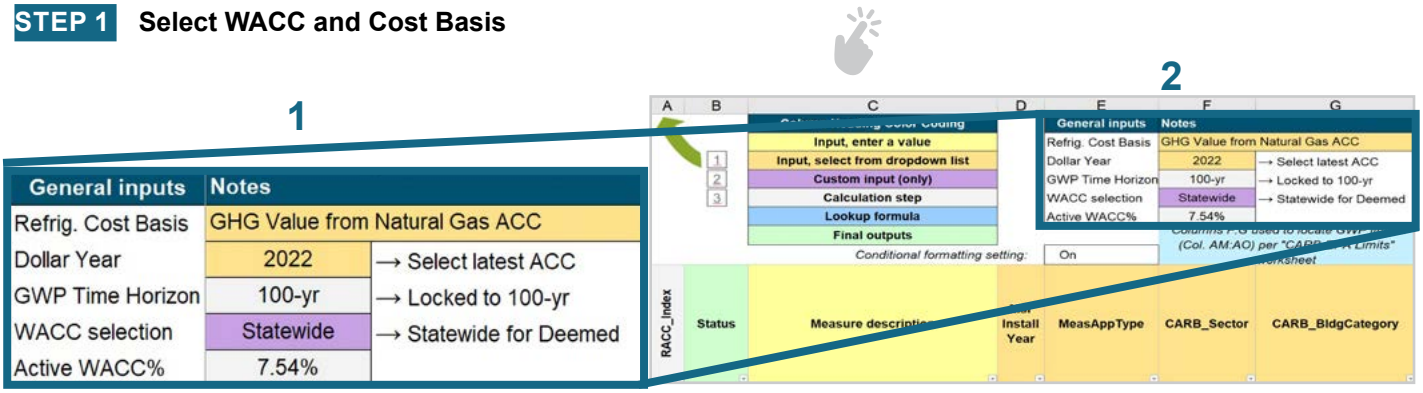
  EXAMPLE: For this example, we are using the CARB default charge size for household refrigerator freezer devices. We input 0.342 lb. of refrigerant charge.

7 Search the pivot table of EUL_IDs located to the right of the Device Builder table to identify the most appropriate EUL from the DEER database for this device. Once an EUL_ID is identified, copy as text into the EUL_ID column.

  EXAMPLE: The ***EUL_ID*** selected for this example is "Appl-ESRefg" as the best choice of EUL for the commercial ice machine.

Input Worksheet: 2 RACC

STEP 1 **Select WACC and Cost Basis**



1 Select the ***WACC*** for the measure from the dropdown menu.

EXAMPLE: The example chooses "Statewide" for WACC selection since the example project is among dozens of projects across the state of California.

2 Select the ***Refrigerant emissions cost basis*** from the dropdown menu.

EXAMPLE: The current emissions cost basis for all California measures is "GHG Value from Natural Gas ACC."

STEP 2 **Define General Measure Parameters (Install Year, MAT, CARB_Sector, Building Category)**

1	2	3	4	5
Measure description	**Msr Install Year**	**MeasAppType**	**CARB_Sector**	**CARB_BldgCategory**
Res Refrigerator	2024	AR	Appliance	Residential / Commercial / Industrial
Res Refrigerator	2024	NR	Appliance	Residential / Commercial / Industrial

1 Start by entering in the ***measure description***, use as much detail as necessary to clearly describe the measure.

EXAMPLE ALL: "Res Refrigerator"

2 Select the ***measure installation year*** from the dropdown menu

EXAMPLE ALL: This example is for a 2024 install year.

3 Select the ***MeasAppType (MAT)*** from the dropdown menu

EXAMPLE AR measures: This measure offering is for equipment that would remain in operation without program intervention and has not exceeded the EUL.

EXAMPLE NR measure: The existing equipment has failed or exceeded its EUL and will be replaced with a new standard or code rated device without program intervention.

4 Select the ***CARB_Sector*** from the dropdown menu, based on the CARB_Sector assigned to the equipment in the 1 Device Builder worksheet.

EXAMPLE ALL: "Appliance"

5 Select ***CARB_BldgCategory*** from the dropdown menu, based on the CARB regulation that applies to the measure and equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference. There is no active CARB GWP limits for commercial ice machine.

EXAMPLE: "Residential / Commercial / Industrial"

STEP 3 Assign Measure End-Use, Normal Unit, Device Type, and Unit Quantity

Measure case, new device (Msr)					
Msr CARB_End-Use	**Msr TechGroup (NormUnit)**	**Msr device type**	**Msr NumUnit**	**Msr EUL_ID**	**Msr EUL_Yrs**
Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00
Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Household refrigerators and freezers" was selected for this measure example.

2 Assign ***measure case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)". This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

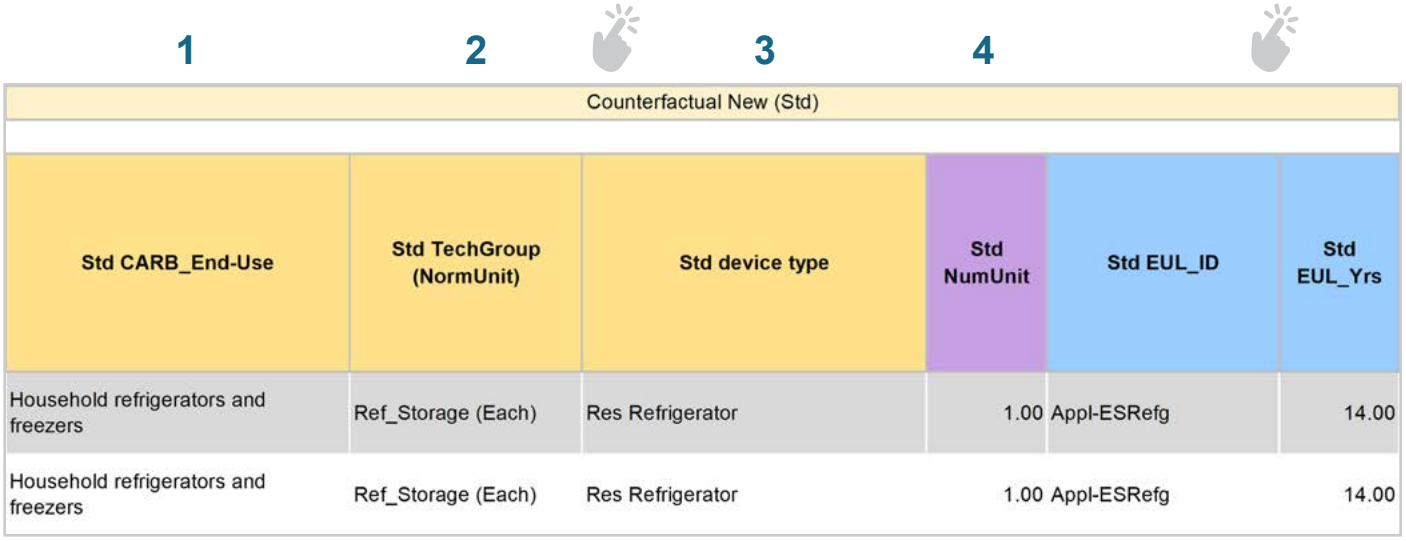
3 Select the ***measure device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The measure case device is the "Res Refrigerator" device added for this example in the 1 Device Builder worksheet.

4 For Custom measures: a custom measure may also input the ***NumUnit*** or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 4 Assign Standard End-Use, Normal Unit, Device Type and Unit Quantity



1	2	3	4		
Counterfactual New (Std)					
Std CARB_End-Use	Std TechGroup (NormUnit)	Std device type	Std NumUnit	Std EUL_ID	Std EUL_Yrs
Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00
Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE: "Household refrigerators and freezers"

2 Assign ***standard case TechGroup (NormUnit)*** ID from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)". This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***standard case device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE: The standard case device is the "Res Refrigerator" device added for this example in the 1 Device Builder worksheet.

4 For Custom measures: a custom measure may also input the ***NumUnit*** or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 **Assign Pre/Existing End-Use, Normal Unit, Device Type, Unit Quantity, and Installation Year**

Note that the Pre/Existing Device input is only for AR measure applications.

Measure Existing (Pre)						
Counterfactual Existing (Ext)						
Pre Refrigerant Reclaimed Flag	Pre/Ext CARB_End-Use	Pre/Ext TechGroup (NormUnit)	Pre/Ext device type	Pre/Ext NumUnit	Pre/Ext EUL_ID	Pre/Ext EUL_Yrs
	Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00
TRUE	Household refrigerators and freezers	Ref_Storage (Each)	Res Refrigerator	1.00	Appl-ESRefg	14.00

1 Select ***CARB_End-Use*** from the dropwdown menu, based on the CARB regulation that applies to the equipment. CARB regulation limits on GWP can be found in the CARB-EPA Limits worksheet for reference.

EXAMPLE BOTH: "Household refrigerators and freezers" was selected for this measure example.

2 Assign ***pre/existing case TechGroup (NormUnit) ID*** from dropdown menu matching the desired parameter from the 1 Device Builder worksheet.

EXAMPLE: The device added to the 1 Device Builder worksheet was given a TechGroup (NormUnit) parameter of "Ref_Storage (Each)". This represents a Tech Group of "Ref_Storage," and a normalizing unit of "Each."

3 Select the ***pre/existing device type*** from the dropdown menu. Device types are associated with the selected TechGroup (NormUnit) parameter.

EXAMPLE AR ONLY: The pre/existing case device is the "Res Refrigerator" device added for this example in the 1 Device Builder worksheet.

4 For custom measures: a custom measure may also input the NumUnit or quantity of units as necessary for custom applications. This could be when a measure is repeated for several identical units for a custom measure.

EXAMPLE: For this case, we will just model a single device and the NormUnit is left at the default value "1".

STEP 5 Pre/Existing Device Normal Unit, and Unit Quantity, and Installation Year, continued

5

Pre/Ext Install Year	Pre/Ext Install Year Basis
2015	Deemed
2010	Deemed

5 For custom measures only: Select the pre/existing device installation year if different from the default based on the RUL of the device selected. Credible evidence is required to deviate from the DEER accepted RUL values.

EXAMPLE: The ***Pre/Ext Install Year*** is unchanged from the default year.

STEP 6 Select Refrigerant Types

1 2 3

Common refrigerant type according to Device Builder worksheet (for reference)			Refrigerant Type for Avoided Cost Calculation			CARB-EPA GWP limits, if any			Refrigerant GWP, 100-yr Horizon			Refrigerant GWP, 100-yr Horizon (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
						Refrigerant properties color coding			Refrigerant properties color coding			Refrigerant properties color coding		
						The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
									Exceeds CARB-EPA limit, if any					
Msr Predefined Common Refrigerant(s)	Std Predefined Common Refrigerant(s)	Pre/Ext Predefined Common Refrigerant(s)	Msr Refrigerant Type	Std Refrigerant Type	Pre/Ext Refrigerant Type	Msr GWP limit per CARB-EPA	Std GWP limit per CARB-EPA	Pre/Ext GWP limit per CARB-EPA	Msr GWP	Std GWP	Pre/Ext GWP	Msr GWP, User Specified	Std GWP, User Specified	Pre/Ext GWP, User Specified
0	0.00	0	Isobutane (GWP=2)	Isobutane (GWP=2)	HFC-134a (GWP=1,430)	None	None	None	2	2	1,430	2	2	1,430
0	0.00	0	Isobutane (GWP=2)	Isobutane (GWP=2)	HFC-134a (GWP=1,430)	None	None	None	2	2	1,430	2	2	1,430

1 Select the ***measure refrigerant type (Msr Refrigerant Type)*** from the dropdown menu.

EXAMPLE: "Isobutane (GWP=2)"

2 Select the ***standard refrigerant type (Std Refrigerant Type)*** from the dropdown menu.

EXAMPLE: For this measure select ""Isobutane (GWP=2)," which is the same as the measure device.

3 Select the ***Pre/Ext Refrigerant Type*** from the dropdown menu. Pre/Ext is only used for AR measures.

EXAMPLE: "HFC-134a (GWP=1,430)"

STEP 7 Input Refrigerant Charge

1 2

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)		
Msr	Std	Pre	Msr	Std	Pre
		Ext			Ext
Refrigerant properties color coding			*Refrigerant properties color coding*		
Value replaced formula			Value replaced formula		
Device Builder value replaced					
Msr refrigerant charge (lb/NormUnit) per Device Builder	**Std refrigerant charge (lb/NormUnit) per Device Builder**	**Pre/Ext refrigerant charge (lb/NormUnit) per Device Builder**	**Msr refrigerant charge (lb/NormUnit)**	**Std refrigerant charge (lb/NormUnit)**	**Pre/Ext refrigerant charge (lb/NormUnit)**
0.34	0.34	0.34	0.34	0.34	0.34
0.34	0.34	0.34	0.34	0.34	0.34

1 The ***Refrigerant Charge (lb/NormUnit) per Device Builder*** columns in blue show the default refrigerant charge defined in the 1 Device Builder worksheet, in the ***RefrigCharge Pounds Per NormUnit*** (copy from "0 Refrig Research") column. These values are auto filled based on the device type selected in the 2 RACC worksheet.

EXAMPLE: In this example the refrigerant charge per each is defined in the 1 Device Builder worksheet and should not be adjusted in the 2 RACC worksheet.

2 The ***Refrigerant Charge (lb/NormUnit)*** columns in purple are used in the emissions calculations, and by default auto fill based on the device type selected and the **RefrigCharge Pounds Per NormUnit** (copy from "0 Refrig Research") column in the 1 Device Builder worksheet. For custom measures, a site-specific charge can be specified. Users can override these cells with a custom refrigerant charge based on evidence or audit values supporting the user-specified inputs.

EXAMPLE: In this example, the charge size and leakage rate are defaulted to the CARB average.

STEP 8 **Refrigerant Leakage Rates and Parameters**

The Annual Refrigerant Leakage %, Gross EOL Refrigerant Leakage %, and t_EOL parameters are referenced from CARB by default. Like other parameters in the 2 RACC worksheet, there are purple columns where custom values may be specified overriding the defaults. However, this should be avoided, and if site-specific values are specified, the values should be used only if the rate is less than the CARB averages.

Input worksheet: 3 FSC

0 Refrig Research	1 Device Builder	2 RACC	3 FSC	4 eTRM export	5 RACC Charts	6 FSC Pivot

This measure does not have a fuel-substitution component.

Summary

User inputs of this example are summarized in Table 6-3 and the total avoided cost in 2022 dollars for an AR measure without claiming the EOL existing refrigerant is $1.55 per device, and a NR measure that includes EOL existing refrigerant reclamation is $20.75 per device.

Table 6-3. User inputs for for residential refrigerator, freezer measure example

Worksheet	Input/Column Name	Value		
		Msr	Std	Pre/Ext
0 Refrig Research		Research into charge amount per normalizing unit is required for this measure. This example assumes CARB default values built into the sheet.		
1 Device Builder	Device Type	Res Refrigerator		
	TechTypeID	Ref_Storage:RefrigFrz		
	NormUnit	Each		
	CARB_DeviceType	Household refrigerator freezer		
	Common Refrigerant Type(s)	Optional input for reference only		
	RefrigCharge Pounds Per NormUnit (copy from "0 Refrig Research")	0.342		
	EUL_ID	Appl-ESRefg		
2 RACC (AR measure)	WACC Selection	Statewide		
	Refrig. Cost Basis	GHG Value from Natural Gas ACC		
	Measure Description	Res Refrigerator		
	Msr Install Year	2024		
	MeasAppType	AR		
	CARB_Sector	Appliance		
	CARB_BldgCategory	Residential / Commercial / Industrial		
	CARB_End-Use	Household refrigerators and freezers		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Res Refrigerator		
	Pre Refrigerant Reclaimed Flag	False		
	Pre/Ext Install Year	NA	NA	2015
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	Isobutane (GWP=2)	Isobutane (GWP=2)	HFC-134a (GWP=1,430)
	GWP	Auto populated	Auto populated	Auto populated
	Refrigerant Charge (lb/ NormUnit)	0.345 (auto-populated)		
	Annual Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	Gross EOL Refrigerant Leakage %	CARB average; auto populated from 1 Device Builder		
	t_EOL per Device Builder	CARB average; auto populated from 1 Device Builder		
2 RACC (AR measure)	CARB_End-Use	Household refrigerators and freezers		
	TechGroup (NormUnit)	Ref_Storage (Each)		
	Device type	Res Refrigerator		
	Pre Refrigerant Reclaimed Flag	False		
	Pre/Ext Install Year	NA	NA	2015
	Pre/Ext Install Year Basis	NA	NA	Deemed
	Refrigerant Type	Isobutane (GWP=2)	Isobutane (GWP=2)	HFC-134a (GWP=1,430)
	GWP	Auto populated	Auto populated	Auto populated

Appendix A: Fuel Substitution Measure Technical Documentation

APPENDIX A. Fuel Substitution Measure Technical Documentation

Appendix A-1: Source Energy Calculations

Part One of the fuel substitution test requires that the fuel substitution measure reduces source energy consumption, expressed in Btus. The life-cycle source energy of a measure is the source energy used over the effective useful life (EUL) of the technology. To pass Part One of the fuel substitution test, the life-cycle source energy consumption of the measure technology must be lower than or equal to the life-cycle source energy consumption of the baseline technology. In other words, fuel substitution measure permutations must yield life-cycle source energy savings that are greater than or equal to zero. This must be demonstrated by passing Part One of the test performed in the fuel substitution calculator (embedded within the RACC-FS_v3.0.xlsx) when creating or updating a fuel-substitution measure package. Briefly, the fuel substitution calculator converts site energy to source energy using yearly source energy factors. The yearly source energy factors are provided herein and were developed based on the 2021 Preferred System Plan adopted in the CPUC Integrated Resource Planning (IRP) proceeding (Rulemaking (R.) 20-05-003) that was used in the 2022 Avoided Cost Calculator (ACC).

Table A-1 lists the source energy factors for electricity over the current and future years—through 2049—and Table A-2 lists the source energy factor for natural gas, which remains constant. To calculate the life-cycle source energy savings, the fuel substitution calculator multiplies annual source energy factors from Table A-1 and Table A-2 (in Btu/kWh and Btu/Therm, respectively, for electricity and natural gas) by the site energy savings for each year of the measure's EUL. Please refer to the equations in Appendix A-1: Source Energy Calculations and Appendix A-2: Emissions Calculations for additional detail on these calculations.

Table A-1. Annual Source Energy and Emissions for Site-level Electricity Usage

Year	Emissions Intensity (metric tonne CO2/MWh)	Source Energy Heat Rate (Btu/kWh)
2019	0.198	3,723
2020	0.193	3,638
2021	0.189	3,553
2022	0.184	3,468
2023	0.171	3,226
2024	0.178	3,351
2025	0.176	3,309
2026	0.176	3,308
2027	0.169	3,192
2028	0.163	3,075
2029	0.150	2,825
2030	0.137	2,576
2031	0.132	2,492
2032	0.128	2,408
2033	0.121	2,285
2034	0.115	2,161
2035	0.108	2,037
2036	0.102	1,920
2037	0.096	1,802

Year	Emissions Intensity (metric tonne CO2/MWh)	Source Energy Heat Rate (Btu/kWh)
2038	0.089	1,685
2039	0.083	1,568
2040	0.077	1,450
2041	0.072	1,348
2042	0.066	1,246
2043	0.061	1,145
2044	0.055	1,043
2045	0.050	941
2046	0.050	941
2047	0.050	941
2048	0.050	941
2049	0.050	941

Table A-2. Annual Source Energy and Emissions for Site-level Natural Gas Usage

Year	Emissions Intensity (metric tonne CO2/Therm)	Source Energy Heat Rate (Btu/Therm)
Constant	0.00531	100,000

Using the measure installation year and applying the yearly source energy values from Table A-1 and Table A-2 (in Btu/kWh and Btu/Therm, respectively, for electricity and natural gas) over the measure's EUL, the **3 FSC** worksheet calculates the life-cycle source energy savings as shown in the equations that follow for the Normal Replacement (NR) and Accelerated Replacement (AR) measure application types.

Equation A-1. Life-cycle source energy savings for Normal Replacement measures

$$Life-cycle\ source\ energy\ savings_{NR} = (1+l_e) \times \sum_{i=start\ year}^{EUL_{Msr}+start\ year-1} \left(\Delta\, kWh \times source\ energy_{kWh,i}\right) + \left(1+l_g\right) \times \left(\Delta\, Therm \times source\ energy_{Therm} \times EUL_{Msr}\right)$$

Equation A-2. Life-cycle source energy savings for Accelerated Replacement measures

$$\begin{aligned} Life-cycle\ source\ energy\ savings_{AR} &= (1+l_e) \times \sum_{i=start\ year}^{RUL_{Ext}+start\ year-1} \left(\Delta\, kWh_{\,BL1} \times source\ energy_{kWh,i}\right) \\ &+ \left(1+l_g\right) \times \left(\Delta\, Therm_{BL1} \times source\ energy_{Therm} \times RUL_{Ext}\right) \\ &+ (1+l_e) \times \sum_{i=RUL_{Ext}+start\ year}^{EUL_{Msr}+start\ year-1} \left(\Delta\, kWh_{BL2} \times source\ energy_{kWh,i}\right) \\ &+ \left(1+l_g\right) \times \left(\Delta\, Therm_{BL2} \times source\ energy_{Therm} \times \left(EUL_{Msr} - RUL_{Ext}\right)\right) \end{aligned}$$

Where:

$Life-cycle\ source\ energy\ savings_{NR}\ [Btu]$ = Source energy savings for Normal Replacement (NR) Measure application type over the life of the measure.

$l_e\ [percent\ of\ source\ energy]$= methane leakage rate for the electric system ($= l_{e,1} + l_{e,2}$, per Table A-3)

$l_g\ [percent\ of\ source\ energy]$= methane leakage rate for the natural gas system ($= l_{g,1} + l_{g,2}$, per Table A-3)

$start\ year$ = The year when the measure will go into operational.

$EUL_{Msr}[years]$ = Effective Useful Life of the measure, rounded to the nearest whole number

$\Delta\ kWh$ = Baseline kWh/year – Measure kWh/year in the 1st year. This is typically a negative value for an increase to electric energy usage from a fuel substitution measure.

$source\ energy_{kWh,i}\left[\frac{Btu}{kWh}\right]$ = Yearly source energy values in Table A-1 for electricity

$\Delta\ Therm$ = Baseline Therm/year – Measure Therm/year in the 1st year. This is typically a positive value for a decrease in natural gas usage from a fuel substitution measure.

$source\ energy_{Therm}\left[\frac{Btu}{Therm}\right]$ = Source energy value for natural gas in Table A-2

$Life-cycle\ source\ energy\ savings_{AR}\ [Btu]$= Source energy savings for Accelerated Replacement (AR) Measure application type over the life of the measure.

$RUL_{Ext}[years]$ = Remaining Useful Life of the existing equipment, rounded to the nearest whole number

$\Delta\ kWh_{BL1}$= $\Delta\ kWh$ over the existing baseline

$\Delta\ Therm_{BL1}$ = $\Delta\ Therm$ over the existing baseline

$\Delta\ kWh_{BL2}$ = $\Delta\ kWh$ over the standard practice baseline

$\Delta\ Therm_{BL2}$= $\Delta\ Therm$ over the standard practice baseline

The units for the values are included within brackets, [ ].

Appendix A-2: Emissions Calculations

Part Two of the fuel substitution test requires that fuel substitution measures not adversely impact the environment. Previously, per Decision D.09-12-022, measurement of environmental impact is limited to carbon dioxide (CO2) emissions. However, in 2021, the environmental impact was broadened to include CO2e methane emissions and CO2e refrigerant leakage emissions. To pass Part Two of the test, life-cycle CO2 and CO2e emissions for the measure technology must be lower than or equal to those of the baseline technology. Life-cycle emissions are defined as the total CO2 emissions plus the total CO2e emissions over the EUL of the measure technology. To determine if a fuel substitution measure permutation passes Part Two of the fuel substitution test, programs shall use the RACC-RSC_v3.0.xlsx.

The approach for calculating CO2 emissions for electricity and natural gas is similar to that used to calculate the source energy factors. Like the source energy calculation, the life-cycle CO2 emissions of a fuel substitution measure are calculated by applying the annual factors (in metric tonne CO2/MWh and metric tonne CO2/Therm respectively, for electricity and natural gas) to the site energy savings in each year of the measure's EUL. Added in 2022, Part Two of the test includes CO2e emissions from methane leakage, but—like those for natural gas—these emission rates do not vary over time. More detail regarding the assumptions used for methane leakage is provided in Appendix A-3: Methane Leakage.

Also added in 2022, Part Two of the fuel substitution test includes the life-cycle emissions due to refrigerant leakage. Refrigerant leakage is divided into two components: annual (a.k.a. operational) leakage, and end-of-life (EOL) leakage where annual leakage is constant for each year of the equipment life and EOL leakage only occurs during the last year of the equipment life. Equation A-3 and Equation A-4 are used for Normal Replacement (NR) applications and Accelerated Replacement (AR) applications, respectively. More detail regarding the equations used to determine the emissions due to refrigerant leakage are provided in

Appendix A-4: Emissions due to Refrigerant Leakage.

Equation A-3. Life-cycle emissions savings for Normal Replacement measures

$$Life-cycle\ CO_{2e}\ savings_{NR} = (1+la_e) \times \sum_{i=start\ year}^{EUL_{Msr}+start\ year-1} \left(\frac{\Delta kWh}{1{,}000\ kWh/MWh} \times EI_{MWh,i}\right) + \left(1+la_g\right) \times (\Delta Therm \times EI_{Therm} \times EUL_{Msr}) + (R_{Std} - R_{Msr})$$

Equation A-4. Life-cycle emissions savings for Accelerated Replacement measures

$$\begin{aligned} Life-cycle\ CO_{2e}\ savings_{AR} &= (1+la_e) \times \sum_{i=start\ year}^{RUL_{Ext}+start\ year-1} \left(\frac{\Delta kWh_{BL1}}{1{,}000\ kWh/MWh} \times EI_{MWh,i}\right) \\ &+ \left(1+la_g\right) \times (\Delta Therm_{BL1} \times EI_{Therm} \times RUL_{\ Ext}) \\ &+ (1+la_e) \times \sum_{i=RUL_{Ext}+start\ year}^{EUL_{Msr}+start\ year-1} \left(\frac{\Delta kWh_{BL2}}{1{,}000\ kWh/MWh} \times EI_{MWh,i}\right) \\ &+ \left(1+la_g\right) \times \left(\Delta Therm_{BL2} \times EI_{Therm} \times (EUL_{Msr} - RUL_{\ Ext})\right) \\ &+ \left((R_{Std} + R_{Ext}) - (R_{Msr} + R_{Pre})\right) \end{aligned}$$

Where:

$Life-cycle\ CO_{2e}\ savings_{NR}\ [metric\ tonne\ CO_{2e}]$ = CO2 and CO2e savings for Normal Replacement (NR) Measure application type over the life of the measure.

$la_e\ [percent\ of\ metric\ tonne\ CO_2]$= methane leakage adder for the electric system ($= la_{e,1} + la_{e,2}$, per Table A-3)

la_g $[percent\ of\ metric\ tonne\ CO_2]$= methane leakage adder for the natural gas system (= $la_{g,1} + la_{g,2}$, per Table A-3)

$start\ year$ = The year when the measure will go into operation.

EUL_{Msr} $[years]$ = Effective Useful Life of the measure, rounded to the nearest whole number

Δ kWh = Baseline kWh/year – Measure kWh/year in the 1st year. This is a negative value for an increase in energy usage and a positive value for decrease in electricity usage due to the fuel substitution measure.

$EI_{MWh,i}$ $[metric\ tonne\ CO_2/MWh]$ = Yearly Emission Intensity [EI] values in Table A-1 for electricity

Δ $Therm$ = Baseline Therm/year – Measure Therm/year in the 1st year. Negative value for increase and positive value for decrease in natural gas usage from fuel substitution measures.

$EI_{Therm}[metric\ tonne\ CO_2/Therm]$ = Emission Intensity [EI] value for natural gas in Table A-2

$Life-cycle\ CO_{2e}\ savings_{AR}$ $[metric\ tonne\ CO_{2e}]$ = CO2 and CO2e savings for Accelerated Replacement (AR) Measure application type over the life of the measure.

RUL_{Ext} $[years]$= Remaining Useful Life of the existing equipment, rounded to the nearest whole number

Δ kWh_{BL1} = Δ kWh over the existing baseline

Δ $Therm_{BL1}$= Δ Therm over the existing baseline

Δ kWh_{BL2} = Δ kWh over the standard practice baseline

Δ $Therm_{BL2}$ = Δ Therm over the standard practice baseline

$R_{Msr}, R_{Pre}, R_{Std}, R_{Ext}[metric\ tonne\ CO_{2e}]$ = refrigerant leakage emissions of the measure equipment, existing equipment, counterfactual standard practice equipment, and the counterfactual existing equipment

The units for the values are included within brackets, [ ].

Appendix A-3: Methane Leakage

In addition to CO2 emissions associated with electricity generation and the combustion of natural gas, there are CO2-e emissions associated with the leakage of methane in both energy systems. When methane is combusted, it produces CO2. However, when it is leaked prior to being combusted, it is not only wasted as a fuel but also has a disproportionately high impact on global warming. Uncombusted methane has a 100-year GWP of 25, meaning it is 25 times more potent than CO2 as a greenhouse gas over a 100-year time horizon. (Over a shorter time horizon, uncombusted methane is even more potent and has a 20-year GWP of 72.)

As methane has a high global warming potential (GWP) it is critical to account for changes in methane leakage that result from the measures in Part Two of the fuel substitution test. Thus, the fuel substitution calculator applies a methane leakage adder to changes in emissions from natural gas and electricity consumption. The tool relies on leakage adders and methodology consistent with the 2022 ACC. The 100-year leakage adder is used by default in the tool. The leakage adder for upstream in-state leakage is applied to both changes in electricity and natural gas emissions. The residential behind-the-meter leakage rate is applied only to change in natural gas emissions for residential measures. See the 2022 ACC documentation for more details.[1]

[1]CPUC Avoided Cost Calculator at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm

Table A-3. Methane Leakage Rates and Adders

Leakage Type	Leakage rate (in percent of natural gas consumption)	Leakage adder, 100-year GWP (in percent of CO2e emissions)
Upstream, in state This represents the methane leakage upstream of natural gas power plants and applies to both electric and gas emissions.	$l_{e,1}$: 0.612% $l_{g,1}$: 0.612%	$la_{e,1}$: 5.57% $la_{g,1}$: 5.57%
Downstream, residential behind-the-meter This applies only to programs that eliminate natural gas appliances from a residential building.	$l_{e,2}$: 0% $l_{g,2}$: 0.415%	$la_{e,2}$: 0.00% $la_{g,2}$: 3.78%

Appendix A-4: Emissions due to Refrigerant Leakage

Refrigerants are gases which can absorb and transfer heat and are used in many appliances including refrigerators, air conditioners, and electric heat pumps. Most refrigerants used today are very strong greenhouse gases. The most common refrigerant, R-410A, has a 100-yr GWP of 2,088—or more than 2,000 times the global warming impact of CO2. Refrigerants only contribute to global warming when they leak, but given current practices, leakage is inevitable. Thus, it is important to include refrigerant leakage in the assessment of the life-cycle emissions impact of a measure in Part Two of the fuel substitution test.

The impact of the emissions of refrigerant leakage is a function of characteristics of both the device type and the refrigerant that is used. Devices vary by their refrigerant charge, leakage rates, and "top-off" period. Refrigerant charge refers to the amount of refrigerant in the device. Annual leak rate and end of life loss rate dictate how much refrigerant is lost each year and at the EUL of the device, respectively. The last necessary metric is the number of years prior to EOL with no "top-off" refrigerant added to the device. The type of refrigerant dictates the GWP used to calculate the emissions due to leakage.

For NR measures, the refrigerant leakage is calculated in two parts, the cumulative annual leakage and the EOL leakage. Annual leakage is the refrigerant charge multiplied by the GWP of the refrigerant and the annual leakage rate. This is then multiplied by EUL and added to the EOL leakage. The EOL leakage is found by calculating the amount of refrigerant charge in the device remaining at its end of life since its last top off multiplied by the EOL loss rate and the GWP of the refrigerant. Refrigerant leakage is calculated for the measure case (Msr), the existing case (Pre), the counterfactual standard practice case (Std), and the counterfactual existing case as indicated in Equation A-5, Equation A-6, Equation A-7, and Equation A-8 respectively.

Equation A-5. Refrigerant Leakage Emissions for Measure Equipment

$$R_{Msr} = m_{Msr} \times GWP_{Msr} \times \left(q_{ann,Msr} \times EUL_{Msr} + q_{EOL,Msr} \times \left(1 - q_{ann,Msr} \times t_{EOL,Msr}\right)\right)$$

Equation A-6. Refrigerant Leakage Emissions for Existing Equipment

$$R_{Pre} = m_{Ext} \times GWP_{Ext} \times q_{EOL,Ext} \times \left(1 - q_{ann,Ext} \times t_{EOL,Ext}\right) \times Factor_{Recovery}$$

Equation A-7. Refrigerant Leakage Emissions for Counterfactual Standard Practice Equipment[2]

$$R_{Std} = m_{Std} \times GWP_{Std} \times \left(q_{ann,Std} \times \begin{cases} 0 \; for \; NR \\ RUL_{Ext} \; for \; AR \end{cases} + q_{EOL,Std} \times \left(1 - q_{ann,Std} \times t_{EOL,Std}\right)\right)$$

[2] When the EUL of the standard practice equipment is less than that of the measure equipment (or, for accelerated replacement applications, the measure equipment EUL minus the RUL of the existing equipment), it is assumed that the standard practice equipment will be installed more than once. Whenever an EOL refrigerant emissions event due to a *subsequent* installation of the standard practice equipment is assumed to occur beyond the life of the measure equipment, the emissions from that event are pro-rated by the extent to which they coincide with the measure. (When the standard practice equipment is assumed to be installed one time, however, the EOL refrigerant leakage event that occurs beyond the life of the measure is not pro-rated.)

Equation A-8. Refrigerant Leakage Emissions for Counterfactual Existing Equipment

$$R_{Ext} = m_{Ext} \times GWP_{Ext} \times \left(q_{ann,Ext} \times RUL_{Ext} + q_{EOL,Ext} \times \left(1 - q_{ann,Ext} \times t_{EOL,Ext}\right)\right)$$

Where:

$R_{Msr}, R_{Pre}, R_{Std}, R_{Ext}[metric\ tonne\ CO_{2e}]$ = refrigerant leakage emissions of the measure equipment, existing equipment, counterfactual standard practice equipment, and counterfactual existing equipment, respectively

$m_{Msr}, m_{Ext}, m_{Std}[lb]$ = refrigerant charge contained by the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$GWP_{Msr}, GWP_{Ext}, GWP_{Std}[metric\ tonne\ CO_{2e}/metric\ tonne\ CO_2]$ = the global warming potential (GWP) of the refrigerant in the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$q_{ann,Msr}, q_{ann,Ext}, q_{ann,Std}[percent]$ = annual leakage rate of the refrigerant in the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$EUL_{Msr}, EUL_{Ext}, EUL_{Std}[years]$ = the effective useful life (EUL) of the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$q_{EOL,Msr}, q_{EOL,Ext}, q_{EOL,Std}[percent]$ = the end of life (EOL) leakage rate of the refrigerant in the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$t_{EOL,Msr}, t_{EOL,Ext}, t_{EOL,Std}[years]$ = the time since the refrigerant was last topped off in the measure equipment, existing equipment, and counterfactual standard practice equipment, respectively

$Factor_{Recovery}[dimensionless]$ = a factor that varies depending upon the measure application type and whether documentation is provided showing that refrigerant was appropriately recovered from existing equipment as indicated in Table A-4.

$RUL_{Ext}[years]$ = the remaining useful life (RUL) of the existing equipment

The units for the values are included within brackets, [ ].

Table A-4. $Factor_{Recovery}$ by Existing Refrigerant Recovery Documentation and Measure Application Type

Existing Refrigerant Recovery Documentation	Normal Replacement (NR)	Accelerated Replacement (AR)
No Recovery Documentation Provided (status quo)	0 (see Figure A-1)	1 (see Figure A-3)
Recovery Documentation Provided	-1 (see Figure A-2)	0 (see Figure A-4)

As indicated in Table A-4, the figures that follow show the annual and end-of-life refrigerant leakage emissions for the four possible combinations of existing equipment recovery documentation and measure application type described for the fuel substitution measure involving a residential central heat pump replacing a central gas furnace with air-conditioning.[3]

[3] Per measure package SWHC045-03 at https://www.caetrm.com

Figure A-1. Normal Replacement Application without Existing Refrigerant Recovery Documentation

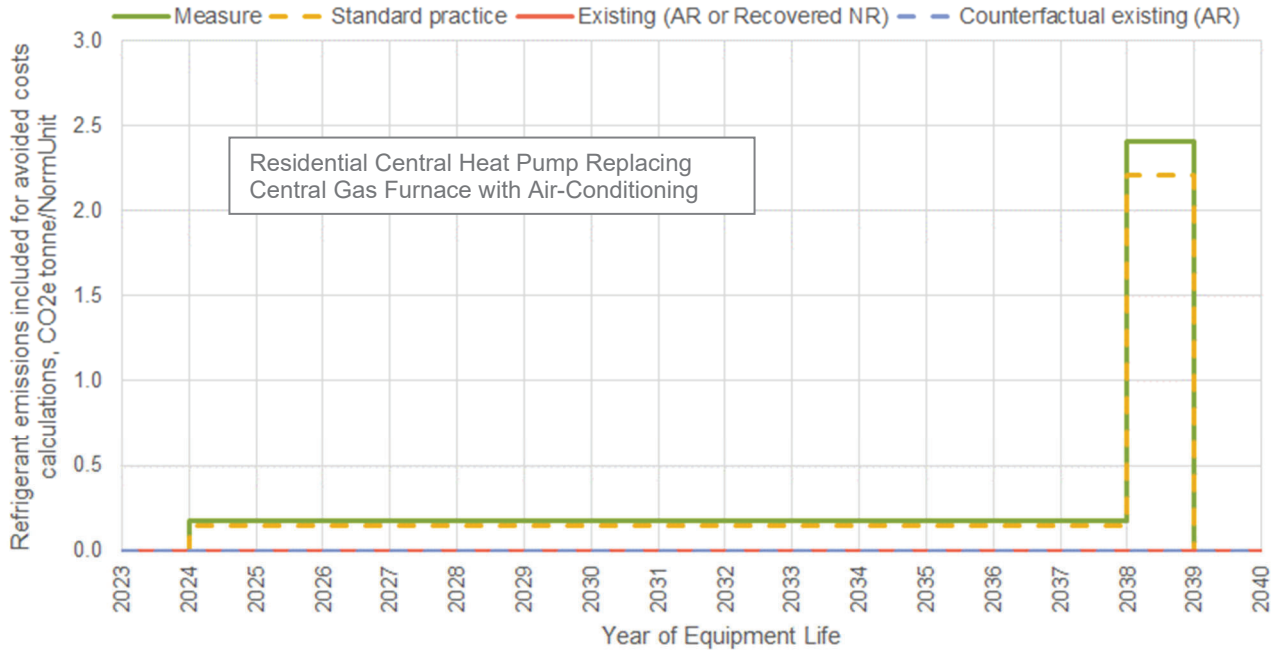


Figure A-2. Normal Replacement Application <u>with</u> Existing Refrigerant Recovery Documentation

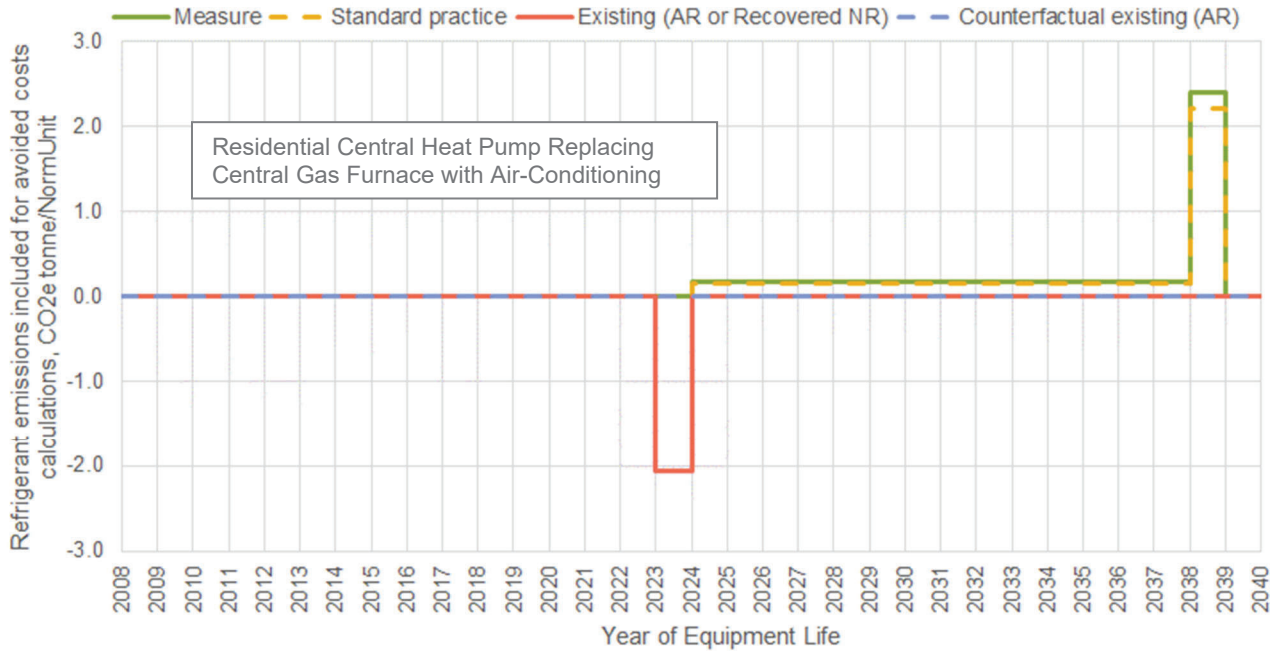


Figure A-3. Accelerated Application without Existing Refrigerant Recovery Documentation

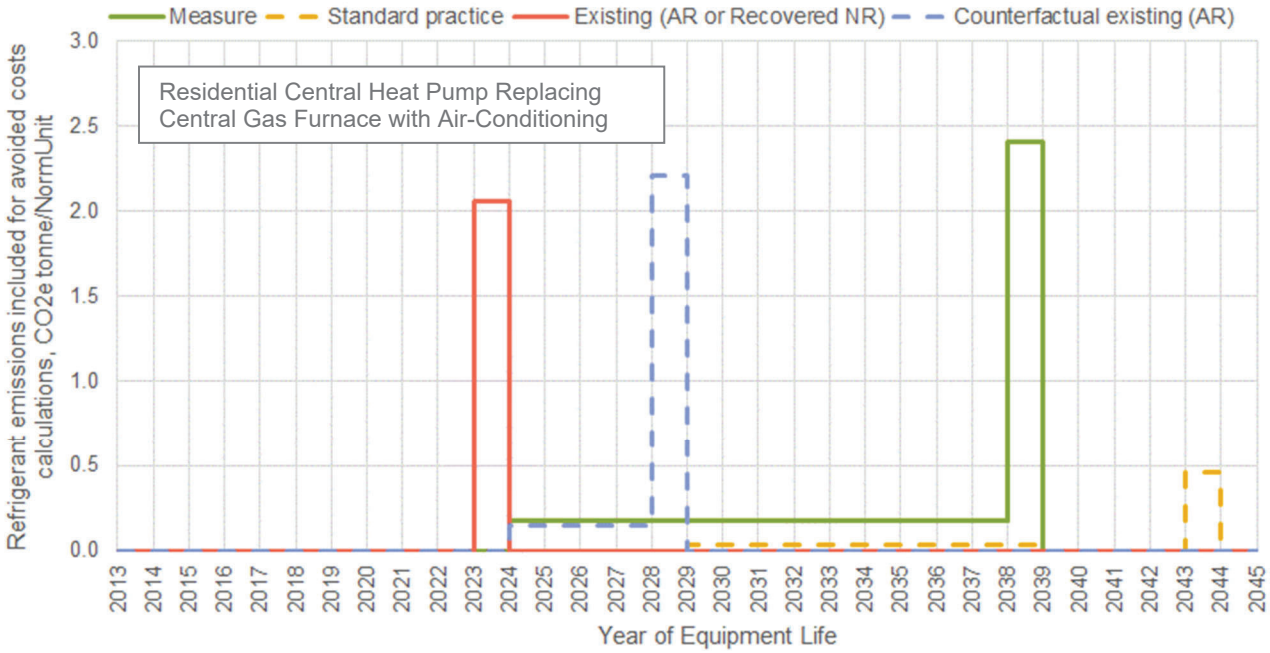
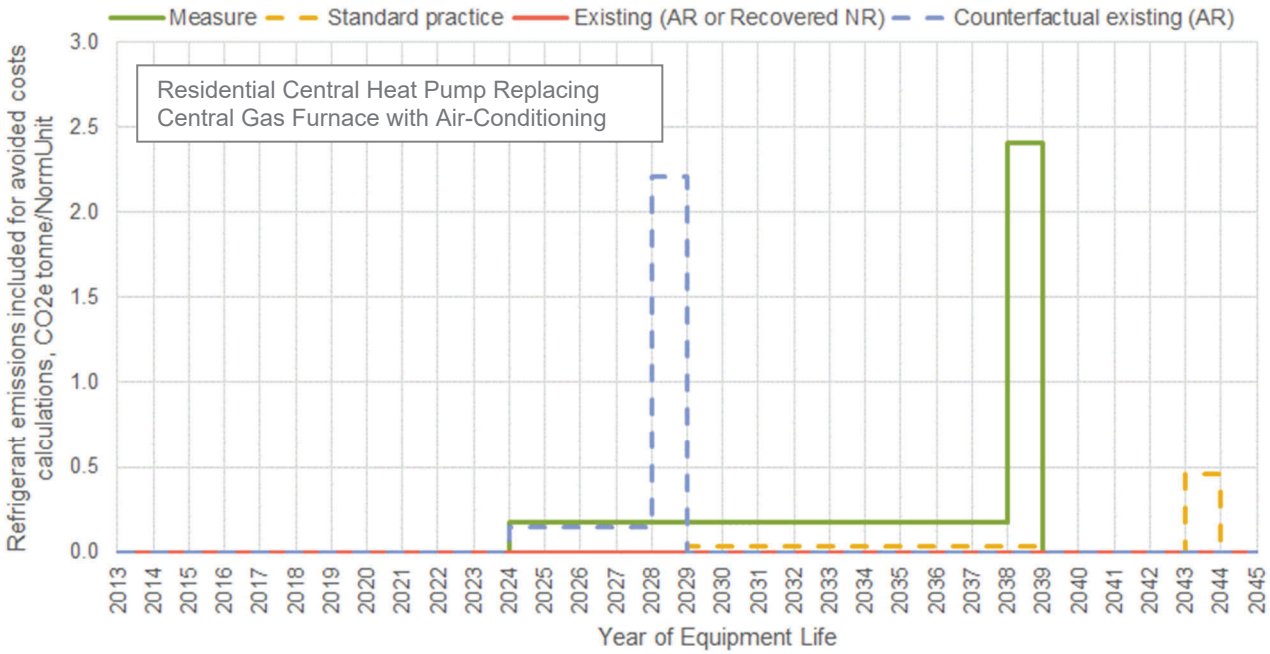


Figure A-4. Accelerated Application <u>with</u> Existing Refrigerant Recovery Documentation



When a given permutation of a fuel substitution measure does not pass Part 2 of the fuel substitution test, the maximum refrigerant GWP that would allow the permutation to pass is calculated using Equation A-9.

Equation A-9. Maximum Allowable Measure Refrigerant GWP

$$maxGWP_{Msr} = \frac{(Life - cycle\ CO_2 + R_{Std} + R_{Ext} - R_{Pre}) \times 2,204.62\ lb/metric\ tonne}{m_{Msr} \times \left(q_{ann,Msr} \times EUL_{Msr} + q_{EOL,Msr} \times \left(1 - q_{ann,Msr} \times t_{EOL,Msr}\right)\right)}$$

Appendix A-5: Basis for Weights Used for Residential Fuel Substitution Heat Pump Measures

Given that weather is warming and the proportion of residential homes with HVAC space cooling is increasing, a comparison of the results of the 2009 and 2019 Residential Appliance Saturation Studies[4][5] (RASS) were used to establish a set of climate-zone specific weights for imputing space cooling for the standard practice baseline case for residential heat pump fuel substitution measures.

Table A-5. Proportions of Homes with Natural Gas Furnace and Room/Central Air Conditioning

Building Location	2009 RASS (n=17,056)	2019 RASS (n=24,323)	Ten-year Increase Extrapolated to 2024
CZ01	2.8%	41.5%	61.0%
CZ02	43.8%	54.6%	60.1%
CZ03	13.3%	30.7%	39.2%
CZ04	61.3%	74.2%	80.7%
CZ05	17.5%	17.4%	17.4%
CZ06	43.7%	62.4%	71.9%
CZ07	42.0%	65.2%	76.7%
CZ08	69.8%	89.4%	99.4%
CZ09	87.3%	94.0%	97.5%
CZ10	96.4%	98.1%	99.1%
CZ11	98.6%	94.3%	94.3%
CZ12	93.2%	97.5%	99.5%
CZ13	97.8%	95.7%	95.7%
CZ14	98.8%	95.6%	95.6%
CZ15	96.7%	99.0%	100.0%
CZ16	74.4%	91.9%	100.0%
Statewide	67.4%	80.1%	86.6%

On the **3 FSC** worksheet in RACC-FSC_v3.0.xlsx, users shall use an imputed-cooling standard-practice baseline for residential electric heat pump measures where the existing equipment does not include air conditioning. Refer to examples provided in the body of the Technical Guidance Document for more information regarding how this is done.

Appendix A-6: Sites with On-Site Generation

The presence of non-IOU fuel on-site generation sources does not impact the fuel substitution test used to determine the fuel substitution measure eligibility. The measures should comply with established fuel substitution test requirements.

For claimable energy savings used for incentive, reporting, and cost effectiveness calculations, the guidance established in Non-IOU Supplied Energy Sources – Guidance Document – V1.1[6] shall be followed with no exemptions.

The language that follows discusses the potential impact of fuel substitution measures on claimable energy savings.

The main premise in CPUC's non-IOU fuel guidance applies when non-IOU energy sources are present and there is a reduction in energy supplied from grid/ system that is subject to electric energy efficiency surcharges or the non-bypassable

[4] KEMA, Inc. 2010. *2009 California Residential Appliance Saturation Study*, California Energy Commission. Publication number: CEC-200-2010-004.

[5] DNV GL Energy Insights USA, Inc. 2020. *2019 California Residential Appliance Saturation Study*. California Energy Commission. Publication Number: CEC-200-2021-005.

[6] Energy Efficiency Savings Eligibility at Sites with non-IOU Supplied Energy Sources—Guidance Document. Version 1.1 November 6, 2015

gas surcharge. Therefore, only the reduced fuel usage requires the non-IOU fuel analysis.[7] The increased fuel usage does not require non-IOU fuel analysis unless new non-IOU on-site generation sources are added at the facility.

For natural gas to electric measures, the increase in kWh usage is not subject to non-IOU fuel analysis. The Therm savings are not subject to non-IOU fuel analysis because there is no on-site generation of natural gas which is regulated. Hence, the calculations of claimable energy savings are not impacted even when on-site natural gas generation is present.

For electric to natural gas measures, the decrease in kWh usage is subject to non-IOU fuel analysis similar to other energy efficiency measures. For the same reason explained above, the Therm increase does not require non-IOU fuel analysis. The kWh savings after non-IOU fuel analysis is added to the Therm savings (converted to kWh) for calculating the claimable energy savings.

Please note, for natural gas to electric measures, there could be scenarios where mixed fuel (electricity + natural gas) is substituted with one new fuel (electricity) and the increase in substituted fuel (gas to electricity) is outweighed by the savings from electricity part of the mixed fuel, resulting in decreased kWh. In such a scenario, kWh savings will require non-IOU fuel analysis.

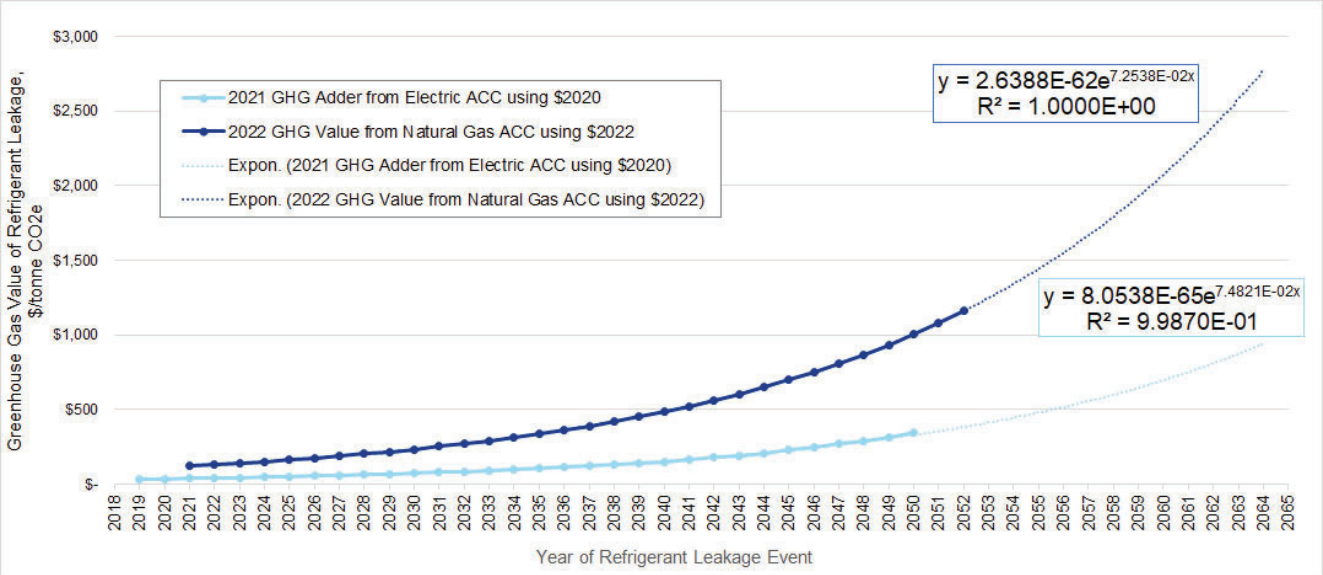
[7] Monthly or hourly analysis as required by Energy Efficiency Savings Eligibility at Sites with non-IOU Supplied Energy Sources—Guidance Document. Version 1.1 November 6, 2015

Appendix B: Extrapolated Avoided Costs for RACC

APPENDIX B. Extrapolated Avoided Costs for RACC

Since equipment effective useful life values (EULs) are being extended beyond the previous cap of 20 years to up to 30 years, it is possible that refrigerant leakage emissions for the counterfactual standard practice equipment will require avoided costs that have not been forecasted nor approved. In these rare instances, extrapolated values will be used for years 2053 through 2065 as shown in Figure B-1.

Figure B-1. Greenhouse Gas Value of Refrigerant Leakage Emissions by Year



Note: The extrapolated GHG values from the 2022 Natural Gas ACCs—shown in the chart for years beyond 2052—are only approved for use in the RACC-FSC_v3.0 workbook. They are not approved for use in other applications.

Given the very high R-squared values of the fitted curve, this specific application of these extrapolated values has the approval of the CPUC. The use of these extrapolated values is not approved, however, for use in other applications.

Appendix C: Connecting RACC-FSC to DEER Database

APPENDIX C. Connecting RACC-FSC to DEER Database

Multiple DEER database tables are connected to the RACC-FSC_v3.0 workbook so that they are available to stakeholders and can be easily updated without needing to reissue the workbook as frequently. Questions can be sent to: DEERsupport@dnv.com.

The DEER database is a PostgreSQL database. Since DEER tables are updated as warranted by new EM&V studies or stakeholder requests, they may require periodic refreshing. It is recommended that users sign up for alerts to the DEER database webpage within the DEER Module of the CEDARS website. Updates to these tables will be announced as they occur at https://cedars.sound-data.com/deer-resources/deer-database/deer-change-log/.

First-time DEER Database Access Instructions for Windows Computers

To learn about PostgreSQL Office Database Connection (ODBC) drivers, go to https://odbc.postgresql.org/.

1. Download the most recent version of the available zip files (with newest at the bottom of the page) from https://www.postgresql.org/ftp/odbc/versions/msi/. If your computer has 64-bit Office installed, be sure to download the zip file with its name appended by "-x64." While most users have 32-bit Office installed. This can be confirmed by, in Excel, going to **Account > About Excel**. If the version title doesn't contain "64-bit" somewhere, then it is most likely a 32-bit installation.
2. Unzip the downloaded zip file and run the .msi file appropriate for your Office installation.
3. From the Windows Start menu, launch Windows Administrative Tools > ODBC Data Source Administrator.
    a. Select the "User DSN" tab (rather than the "System DSN" tab that runs along the top of the dialog box.
    b. Click the "Add" button.
    c. Select PostgreSQL Unicode from the dropdown menu.
    d. Populate the "PostgreSQL Unicode ODBC Driver (psqlODBC) Setup" dialog box as shown in Table C-6.

Table C-6. Recommended Field Contents in PostgreSQL Unicode ODBC Driver

Left Column Fieldname	Contents	Right Column Fieldname	Contents
Data Source	PostgreSQL35W	**Description**	PostgreSQL
Database	DEER	**SSL Mode**	Allow
Server	cpucexante.cwuiixjcexyp.us-east-1.rds.amazonaws.com	**Port**	5432
User Name	sptviewer	**Password**	deereddev

    e. Click the "Test" button. Doing so should return: "Connection successful" message.
    f. Click the "Save" button.

Updating DEER Database Table(s) in RACC-FSC_v3.0

1. Within the RACC-FSC_v3.0 workbook, go to **Data > Queries & Connections** and click on the **Refresh All** button.
2. While the DEER tables are refreshing, the following status will be shown on the lower left corner of your Excel window:

3. Updates are typically completed in a minute or two.

Appendix D: References

California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change, Article 4, Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Stationary Air-conditioning, and Other End-Uses, https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hfc2020/frorevised.pdf

Statewide Custom Project Guidance Document, version 1.4, SW Custom Project Guidance Document_v1.4 DRAFT for comment.docx (live.com)

2022 Distributed Energy Resources Avoided Cost Calculator Documentation, September 15, 2022, https://willdan.box.com/v/2022CPUCAvoidedCosts

California Public Utilities Commission, Resolution E-4818 p. 11, 179264220.PDF (ca.gov)

California California Public Utilities Commission, Decision D.19-08-009, pp. 12, 37, and 53, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M310/K159/310159146.PDF

California Public Utilities Commission, Resolution E-4939, p. 8, 232460214.pdf (ca.gov)

California Public Utilities Commission, Resolution E-4795, p. 39, 166269506.PDF (ca.gov)

California Public Utilities Commission, Energy Division, Final Ex Ante Review Disposition, Project ID x240. CPUC Industry Standard Practice Guide Version 1.2A, Section 2.7 ISP by Code or Regulation, ISPGuideBookv12_A_livingfinal.pdf (doe2.com)

California Public Utilities Commission, Interim Decision Determining Policy and Counting Issues for 2009 to 2011 Energy Efficiency Programs (D.09-05-037), OP 4, Microsoft Word - 101543.DOC (ca.gov)

California Public Utilities Commission, Energy Efficiency Policy Manual, v 6.0, pp. 39-4, 6442465683-eepolicymanualrevised-march-20-2020-b.pdf (ca.gov)

California Public Utilities Commission, Decision Providing Guidance On 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach (D.12-05-015), Microsoft Word - 166830.DOC (ca.gov)

California Public Utilities Commission, Resolution for the Approval of the Database for Energy-Efficient Resources updates for 2020 and revised version 2019 in Compliance with D.15-10-028, D.16-08-019, and Resolution E-4818 (Resolution E-4952), p.A-46, 225049353.PDF (ca.gov)

Statewide Deemed Workpaper Rulebook, v. 4.0, p. 12, Statewide Deemed Workpaper Rulebook (squarespace.com)

T1 Working Group Report, 6442451953-cpuc-ml-poe-dec12.pdf (ca.gov)

Weighted Average Cost of Capital, https://www.britannica.com/money/weighted-average-cost-of-capital-wacc

DER Cost-Effectiveness, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm

2022 ACC Documentation v1b updated, p. 31

California Public Utilities Commission, "Early Retirement Using Preponderance of Evidence Version 1.0," 5325-projectbasis-eulrul-evidencev1july172014.pdf (ca.gov)

California Public Utilities Commission, "Draft Resolution E-5115," cpuc.ga.gov, February 11th, 2021. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M360/K017/360017972.PDF

"Fuel Substitution Technical Guidance v1.1," by E3 for the CPUC, October 31, 2019

"Fuel Substitution Technical Guidance v2.0," by E3 for the CPUC, October 13, 2022

Final Regulation Order, California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change, Article 4, California Code of Regulations, Subchapter 10, Article 4 - Regulations to Achieve Greenhouse Gas Emission Reductions | California Code of Regulations | Justia

California Technical Forum, "California Electronic Technical Reference Manual," caetrm.com, https://www.caetrm.com/cpuc/table/effusefullife/

Executive Order R-21-008 to adopt Resolution 20-37 with amendments to §95375 of Article 4, Subarticle 5, Chapter 1, Division 3, Title 17 California Code of Regulations, p. 38., Executive Order R-21-008 (ca.gov)

California Environmental Protection Agency, CARB R3 Registration Checklist, https://ww2.arb.ca.gov/sites/default/files/2020-11/r3-registration-checklist_0.pdf

California Air Resources Board, Retail Food Refrigeration, https://ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/retail-food-refrigeration

Environmental Protection Agency, 40 CFR Part 84 [EPA–HQ–OAR–2021–0643; FRL–8831–01– OAR], Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under Subsection (i) the American Innovation and Manufacturing Act of 2020, https://www.epa.gov/system/files/documents/2023-10/technology-transitions-final-rule-fact-sheet-2023.pdf