ET Summit 2024

Presented by

California: Low-GWP Refrigerant Transition Opportunities for Energy Efficiency Programs

Brad Hoover

Principal Consultant

DNV Energy Insights USA

DNV led CPUC Low-GWP Refrigerant Studies:

2021: A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants

2024: Combined Refrigerant and Fuel Substitution Avoided Cost Calculator (RACC-FSC_v3.0.xlsx)

2024: Low-Global Warming Potential Refrigerant Transition Study

https://www.calmac.org/publications/CPUC_HVAC_Refrigerants_-_PDS_05032021_FinalReport.pdf
https://cedars.sound-data.com/deer-resources/tools/supporting-files/resource/2/history/
https://www.calmac.org/publications/CPUC_Forward-Looking_Low-GWP_Refrigerant_Transition_Study.pdf

2021 HVAC Refrigerant Study Safety Findings

Near-term lower-GWP HVAC refrigerants (<750 GWP) are mildly flammable or A2L

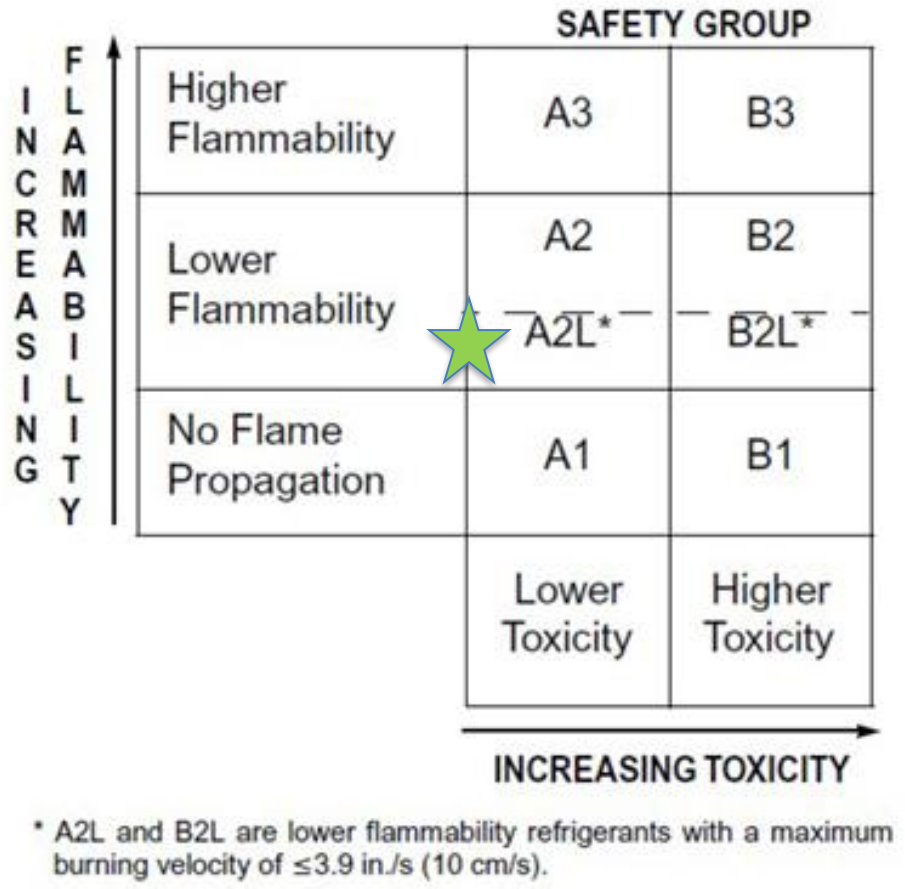
Codes updated in 2021 to allow mildly flammable refrigerants with appropriate measures to minimize risk

Surveyed CA Contractors prefer national code updates over CA-specific codes

Long-term goals include more flammable refrigerants like propane and isobutane

2024 Mildly Flammable (A2L) Refrigerant Safety

ASHRAE Standard 34



- In 2025, new Residential and Light Commercial HVAC equipment will contain mildly flammable refrigerants
- ASHRAE Standard 34 classifies R-32 and R-454B as A2Ls
- A2Ls are now permitted for use by:
  - EPA Significant New Alternatives Policy (SNAP)
  - Underwriters Laboratories (UL 484, UL/CSA 60335-2-40, and UL/CSA 60335-2-89)
  - International building, fire, and mechanical codes (IBC, IFC, IMC)
  - California Title 24 and more
- A2L refrigerants are lab-proven to be very difficult to ignite and have low toxicity
- Safely used in Europe and Asia for over six years

https://www.ashrae.org/file%20library/technical%20resources/bookstore/factsheet_ashrae_english_november2022.pdf

Current State of the Low-GWP Refrigerant transition

HVAC refrigerant transition is in the early stages

- High-GWP HVAC systems still standard practice in 2024
- 2025 standard practice: R-454B: 100-yr GWP = 466; HFC-32 (R-32): 100-yr GWP = 675
- Flammability, toxicity, and design challenges are limiting the immediate adoption of natural refrigerants

Stationary refrigeration is further along; limited by current workforce

- Natural refrigerants available for residential, retail, industrial systems
- Lack of skilled workforce = biggest barrier to widespread natural refrigerant adoption
- Existing refrigeration infrastructure remains high GHG liability

2021 and 2024 Findings: Ongoing Equipment Emissions GHG Liability/Total System Benefit Opportunity

- Operational leakage highest for large commercial
- End-of-life (EOL) emissions highest for residential and small commercial
- Little to no incentive to recover and reclaim EOL refrigerant in smaller equipment
- Minimal enforcement of EPA laws prohibiting venting
- Lack of tracking requirements enables increased emissions (leaks and venting)

Combined Refrigerant and Fuel Substitution Avoided Cost Calculator

RACC

Refrigerant Avoided Cost Calculator

- Deemed Measure RACC v2.2: 8/2023
- RACC v1b updated: 9/2022
- Deemed Measure RACC v1.3-Rev4: 11/2021
- RACC v1b: 6/2021

+

FSC

Fuel Substitution Calculator

- DRAFT Fuel Substitution Calculator v2.0: 10/2022 (never approved)
- Fuel Substitution Calculator v.1.1: 12/2020

=

RACC-FSC

Refrigerant Avoided Cost Calculator and Fuel Substitution Calculator

- RACC-FSC_v3.0: 4/19/2024

RACC and FSC were combined to ensure that both used the same assumptions:

Code updates | GWP baselines | Leakage rates | ACCs & heat rates

<700 GWP: A2L Refrigerants

Refrigerant	Pros	Cons
R-32	• Single-component refrigerant • No per- and polyfluoroalkyl (PFAS) • Improved cooling capacity** • Improved heating capacity** • Similar EER cooling efficiency** • Similar COP heating efficiency** • Lower charge requirements**	• Mildly flammable • 100-year GWP 675
R-454B	• 100-year GWP 466 • Slightly improved cooling efficiency** • Slightly improved heating efficiency** • Lower charge requirements**	• Contains PFAS • Blended refrigerant • Slightly lower cooling capacity** • Lower heating capacity** • Mildly flammable

**Drop-in refrigerant testing of a R-410 system (95ºF cooling, 47ºF heating conditions)

<10 GWP: Natural refrigerants

Benefits

- Ultra-low GWP (0 to 4)
- Zero ozone depletion potential (ODP)
- Do not contain PFAS
- Single-element chemicals (no glide)
- Often cheaper to manufacture
- Often have similar or improved performance

Challenges

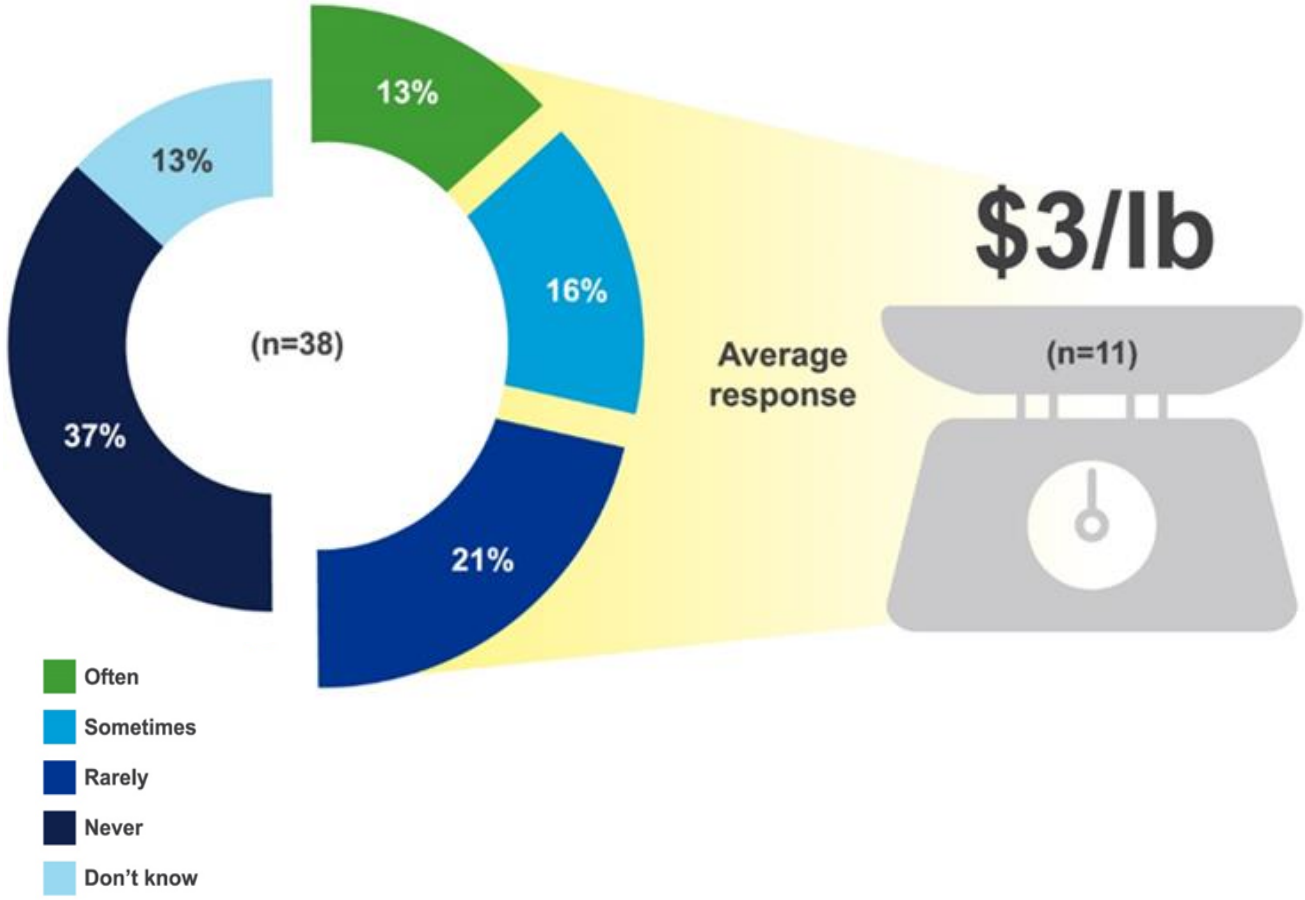
- Flammability: Propane, isobutane, ammonia
- Toxicity: Ammonia
- Engineering design challenges: CO_2

Finding: End-of-life refrigerant recovery and reclamation come with a heavy burden

- Adds time to all system changeouts
- Requires additional equipment and access to empty recovery cylinders
- Little to no compensation received for recovered refrigerant
- Little to no enforcement of EPA laws prohibiting venting

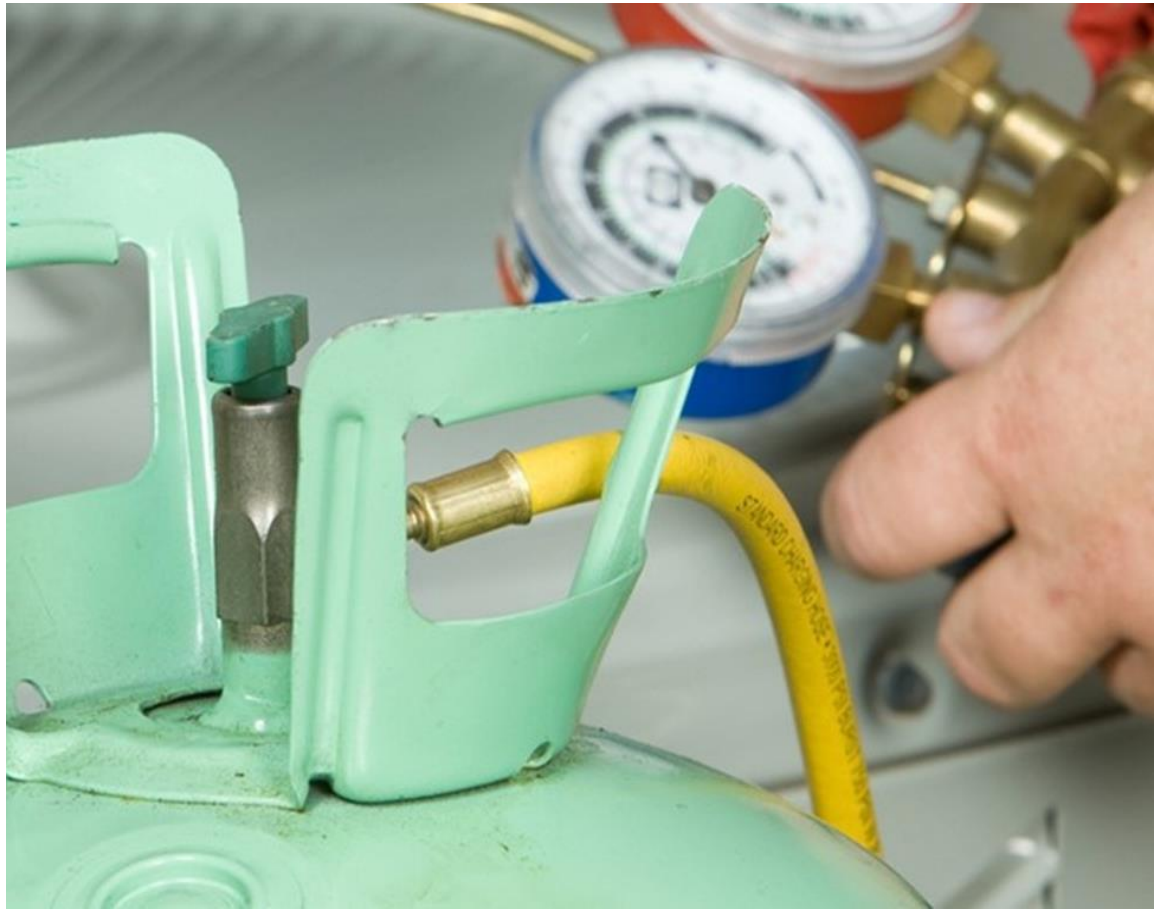
Web survey finding: Frequency performed and amount received for recovered refrigerant

- Only half of survey respondents report receiving payment
- Residential recovery time varies substantially
- Better recovery equipment helps
- Distributors often compensate in the form of credits



Recommendation: Provide end-of-life avoided emissions credit and compensation with appropriate documentation

- Allow credit for documented end-of-life refrigerant recovery and reclamation.
- Compensate contractors, technicians, and market actors who perform and assist.
- Provide bonus incentives to distributors who assist with refrigerant recovery and reclamation.
- Compensate EPA licensed reclaimers who directly support documented end-of-life reclamation.



Finding: Near-term end-of-life emission credits could help transition workforce standard practice

SMEs agreed with proposed documentation requirements.

Incentives could serve as a bridge to making end-of-life recovery and reclamation standard practice.

SMEs noted future regulatory requirements impacting recovery and reclamation rates.

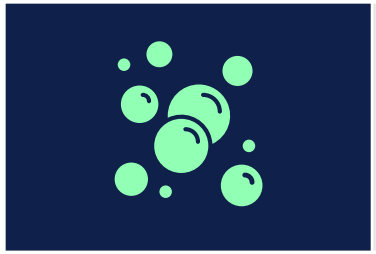
Recommendation: Monitor the market and eventually sunset documented avoided end-of-life emission claims

Bad actors are found in every market.

Validate all claims.

Sunset incentives once CARB estimates show reclamation rates exceed 50%.

Summary



Refrigerants are potent greenhouse gases.

The transition to environmentally friendly refrigerants is in the early stages.

Much more can (and must) be done to mitigate refrigerant emissions.

Resources

2024 CPUC Forward-Looking Low-GWP Refrigerant Transition Study

CPUC Combined Refrigerant and Fuel Substitution Avoided Cost Calculator (RACC-FSC_v3.0.xlsx)

RACC-FSC Technical Guidance Document

2021 CPUC Proposer Defined Study - A Roadmap for Accelerating the Adoption of Low-Global Warming Potential HVAC Refrigerants

Brad Hoover
Principal Consultant
DNV Energy Insights USA
brad.hoover@dnv.com