



WHEN TRUST MATTERS

Combined Refrigerant Avoided Cost and Fuel-Substitution Calculators w/Technical Guidance Presentation

RACC-FSC_v3.0 Workbook and RACC-FSC Technical Guidance for
California Public Utilities Commission – Energy Division

March 6, 2024

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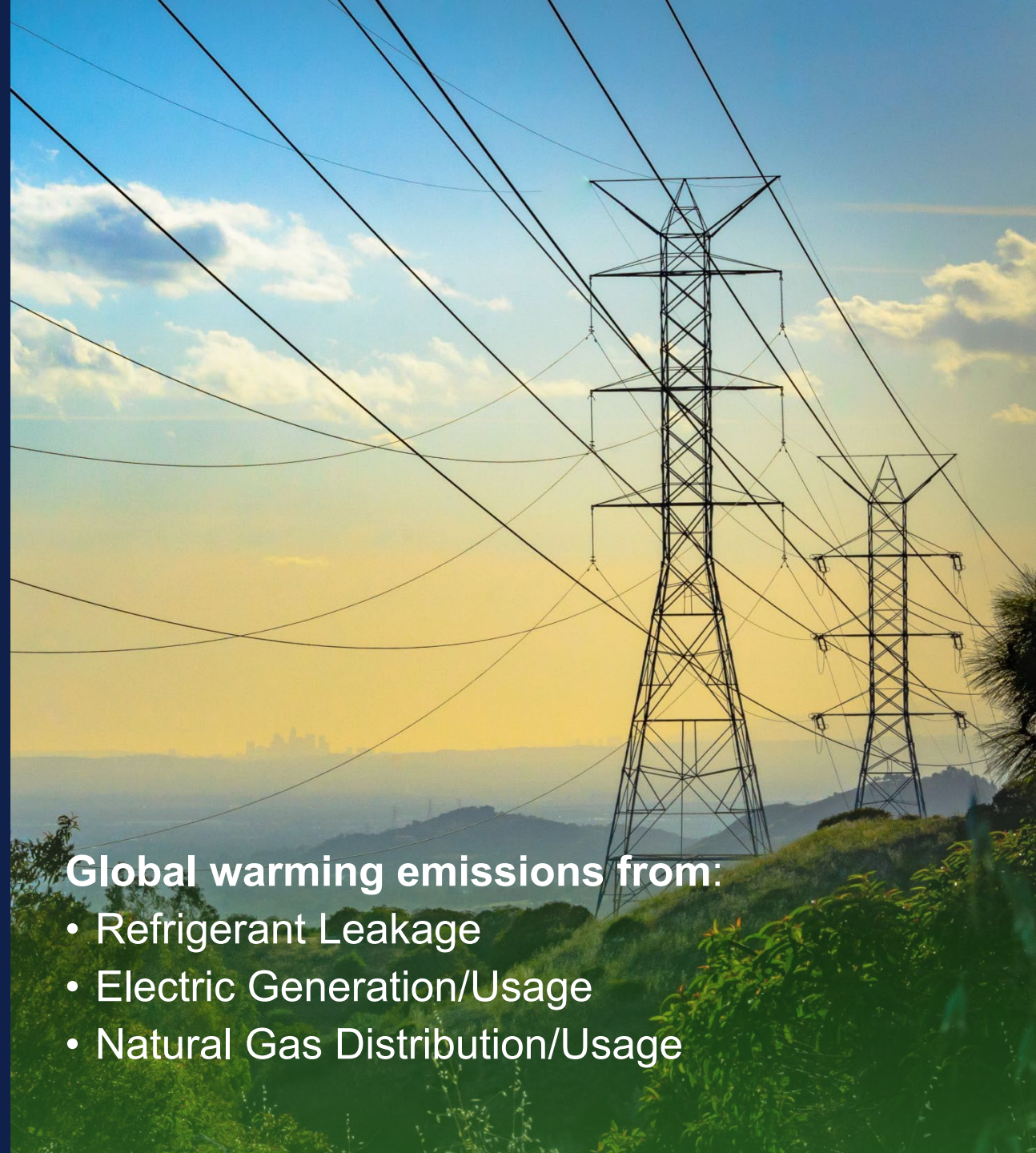
Subject Matter Expert

Acknowledgements to Energy + Environmental Economics, Inc. (E3) and Solaris Technical LLC for their contributions to and review of these tools.

Agenda

- 3:00 pm Background
- 3:10 Refrigerant Code Updates
- 3:15 RACC Examples
- 3:35 FSC Examples
- 3:55 Technical Guidance Document
- 4:05 RACC-FSC Workbook
- 4:15 Next Steps
- 4:20 Questions

- Please post questions in Q&A
- Responses will be provided between agenda items



Global warming emissions from:

- Refrigerant Leakage
- Electric Generation/Usage
- Natural Gas Distribution/Usage



Background

Core Functionality of Tools

RACC

Refrigerant Avoided Cost Calculator

- Calculates lifecycle emissions due to refrigerants in measure and baseline equipment
- Uses California Air Resources Board (CARB) lifecycle equipment emissions rates to determine:
 - Annual operational leakage
 - End-of-life leakage
- Determines net present value (NPV) lifecycle costs of refrigerant leakage emissions
- **Must be completed for measure packages or custom applications that involve addition of refrigerant or changes to refrigerant types or charges**

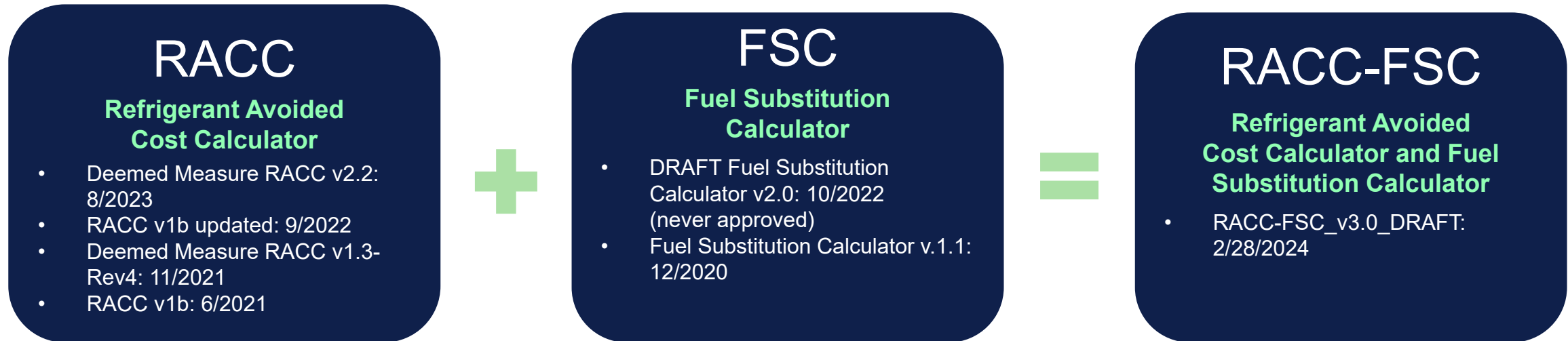
FSC

Fuel Substitution Calculator

- Determines whether fuel substitution measures pass Part 1 and Part 2 of the fuel substitution test:
 - No increase to source energy* usage
 - No increase in net CO2e emissions
- Accounts for refrigerant leakage
- Accounts for methane leakage
 - Upstream of natural gas power plants
 - Behind the meter (residential, only)
- **Must be completed for deemed or custom fuel substitution measures**

*Source energy represents the total amount of raw fuel that is required to operate a given piece of equipment or end-use. It includes transmission, delivery, and production losses.

RACC and FSC Updates



RACC and FSC were combined to ensure that both used same assumptions:
Code updates | GWP baselines | Leakage rates | ACCs & Heat rates

Refrigerant Code Updates

U.S. Environmental Protection Agency (EPA)
California Air Resources Board (CARB)

Key EPA and CARB Refrigerant GWP Updates

Equipment	2024	2025	2026
HVAC: Systems and Chillers	GWP: $\leq 3,985$ R-410A (GWP 2,088)	EPA: GWP ≤ 700 CARB: GWP < 750	
HVAC: Products (Portable, Window, PTAC,[†] & PTHP[‡])	EPA: GWP: - CARB: GWP < 750	EPA: GWP $\leq 700^*$ CARB: GWP < 750	
HVAC: Variable Refrigerant Flow	GWP: $\leq 3,985$ R-410A (GWP 2,088)		EPA: GWP ≤ 700 CARB: GWP < 750
HP Water Heater	EPA: - ENERGY STAR: [®] GWP $\leq 2,088$	EPA: -	
HP Clothes Dryer	EPA: - ENERGY STAR: GWP $\leq 1,430$	EPA: -	

*EPA limits for products manufactured after January 1, 2025

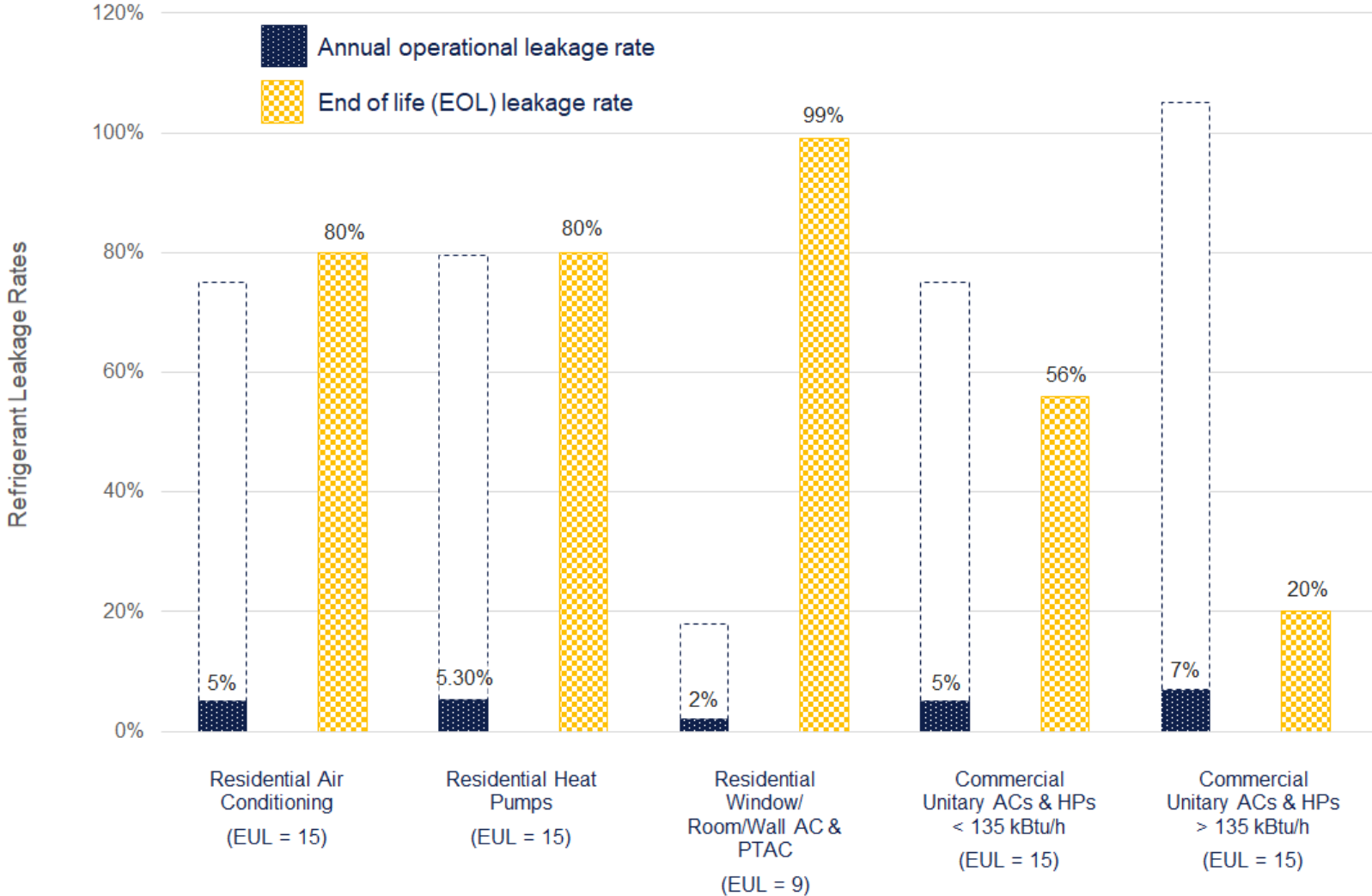
[†]Packaged Terminal Air Conditioner

[‡]Packaged Terminal Heat Pump

Key EPA and CARB Refrigerant GWP Updates

Equipment	2024	2025	2027	2030
New Retail Refrigeration > 50 lb. refrigerant	CARB GWP: <150			
Existing Retail Refrigeration > 50 lb. (≥ 20 stores)	CARB GWP: - EPA GWP: -	CARB GWP: - EPA GWP: -	CARB GWP: < 2,500 (average) EPA GWP: -	CARB GWP: 1,400 (average) EPA GWP: -
Existing Retail Refrigeration > 50 lb. (< 20 stores)	CARB GWP: - EPA GWP: -			CARB GWP: 1,400 (average) EPA GWP: -
New Stand-alone Refrigeration Unit	EPA/CARB GWP: - ENERGY STAR® GWP: 2	EPA GWP: ≤ 150		

Refrigerant Leakage/Loss Rates





Key Updates & Examples

Refrigerant Avoided Cost Calculator (RACC)

Key RACC Updates*

- Incorporates EPA and CARB refrigerant global-warming potential (GWP) limits:
 - Establishes GWP-limit baselines
 - Uses future GWP-limit baseline for Accelerated Replacement (AR) measure application type (MAT)
- Eliminates pro-rating of end-of-life refrigerant emissions for counterfactual cases of AR MAT
- Enables possible avoided emissions credit when recovery/reclamation of existing equipment's high-GWP refrigerant is documented†
- Adds graphs to provide visual representation of refrigerant emissions over equipment life(s)
- Connects to DEER database for updates

* Compared to Deemed_Measure_RACC_Workbook_v2.2.xlsx

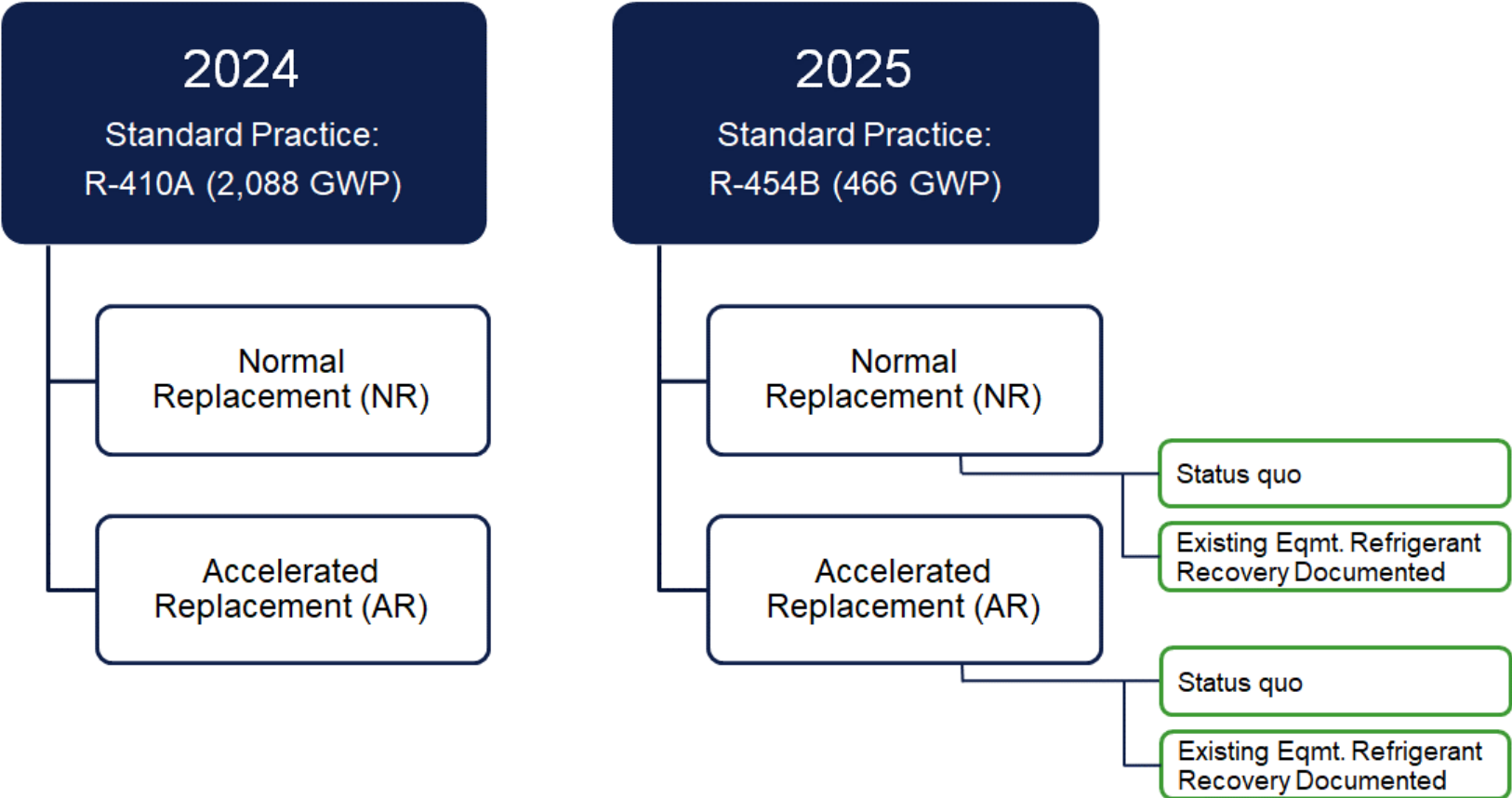
† Documentation requirements are under development and will need to be agreed upon during measure package/custom application development for avoided emissions credit to be claimed.



U.S. Environmental
Protection Agency
(EPA)

California Air
Resources Board
(CARB)

RACC Analysis Charts: Res. HP replacing AC/gas furnace*



* Using SWHC045-03 fuel-substitution measure package permutations approved for PY2024-2025

2024 Heat Pump Fuel Substitution: Refrigerant Emissions

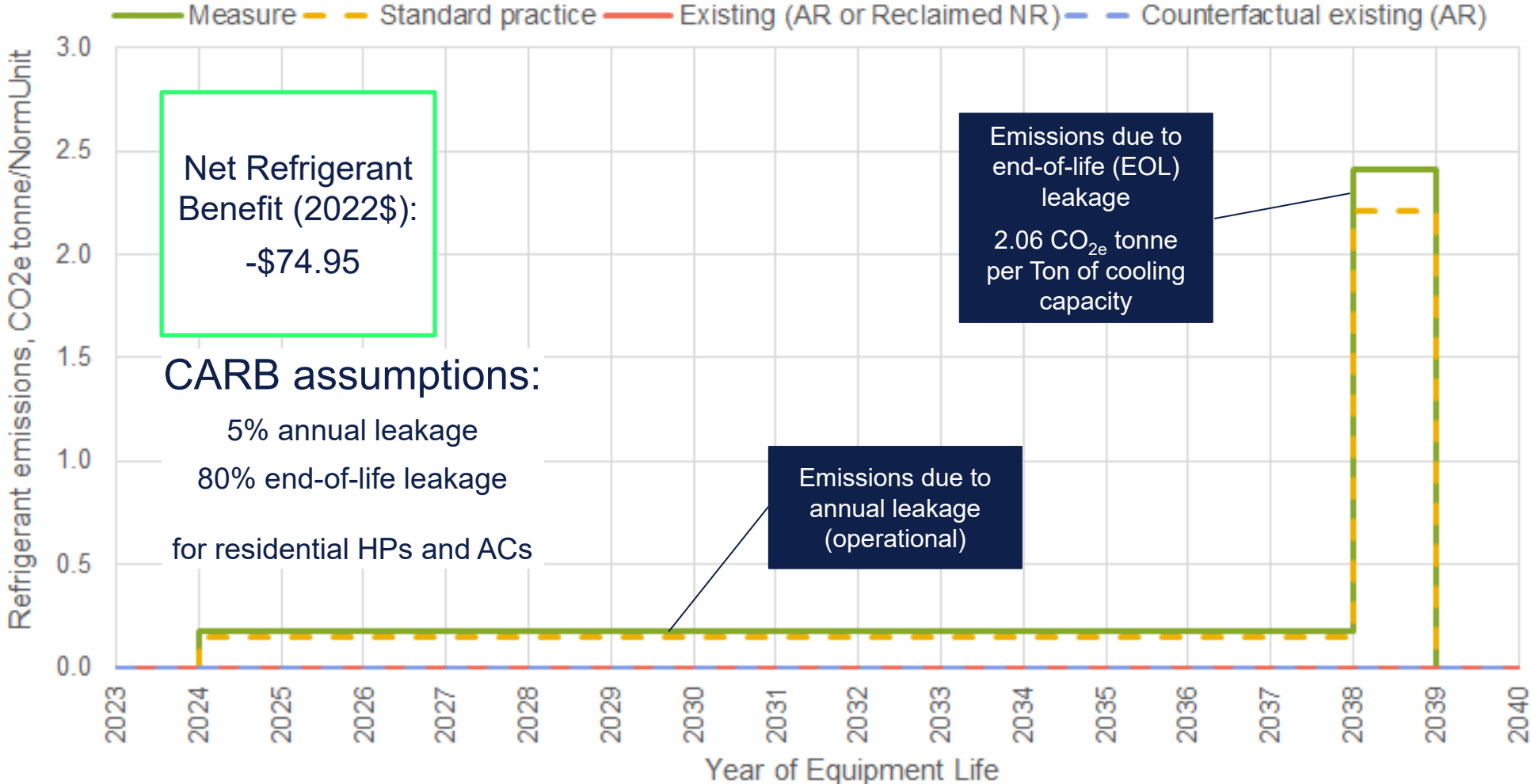
Sector = Residential
MAT = Normal Replacement (NR)

Measure:

- Heat Pump
- R-410A (2,088)
- 3.5 lb. charge/ton

Standard:

- AC w/Gas furnace
- R-410A (2,088)
- 3.2 lb. charge/ton



2024 Heat Pump Fuel Substitution: Refrigerant Emissions

Sector = Residential

MAT = Accelerated Replacement (AR)

Measure:

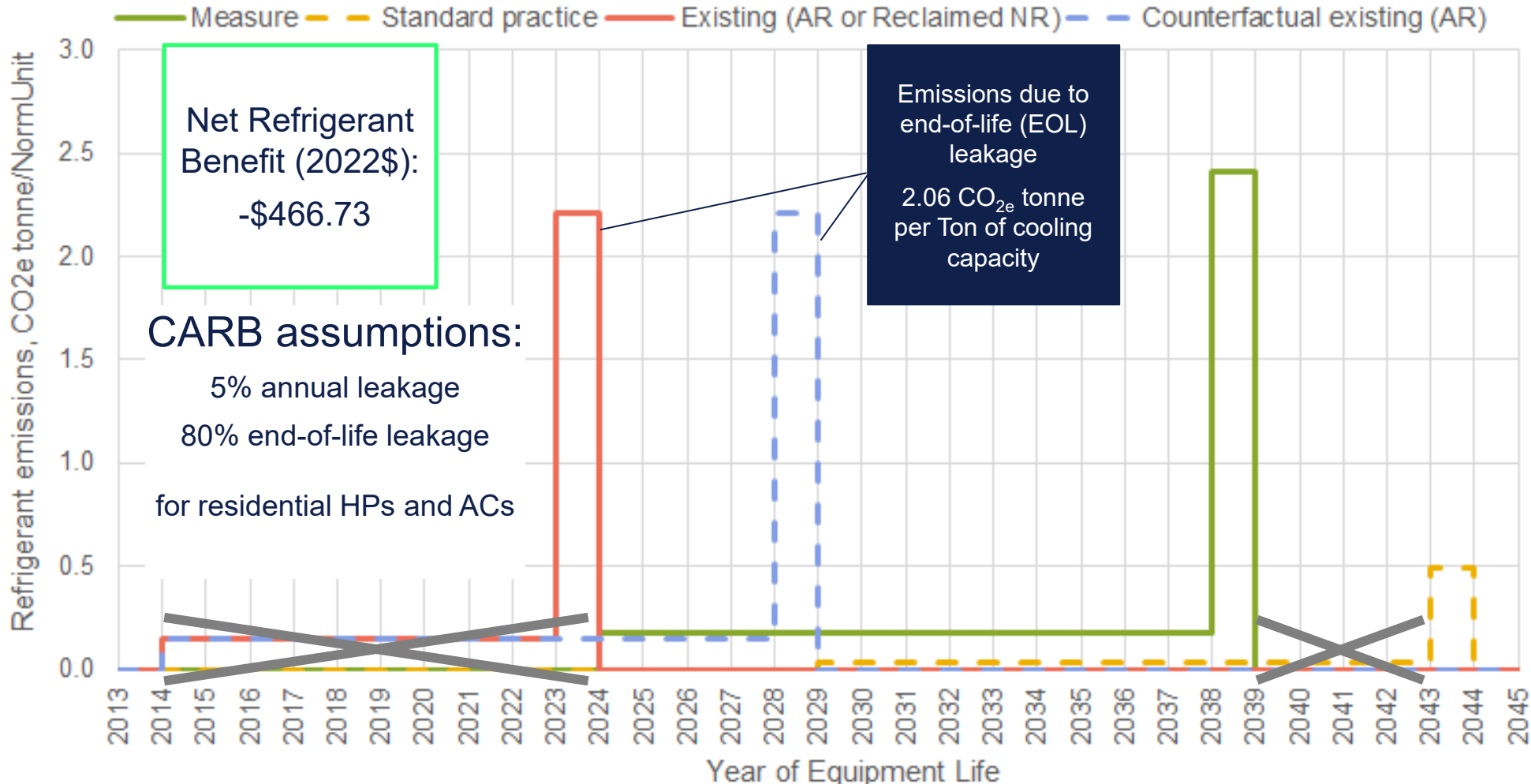
- Heat Pump
- R-410A (2,088)
- 3.5 lb. charge/ton

Standard:

- AC w/Gas furnace
- **R-454B (466)**
- 3.2 lb. charge/ton

Existing/Existing:

- AC w/Gas furnace
- R-410A (2,088)
- 3.2 lb. charge/ton



2025 Heat Pump Fuel Substitution: Refrigerant Emissions

Sector = Residential

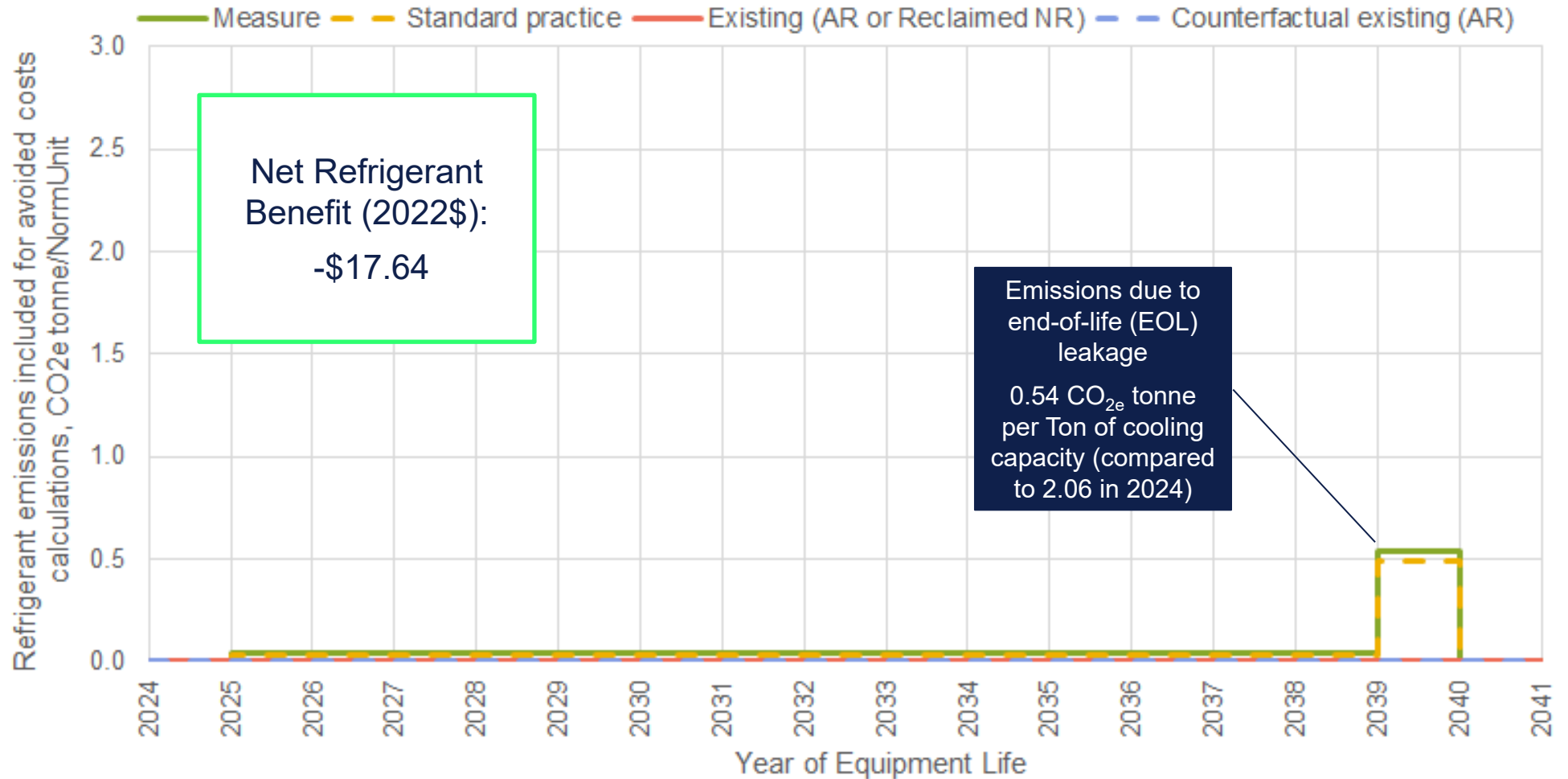
MAT = Normal Replacement (NR)

Measure:

- Heat Pump
- R-454B (466)*
- 3.5 lb. charge/ton

Standard:

- AC w/Gas furnace
- R-454B (466)
- 3.2 lb. charge/ton



* The only current viable and compliant alternative to R-454B is HFC-32 (675), a.k.a. R-32.

2025 Heat Pump Fuel Substitution: Refrigerant Emissions

Sector = Residential

MAT = NR Normal Replacement

Measure:

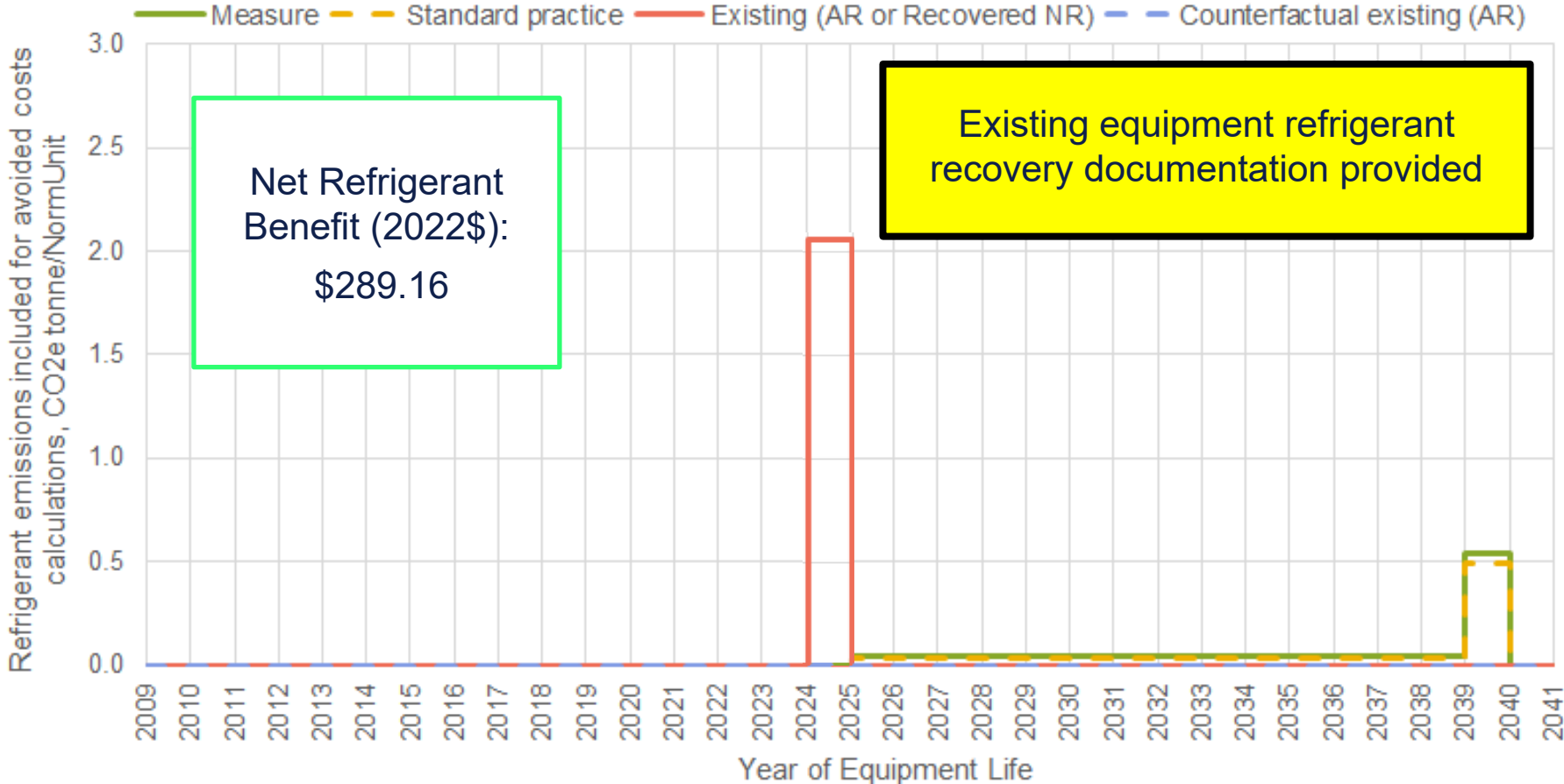
- Heat Pump
- R-454B (466)
- 3.5 lb. charge/ton

Standard:

- AC w/Gas furnace
- R-454B (466)
- 3.2 lb. charge/ton

Existing:

- AC w/Gas furnace
- R-410A (2,088)
- 3.2 lb. charge/ton



2025 Heat Pump Fuel Substitution: Refrigerant Emissions

Sector = Residential

MAT = Accelerated Replacement (AR)

Measure:

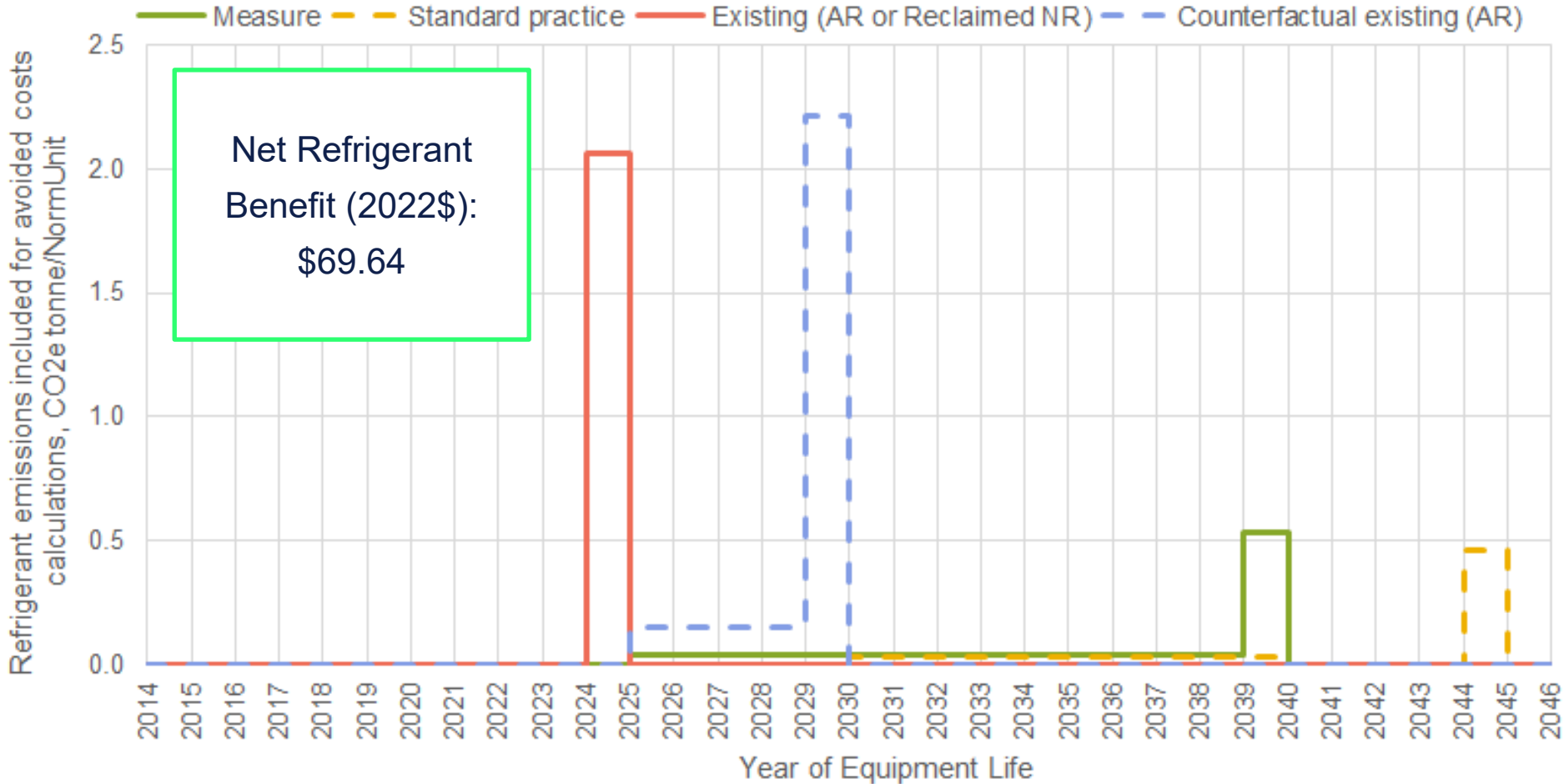
- Heat Pump
- R-454B (466)
- 3.5 lb. charge/ton

Standard:

- AC w/Gas furnace
- R-454B (466)
- 3.2 lb. charge/ton

Existing/Existing:

- AC w/Gas furnace
- R-410A (2,088)
- 3.2 lb. charge/ton



2025 Heat Pump Fuel Substitution: Refrigerant Emissions

Sector = Residential

MAT = Accelerated Replacement (AR)

Measure:

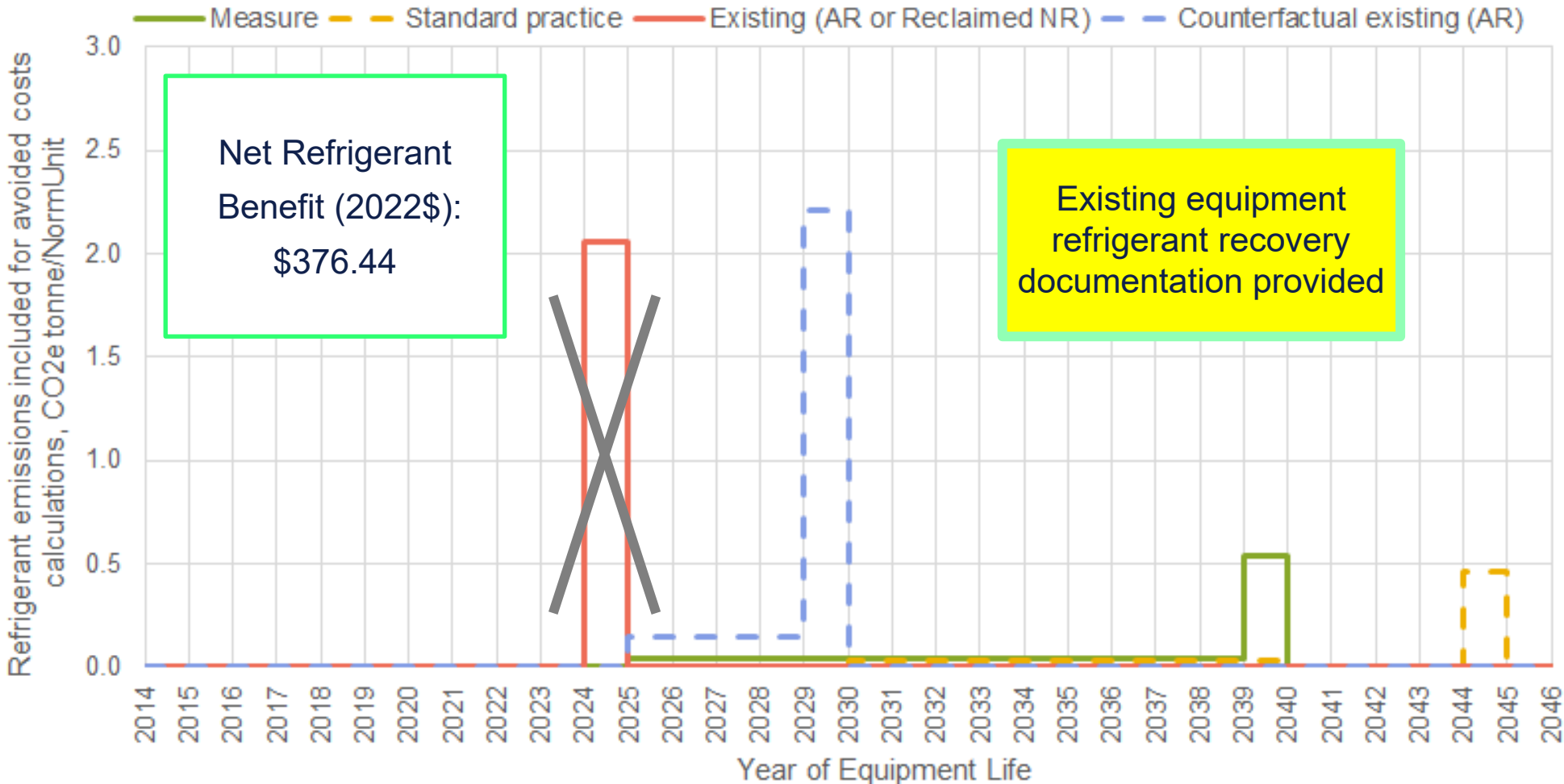
- Heat Pump
- R-454B (466)
- 3.5 lb. charge/ton

Standard:

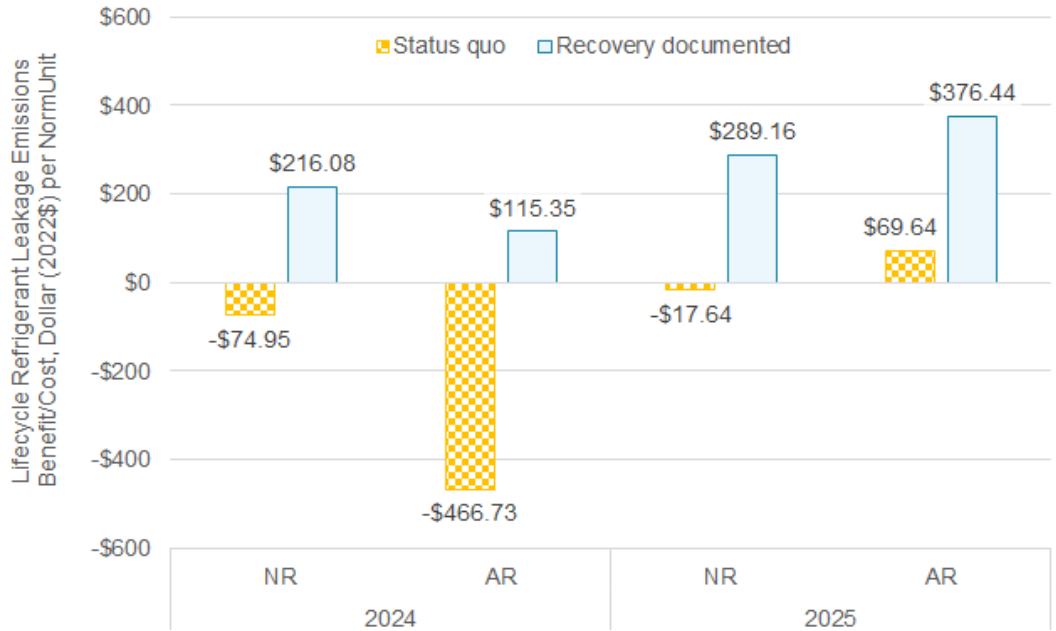
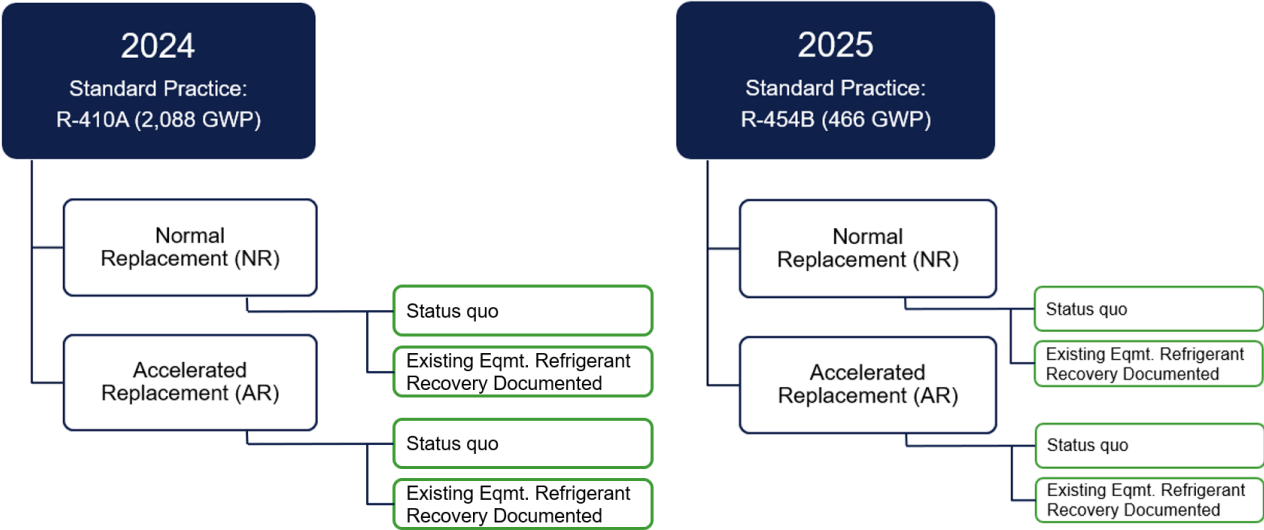
- AC w/Gas furnace
- R-454B (466)
- 3.2 lb. charge/ton

Existing/Existing:

- AC w/Gas furnace
- R-410A (2,088)
- 3.2 lb. charge/ton



Lifecycle Refrigerant Benefit for Residential Heat Pump Fuel Substitution Measure, Dollar per Cap-Ton (2022\$)



**Documentation requirements are still very much under development and will need to be agreed upon during measure package/custom application development for avoided emissions credit to be claimed.*

Export for Measure Package Developers on 4 eTRM export

Index	per NormUnit values ->	RACC Measure description	REFRIGERANT NPV COSTS MEASURE CASE NEW DEVICE (USD)	REFRIGERANT NPV COSTS MEASURE CASE EXISTING DEVICE (USD)	REFRIGERANT NPV COSTS BASE CASE STANDARD DEVICE (USD)	REFRIGERANT NPV COSTS BASE CASE EXISTING DEVICE (USD)	UNIT REFRIGERANT COSTS (USD)	UNIT REFRIGERANT BENEFITS (USD)
1		1: Res DXHP replacing central AC and gas furnace in 2024 (NR)	\$685.92		\$610.96		\$74.95	
2		2: Res DXHP replacing central AC and gas furnace (w/recovery documentation collected) in 2024 (NR)	\$685.92	-\$291.04	\$610.96			\$216.08
3		3: Res DXHP replacing gas furnace in 2024 (NR)	\$685.92		\$0.00		\$685.92	
4		4: Res DXHP replacing central AC and gas furnace in 2024 (AR)	\$685.92	\$291.04	\$112.46	\$397.76	\$466.73	
5		5: Res DXHP replacing central AC and gas furnace (w/recovery documentation collected) in 2024 (AR)	\$685.92	\$0.00	\$112.46	\$397.76	\$175.69	
6		6: Res DXHP replacing gas furnace in 2024 (AR)	\$685.92	\$0.00	\$0.00	\$0.00	\$685.92	



Key Updates & Examples

Fuel Substitution Calculator (FSC)

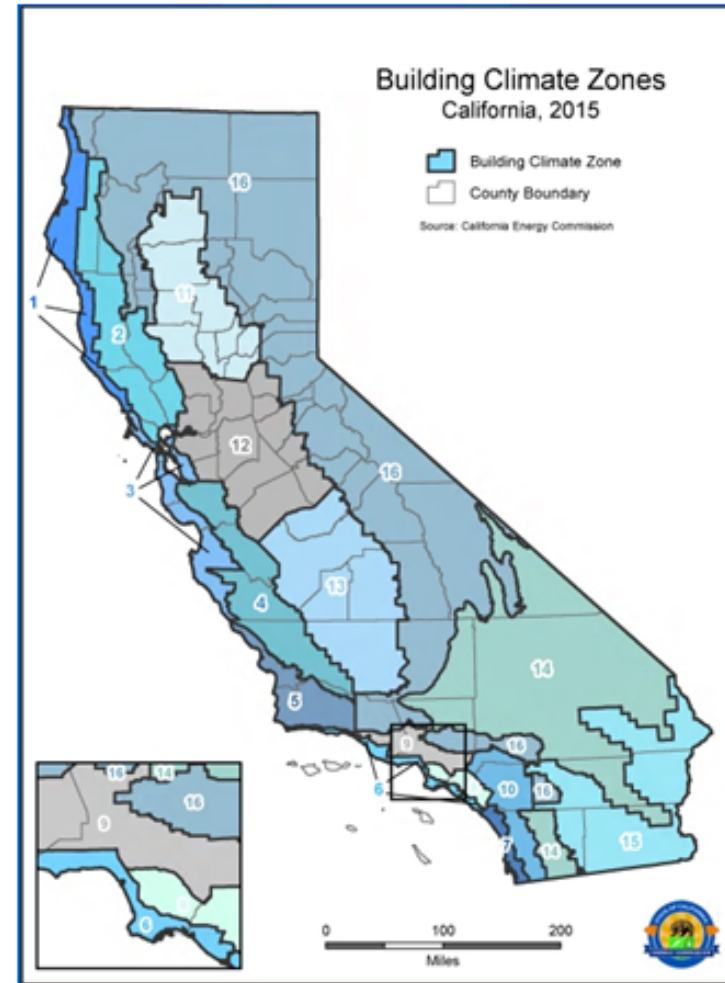
Key FSC Updates

- Accounts for lifecycle refrigerant leakage emissions
- Accounts for methane leakage emissions
- Uses lifecycle emissions due to annual and end-of-life refrigerant leakage drawn from the RACC worksheet
- Imputes residential space cooling adoption by climate zone when existing cooling equipment was not present (compares 2009 RASS to 2019 RASS data)
- Calculates maximum refrigerant GWP threshold by permutation to pass Part 2 of the Fuel Substitution Test
- RACC-FSC is connected to DEER tables to enable updates to EULs, ACCs, etc. without re-issuing workbook



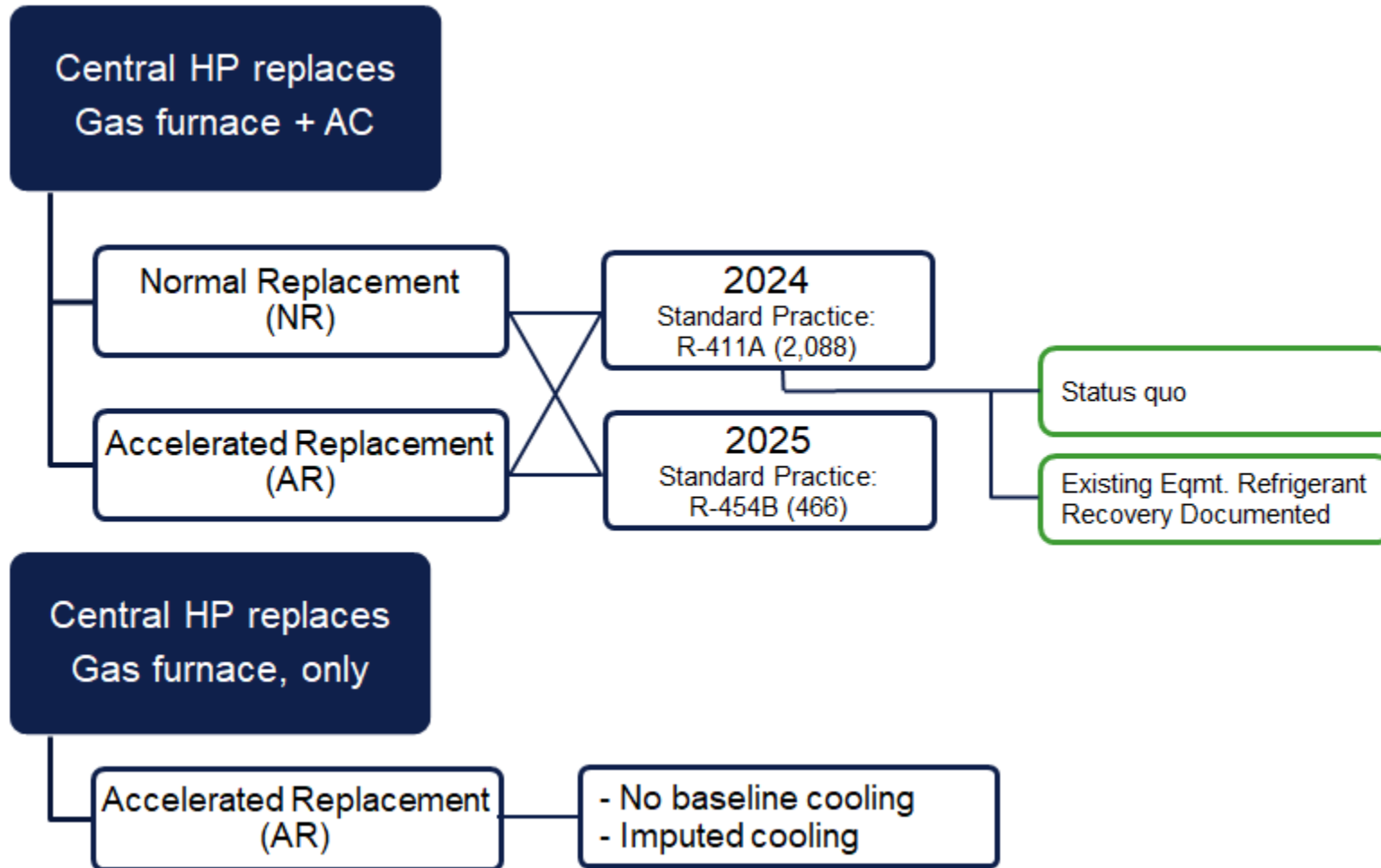
Residential Space Cooling Proportions by Climate Zone

Proportions		10-yr Change	CEC RASS Studies		Extrapolation
BldgLoc	Delta		2009 (n=17,056)	2019 (n=24,323)	2024
CZ01		39.0%	2.8%	41.5%	61.0%
CZ02		11.0%	43.8%	54.6%	60.1%
CZ03		17.0%	13.3%	30.7%	39.2%
CZ04		13.0%	61.3%	74.2%	80.7%
CZ05		0.0%	17.5%	17.4%	17.4%
CZ06		19.0%	43.7%	62.4%	71.9%
CZ07		23.0%	42.0%	65.2%	76.7%
CZ08		20.0%	69.8%	89.4%	99.4%
CZ09		7.0%	87.3%	94.0%	97.5%
CZ10		2.0%	96.4%	98.1%	99.1%
CZ11		0.0%	98.6%	94.3%	94.3%
CZ12		4.0%	93.2%	97.5%	99.5%
CZ13		0.0%	97.8%	95.7%	95.7%
CZ14		0.0%	98.8%	95.6%	95.6%
CZ15		2.0%	96.7%	99.0%	100.0%
CZ16		18.0%	74.4%	91.9%	100.0%
Statewide		13.0%	67.4%	80.1%	86.6%



FSC Analysis Pivot Tables

Res. HP replacing gas furnace w/ & w/o AC*

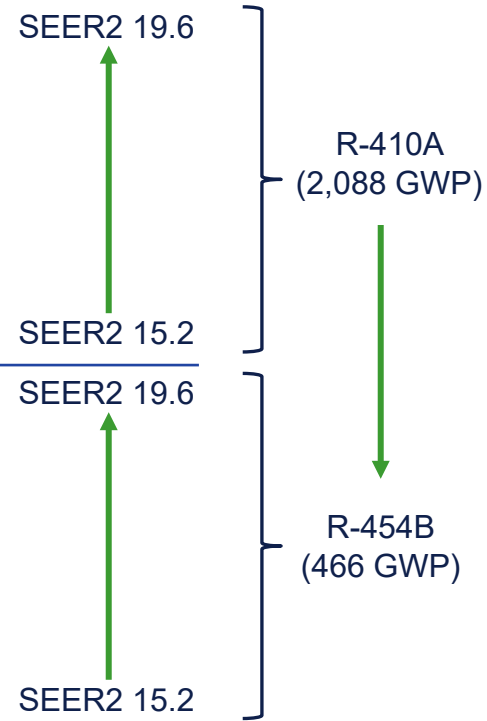


* Using SWHC045-03 fuel-substitution measure package permutations approved for PY2024-2025

FuelSub Test Results at Single-family Homes

Central Heat Pump Replacing Central AC and Gas Furnace – NR*

Bin	Offering ID Description	Part 1 PASS/ FAIL	Bldg Loc Part 2: Net Emissions Avoided, metric tonne CO2e per NormUnit																
			CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16	
2024 NR	AR: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	3.7	3.7	3.3	3.4	3.2	1.8	2.3	1.9	2.0	1.8	3.6	3.7	4.0	3.7	1.4	3.7	SEER2 19.6 SEER2 15.2
	AO: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	3.7	3.6	3.3	3.3	3.1	1.7	2.3	1.8	2.0	1.7	3.5	3.6	3.8	3.6	1.3	3.5	
	AL: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	3.6	3.5	3.2	3.2	3.1	1.7	2.2	1.8	1.9	1.7	3.5	3.5	3.7	3.5	1.3	3.5	
	AI: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	3.6	3.5	3.2	3.2	3.1	1.7	2.2	1.8	1.9	1.6	3.4	3.5	3.7	3.5	1.2	3.4	
	AF: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS	3.6	3.5	3.2	3.2	3.1	1.7	2.2	1.8	1.9	1.6	3.4	3.4	3.7	3.5	1.1	3.4	
	AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	3.5	3.5	3.1	3.2	3.0	1.6	2.2	1.7	1.8	1.6	3.3	3.4	3.6	3.4	1.1	3.3	
2025 NR	AR: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	4.2	4.1	3.8	3.8	3.7	2.2	2.7	2.3	2.4	2.2	4.1	4.1	4.4	4.1	1.8	4.1	SEER2 19.6 SEER2 15.2
	AO: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	4.1	4.1	3.7	3.8	3.6	2.2	2.7	2.3	2.4	2.1	4.0	4.0	4.3	4.1	1.7	4.0	
	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	3.9	4.2	4.0	1.7	3.9	
	AI: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	4.1	4.0	3.6	3.7	3.5	2.1	2.6	2.2	2.3	2.1	3.9	3.9	4.1	3.9	1.6	3.9	
	AF: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, 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	
	AC: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	4.0	3.9	3.6	3.6	3.5	2.1	2.6	2.2	2.2	2.0	3.8	3.8	4.0	3.9	1.5	3.8	



* Using SWHC045-03 fuel-substitution measure package permutations approved for PY2024-2025

FuelSub Test Results at Single-family Homes: Central Heat Pump

Replacing Central AC and Gas Furnace – Accelerated Replacement

Bin	Offering ID Description	Part 1 PASS/ FAIL	Bldg Loc Part 2: Net Emissions Avoided, metric tonne CO2e per NormUnit																SEER2
			CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16	
2024 AR	AP: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	1.0	0.9	0.6	0.6	0.4	-1.0	-0.5	-0.9	-0.8	-1.0	0.9	0.9	1.2	0.9	-1.4	0.9	SEER2 19.6
	AM: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	0.9	0.8	0.5	0.5	0.4	-1.0	-0.5	-0.9	-0.8	-1.1	0.7	0.8	1.1	0.8	-1.5	0.8	
	AJ: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	0.8	0.8	0.4	0.5	0.3	-1.1	-0.5	-1.0	-0.9	-1.1	0.7	0.7	1.0	0.8	-1.5	0.7	
	AG: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	0.8	0.8	0.4	0.5	0.3	-1.1	-0.6	-1.0	-0.9	-1.1	0.6	0.7	0.9	0.7	-1.6	0.7	
	AD: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS	0.8	0.7	0.4	0.4	0.3	-1.1	-0.6	-1.0	-0.9	-1.2	0.6	0.7	0.9	0.7	-1.6	0.6	
	AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	0.8	0.7	0.4	0.4	0.3	-1.1	-0.6	-1.0	-1.0	-1.2	0.6	0.6	0.8	0.6	-1.7	0.5	SEER2 15.2
2025 AR	AP: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	4.8	4.7	4.4	4.4	4.2	2.8	3.3	2.9	3.0	2.8	4.7	4.7	5.0	4.7	2.4	4.7	SEER2 19.6
	AM: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	4.7	4.6	4.3	4.3	4.2	2.7	3.3	2.9	3.0	2.7	4.6	4.6	4.9	4.6	2.3	4.6	
	AJ: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	4.7	4.6	4.3	4.3	4.1	2.7	3.3	2.8	2.9	2.7	4.5	4.5	4.8	4.6	2.2	4.5	
	AG: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	4.7	4.6	4.2	4.3	4.1	2.7	3.2	2.8	2.9	2.7	4.5	4.5	4.7	4.5	2.2	4.5	
	AD: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS	4.6	4.6	4.2	4.3	4.1	2.7	3.2	2.8	2.9	2.6	4.4	4.5	4.7	4.5	2.1	4.4	
	AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	4.6	4.5	4.2	4.2	4.1	2.7	3.2	2.7	2.8	2.6	4.4	4.4	4.6	4.4	2.1	4.4	SEER2 15.2

If Failing, Maximum Msr Refrig. GWP to Pass FuelSub Test Part #2

1,480
1,454
1,427
1,392
1,375
1,357

FuelSub Test Results at Single-family Homes: Central Heat Pump

Replacing Central AC and Gas Furnace, without and with EOL refrigerant recovery/reclamation

Bin	Offering ID Description	Part 1 PASS/ FAIL	Bldg Loc Part 2: Net Emissions Avoided, metric tonne CO2e per NormUnit																
			CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16	
2024 AR status quo	AP: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	1.0	0.9	0.6	0.6	0.4	-1.0	-0.5	-0.9	-0.8	-1.0	0.9	0.9	1.2	0.9	-1.4	0.9	SEER2 19.6
	AM: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	0.9	0.8	0.5	0.5	0.4	-1.0	-0.5	-0.9	-0.8	-1.1	0.7	0.8	1.1	0.8	-1.5	0.8	↑
	AJ: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	0.8	0.8	0.4	0.5	0.3	-1.1	-0.5	-1.0	-0.9	-1.1	0.7	0.7	1.0	0.8	-1.5	0.7	
	AG: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	0.8	0.8	0.4	0.5	0.3	-1.1	-0.6	-1.0	-0.9	-1.1	0.6	0.7	0.9	0.7	-1.6	0.7	
	AD: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS	0.8	0.7	0.4	0.4	0.3	-1.1	-0.6	-1.0	-0.9	-1.2	0.6	0.7	0.9	0.7	-1.6	0.6	
	AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	0.8	0.7	0.4	0.4	0.3	-1.1	-0.6	-1.0	-1.0	-1.2	0.6	0.6	0.8	0.6	-1.7	0.5	
2024 AR Existing refrig. Recovered	AP: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing AC and gas furnace	PASS	3.0	3.0	2.6	2.7	2.5	1.1	1.6	1.2	1.3	1.1	2.9	2.9	3.2	3.0	0.7	3.0	
	AM: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing AC and gas furnace	PASS	2.9	2.9	2.5	2.6	2.4	1.0	1.6	1.1	1.2	1.0	2.8	2.9	3.1	2.9	0.6	2.8	↑
	AJ: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	2.9	2.8	2.5	2.5	2.4	1.0	1.5	1.1	1.2	1.0	2.7	2.8	3.0	2.8	0.5	2.8	
	AG: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing AC and gas furnace	PASS	2.9	2.8	2.5	2.5	2.4	1.0	1.5	1.1	1.1	0.9	2.7	2.7	3.0	2.8	0.5	2.7	
	AD: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing AC and gas furnace	PASS	2.9	2.8	2.5	2.5	2.4	1.0	1.5	1.0	1.1	0.9	2.7	2.7	2.9	2.8	0.4	2.7	
	AA: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing AC and gas furnace	PASS	2.8	2.8	2.4	2.5	2.3	0.9	1.5	1.0	1.1	0.8	2.6	2.7	2.9	2.7	0.4	2.6	

FuelSub Test Results at Single-family Homes: Central Heat Pump

Replacing Gas Furnace, only, with/without Imputed Cooling

			Net Emissions Avoided, tonne CO2e per Cap-Ton (NormUnit)															
Bin	Offering ID Description	Test Part 1	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ16	
2024 As Is AR	CB: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing gas furnace only	PASS	-0.6	-0.9	-1.4	-1.4	-1.5	-3.0	-2.5	-3.2	-3.3	-3.6	-2.1	-1.6	-2.5	-2.4	-2.5	SEER2 19.6
	BY: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing gas furnace only	PASS	-0.7	-0.9	-1.5	-1.5	-1.6	-3.1	-2.5	-3.2	-3.3	-3.7	-2.2	-1.6	-2.6	-2.4	-2.6	
	BV: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing gas furnace only	PASS	-0.7	-1.0	-1.5	-1.5	-1.6	-3.1	-2.6	-3.2	-3.4	-3.7	-2.2	-1.7	-2.7	-2.5	-2.6	
	BS: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing gas furnace only	PASS	-0.7	-1.0	-1.6	-1.5	-1.7	-3.1	-2.6	-3.3	-3.4	-3.7	-2.3	-1.7	-2.7	-2.6	-2.7	
	BP: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing gas furnace only	PASS	-0.7	-1.0	-1.6	-1.5	-1.7	-3.1	-2.6	-3.3	-3.4	-3.8	-2.3	-1.8	-2.7	-2.6	-2.7	
	BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	PASS	-0.8	-1.0	-1.6	-1.6	-1.7	-3.2	-2.7	-3.3	-3.5	-3.8	-2.3	-1.8	-2.8	-2.7	-2.8	SEER2 15.2
2024 Imputed Cooling, Standard Case AR	CB: Residential SEER2-rated split/pkg HP, SEER2 >= 19.6 and HSPF2 >= 8.9, replacing gas furnace only	PASS	2.1	1.9	0.4	2.5	-0.7	0.4	1.2	1.9	1.8	1.7	3.3	3.7	3.6	3.3	3.6	SEER2 19.6
	BY: Residential SEER2-rated split/pkg HP, SEER2 >= 18.7 and HSPF2 >= 8.5, replacing gas furnace only	PASS	2.0	1.8	0.4	2.4	-0.8	0.4	1.2	1.8	1.8	1.7	3.2	3.6	3.5	3.2	3.5	
	BV: Residential SEER2-rated split/pkg HP, SEER2 >= 17.8 and HSPF2 >= 8.1, replacing gas furnace only	PASS	2.0	1.8	0.3	2.4	-0.8	0.4	1.1	1.8	1.7	1.6	3.1	3.5	3.4	3.1	3.4	
	BS: Residential SEER2-rated split/pkg HP, SEER2 >= 16.9 and HSPF2 >= 8.1, replacing gas furnace only	PASS	2.0	1.8	0.3	2.4	-0.8	0.3	1.1	1.8	1.7	1.6	3.0	3.5	3.4	3.1	3.4	
	BP: Residential SEER2-rated split/pkg HP, SEER2 >= 16 and HSPF2 >= 8.0, replacing gas furnace only	PASS	1.9	1.7	0.3	2.3	-0.8	0.3	1.1	1.7	1.7	1.5	3.0	3.5	3.3	3.1	3.3	
	BM: Residential SEER2-rated split/pkg HP, SEER2 >= 15.2 and HSPF2 >= 7.7, replacing gas furnace only	PASS	1.9	1.7	0.3	2.3	-0.9	0.3	1.1	1.7	1.7	1.5	3.0	3.4	3.2	3.0	3.3	SEER2 15.2

If Failing, Maximum Msr Refrig. GWP to Pass FuelSub Test Part #2

1,502
1,475
1,458
1,449
1,449
1,432

Technical Guidance Document

Refrigerant ACC and Fuel-Substitution Calculator
Technical Guidance

Refrigerant ACC and Fuel-Sub Calculator Technical Guidance



Guidance Document overview

- Document posted to PDA on 2/28/2024 with RACC-FSC Workbook
- Document Includes:
 - Detailed review of RACC-FSC workbook
 - Baseline Guidance
 - Appropriate baselines
 - EUL/RUL considerations
 - Refrigerant charge
 - Current refrigerant emissions policies
 - Measure Example Walkthroughs
 - Stationary Refrigeration
 - Stationary Air-Conditioning
 - Appliance

Navigating the Guidance Document

- PDF document produced using InDesign
- Easy navigation through the document
 - Section tabs allow quick-access to each section
 - Return to cover page
 - Previous/Next page
 - Click to open dialogue boxes for additional notes/guidance

Document Navigation Use the following symbols to navigate through the guidance document.



Background

Refrigerant Code
Updates

RACC Examples

FSC Examples

Technical Guidance

RACC-FSC
Walkthrough

Next Steps

Questions

Example Walkthrough Index

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	Refrigerant gas replacement, <50 lbs. charge systems	AR	Msr: R-448A Std: R-448A Pre/Ext: R-404A	No	4-1
Stationary refrigeration	Cascade retail food refrigeration system with natural refrigerants, >50 lbs. 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	4-12
Stationary refrigeration	Cascade retail food refrigeration system with natural refrigerants, >50 lbs. 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	4-25
Stationary refrigeration	Cascade retail food refrigeration system with hybrid refrigerants, >50 lbs. charge systems	AR	(Low/Med temp) Msr: CO2 (R-744) Std: R-448A Pre/Ext: R-404A	No	4-36

- Found in the Introduction Section
- Provides quick overview of measure examples
 - Description
 - Measure Application Type
 - Refrigerant types
 - Fuel substitution flag
 - Link to measure example document

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.

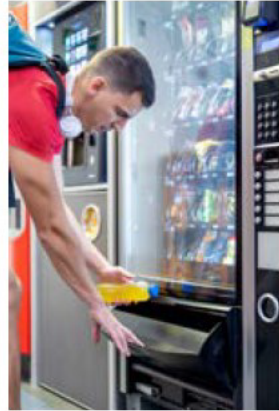
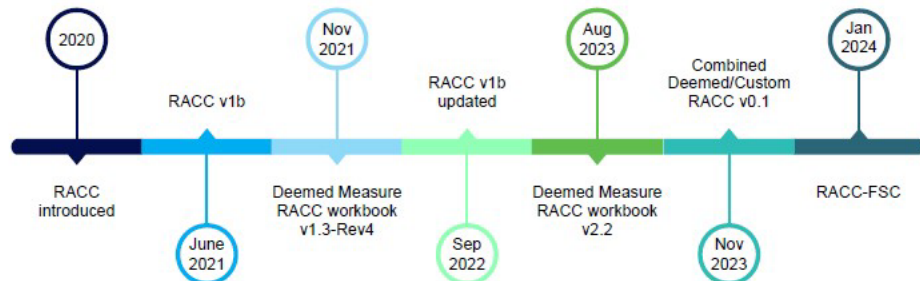


Figure 2-1. RACC timeline



RACC-FSC Overview Section

- Provides overview of each worksheet
 - Describes each column and
 - Worksheet methodology
- Defines color coding for worksheets and columns

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

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

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".

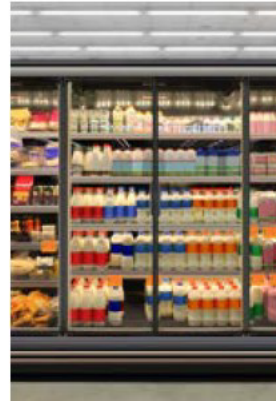
Measures may only be categorized as accelerated replacement (AR) if the existing equipment being replaced could and would remain operation without program intervention. AR measures need to pass the CPUC's POE criteria to be eligible. If the POE criteria are passed, the baseline for the AR measure would 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.

REFRIGERANT RETROFIT MEASURES

A common and lower cost option to reduce a systems GWP is to retrofit the existing system by replacing the current refrigerant with a compatible lower-GWP refrigerant. This type of project is commonly referred to as a refrigerant/gas replacement, refrigerant/gas swap, or a drop-in refrigerant replacement project.

Refrigerant Retrofit, >50 lbs. Charge

Existing retail food refrigeration facilities with systems containing more than 50 lbs of refrigerant must adhere to CARB regulations limited to the company-wide weighted average GWP, down to 1,400 GWP by the year 2030, see **Table 3-1**. A common strategy to achieve this is to replace the refrigerant to a low-GWP alternative as a low-cost option that does not require a full system retrofit.



Definitions and Acronyms

Introduction

RACC-FSC Overview

Baseline Guidance

Stationary Refrigeration

Stationary Air-Conditioning

Appliances

Appendices

Baseline Guidance Section

- Appropriate baselines
- Refrigerant retrofit measures
- EUL/RUL considerations
- Leakage rates
- Refrigerant charges
- Hybrid system measures
- Refrigerant emission policies (CARB/EPA)

section 4

Stationary Refrigeration Measures

REFRIGERANT GAS REPLACEMENT ONLY, <50 LBS. CHARGE

Measure Description

This measure example involves refrigerant replacement projects for small independent retail food facilities with refrigeration equipment containing a refrigerant charge of 50 lbs or less. This could include grocery stores or convenience stores with smaller refrigeration equipment. This example assumes the existing equipment is not at its end-of-life and currently contains R-404A refrigerant. The refrigerant will be replaced as a drop-in replacement with R-448A into the existing systems.

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 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 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.

Example Walkthroughs

Refrigeration Measures

Sample of measure example type:

- Natural refrigerant retail refrigeration
- Hybrid (natural / HFC) retail refrigeration
- Commercial ice machines
- Stand-alone units
- Refrigerated food processing and dispensing
- Cold storage warehouse

section 5

Stationary Air-conditioning Measures

AIR-COOLED CHILLER, WITH R-454B, COMMERCIAL

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.

Example Walkthroughs

HVAC Measures

Sample of measure example type:

- Residential central heat pump, replacing gas furnace with/without AC (Fuel Sub)
- Residential ductless heat pump, replacing gas furnace with/without AC (Fuel Sub)
- HVAC Chiller
- Commercial unitary RTU

section 6

Appliance Measures

HEAT PUMP WATER HEATER, RESIDENTIAL, FUEL-SUBSTITUTION

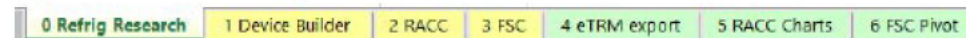
Measure description

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

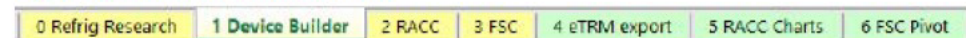
Input worksheet: 0 Refrig Research



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 lbs per device (each).

Input Worksheet: 1 Device Builder



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.

Example Walkthroughs

Appliance Measures

Measure examples included:

- HP water heater
- HP clothes dryer
- Residential refrigerator/freezer

Definitions and Acronyms

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Stationary Air-Conditioning

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RACC-FSC Workbook Overview

Overview of Workbook
Residential Central Heat Pump Measure Example

RACC-FSC Worksheets – 0_Refrig Research

Purpose of **0 Refrig Research** worksheet:
Document and substantiate refrigerant charge per normal unit

Residential Central Heat Pump Example:

- Used existing research into charge levels
 - 3.5 lbs./cap-Tons (HP)
 - 3.2 lbs./Cap-Tons (AC)

Refrigerant type research						
CARB_DeviceType	Common Refrigerant Type(s)	Source for Refrigerant Type	Refrigerant Charge (lb/NormUnit)	NormUnit	Source	Date Added/ Revised
Heat Pump Clothes Dryers	R-134A/R-407C/R-410A	1) https://www.choice.com.au/home-and-living/laundry-and-cleaning/dryers/articles/what-is-a-heat-pump-dryer 2) https://www.researchgate.net/publication/280446701_The_Design_of_Heat_Pump_Clothes_Dryer	0.88	Each	From RACC calculator	2021-12-31
Ductless HVAC, Residential - Heat Pump	R-410A	Table 5-5 CPUC. Proposed Defined Study – A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants, EM&V Group A. March 4, 2021	3.50	Cap-Tons	Appendix B - California Facilities and Greenhouse Gas Emissions Inventory – High-Global Warming Potential Stationary - Source Refrigerant Management Program Research Division, Release Date October 23, 2009	2021-12-31
Window/Room/Wall AC and Packaged Terminal AC (PTAC) Units, residential	R-410A		1.54	Cap-Tons	Assume lookup table refrigerant charge (1.54 lbs) corresponds to a 1.0 ton cooling capacity unit.	2023-07-25
Central HVAC, Residential - Heat Pump	R-410A	Table 5-5 CPUC. Proposed Defined Study – A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants, EM&V Group A. March 4, 2021	3.50	Cap-Tons		2021-12-31
Residential Unitary AC	R-410A	Table 5-5 CPUC. Proposed Defined Study – A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants, EM&V Group A. March 4, 2021	3.20	Cap-Tons	Based on the ratio of residential unitary charge of 7.5 and residential heat pump charge of 8.2 from RACC	2021-12-31
Unitary Air-Cooled HVAC, Commercial - Heat Pump	R-410A	Table 5-5 CPUC. Proposed Defined Study – A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants, EM&V Group A. March 4, 2021	3.50	Cap-Tons		2021-12-31

0 Refrig Research

1 Device Builder

2 RACC

3 FSC

4 eTRM export

5 RACC Charts

6 FSC Pivot

RACC-FSC Worksheets – 1_Device builder

Purpose of **1 Device Builder** worksheet:

Define devices to be used in **2 RACC**, **3 FSC** worksheet calculations

- Device properties: Tech type, Normal units, CARB device type/leakage rates, refrigerant charge

Residential Central Heat Pump Example:

- Devices for this measure already in 1 Device Builder

DeviceType	TechTypeID	TechTypeDesc	NormUnit	TechGroup (NormUnit)	CARB_Sector	CARB_DeviceType
Central HVAC, Residential - Gas Furnace only	SpaceHtg_eq:GasFurnace	Gas Furnace	Cap-kBTUh	SpaceHtg_eq (Cap-kBTUh)	Other / Not specified	Eqmt. w/o refrigerant
Central HVAC, Residential - Heat Pump	dxHP_equip:spltSEER	SEER Rated Split System HP	Cap-Tons	dxHP_equip (Cap-Tons)	Stationary Air-conditioning	Residential Heat Pumps
Central HVAC, Residential - AC and Gas Furnace	dxAC_equip:spltSEER	SEER Rated Split System AC	Cap-Tons	dxAC_equip (Cap-Tons)	Stationary Air-conditioning	Residential Unitary AC

0 Refrig Research

1 Device Builder

2 RACC

3 FSC

4 eTRM export

5 RACC Charts

6 FSC Pivot

RACC-FSC Worksheets – 2_RACC

Purpose of **2 RACC** worksheet:

Calculate refrigerant emissions and avoided cost impacts

Residential Central Heat Pump Example:

- General parameters
- Specify device types (Msr, Std, Pre/Ext)
- Select refrigerant types
- Refrigerant charge

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

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

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

0 Refrig Research

1 Device Builder

2 RACC

3 FSC

4 eTRM export

5 RACC Charts

6 FSC Pivot

RACC-FSC Worksheets – 2_RACC (continued)

Purpose of **2 RACC** worksheet:

Calculate refrigerant emissions and avoided cost impacts

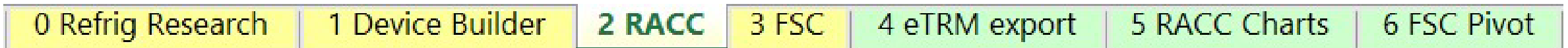
Residential Central Heat Pump Example:

- General parameters
- Specify device types (Msr, Std, Pre/Ext)
- Select refrigerant types
- Refrigerant charge & leakage rates

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
			<i>Refrigerant properties color coding</i>			<i>Refrigerant properties color coding</i>			<i>Refrigerant properties color coding</i>		
			The CARB-EPA limit is used in calcs.			Value replaced formula			Value replaced formula		
			Exceeds CARB-EPA limit, if any								
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-454B (GWP=466)	R-454B (GWP=466)	R-410A (GWP=2,088)	700	700	None	466	466	2,088	466	466	2,088

Refrigerant Charge (lb) per Device Builder			Refrigerant Charge (lb), Actual (typically modified for Custom, only)			Annual Refrigerant Leakage % per Device Builder			Annual Refrigerant Leakage %, Actual (typically modified for Custom, only)		
Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext	Msr	Std	Pre Ext
			<i>Refrigerant properties color coding</i>			<i>Refrigerant properties color coding</i>			<i>Refrigerant properties color coding</i>		
			Value replaced formula			Value replaced formula			Value replaced formula		
			Device Builder value replaced			Device Builder value replaced			Value exceeds CARB rate		
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)	Msr Annual Refrigerant Leakage % per Device Builder	Std Annual Refrigerant Leakage % per Device Builder	Pre/Ext Annual Refrigerant Leakage % per Device Builder	Msr Annual Refrigerant Leakage %	Std Annual Refrigerant Leakage %	Pre/Ext Annual Refrigerant Leakage %
3.50	3.20	3.20	3.50	3.20	3.20	5.3%	5.0%	5.0%	5.3%	5.0%	5.0%

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



RACC-FSC Worksheets – 3_FSC (continued)

Purpose of **3 FSC** worksheet:

Assess whether measure permutations pass the fuel substitution tests

Residential Central Heat Pump Example:

- Measure offering classifications & assign RACC calculation
- Imputed cooling (optional)
- Annual energy usage

FSC_Index	RACC_Index	Overall Result	RACC_Measure Description	Offering ID Description	Sector	BldgType	BldgVint	BldgLoc
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
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

Column Heading Color Coding

Input, enter a value

Input, select from dropdown list

Custom input (only)

Calculation step

Lookup formula

Final outputs

0 Refrig Research

1 Device Builder

2 RACC

3 FSC

4 eTRM export

5 RACC Charts

6 FSC Pivot

RACC-FSC Worksheets – 3_FSC (continued)

Purpose of **3 FSC** worksheet:

Assess whether measure permutations pass the fuel substitution tests

Residential Central Heat Pump Example:

- Measure offering classifications & assign RACC calculation
- Imputed cooling (optional)
- Annual energy usage

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

FSC_Index	Measure case, new device (Msr)		Counterfactual Standard (Std)		
	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
2	Central HVAC, Residential - Heat Pump	Central HVAC, Residential - AC and Gas Furnace	None	None	
6	Central HVAC, Residential - Heat Pump	Central HVAC, Residential - Gas Furnace only	FS-rImputedDX	72%	2

Gas furnace & AC

Gas furn. w/ imputed cooling



RACC-FSC Worksheets – 3_FSC

Purpose of **3 FSC** worksheet:

Assess whether measure permutations pass the fuel substitution tests

Residential Central Heat Pump Example:

- Measure offering classifications & assign RACC calculation
- Imputed cooling (optional)
- Annual energy usage

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

Annual Energy Usage by Case							Imputed
Msr		Std		Pre		Std	
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 <u>without cooling</u> .							
AR, only							
FSC_Index	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
2	1,850.00	46.900	1,700.00	75.600			
6	1,850.00	46.900	1,460.00	75.600			1,632.56

Gas furnace & AC

Gas furn. w/ imputed cooling

0 Refrig Research

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Next Steps

RACC-FSC Use Cases

Measure Packages and Custom Applications Uses	Worksheet(s) to Complete	
	2 RACC	3 FSC
Type of refrigerant changes	X	Only for fuel-substitution measures
Weight/charge of refrigerant changes	X	
EUL/RUL of refrigerant-using equipment changes	X	
Claiming avoided emission when retired equipment's remaining refrigerant is recovered/reclaimed and documented <i>*Documentation requirements are still very much under development and will need to be agreed upon during measure package/custom application development for avoided emissions credit to be claimed.</i>	X	
Fuel-substitution measure w/o refrigerant (e.g., induction range) <i>*Even though equipment contains no refrigerant, information entered on 2 RACC is used by 3 FSC.</i>	X (\$0)*	X
Changes to equipment efficiency only (not refrigerant)	Not needed	Not needed



RACC-FSC_v3.0 Uses

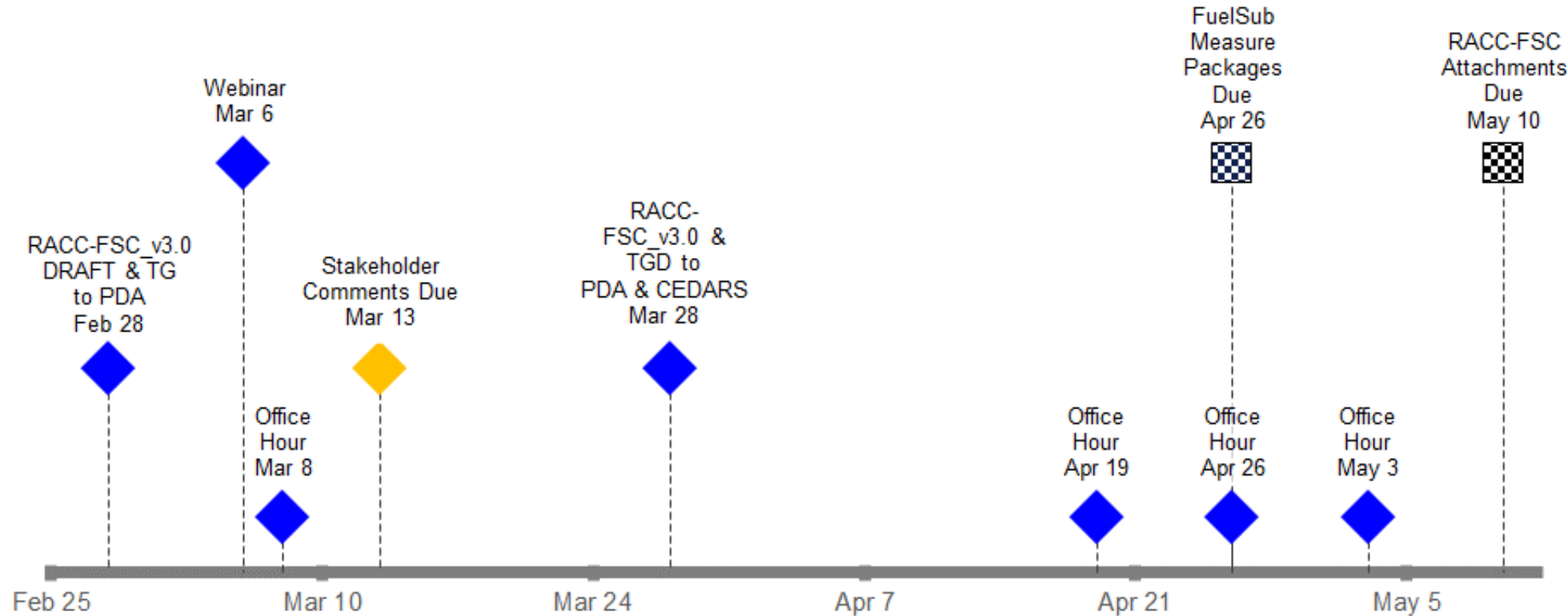
- RACC-FSC_v3.0 w/2022 ACCs

- New measure offerings to existing PY2024-25 measure packages
- New, mid-cycle measure packages
- Mid-cycle measure package updates
 - HVAC system, chiller, and product updates for PY2025 using EPA limit of GWP ≤ 700

- RACC-FSC_v3.0 w/2024 ACCs

- Measure package updates for PY2026-27
 - Due May 10 for measure packages that were due to be submitted by April 26

Timeline and Support



CEDARS

- RACC-FSC_v3.0 Workbook
- RACC-FSC Technical Guidance Document
- Measure example workbooks (from guidance document)

Office Hours (email DEERsupport@dnv.com)

- Planned date/times:
 - [Friday, March 8, 9-10 AM \(during comment period\)](#)
 - Friday, April 19, 9-10 AM
 - Friday, April 26, 9-10 AM
 - Friday, May 3, 9-10 AM



RACC-FSC Office Hour 1 of 4

Friday, March 8, 2024 at 9 AM PST

[Microsoft Teams Meeting Link](#)

Meeting ID: 389 979 809 322

Passcode: npSV9k

Dial-in by phone

[+1 213-336-0347,,624406178#](#) United States, Los Angeles

[Find a local number](#)

Phone conference ID: 624 406 178#

Questions?

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