



PUBLIC WORKSHOP ON RULEMAKING PROPOSAL: HIGH-GLOBAL WARMING POTENTIAL REFRIGERANT EMISSIONS REDUCTIONS



California Air Resources Board

October 24, 2017
Sacramento



Today's Agenda

- CARB Presentation
- Questions/Comments & Open Discussion
- During presentation, webcast viewers can submit questions/comments to:
sierrarm@arb.ca.gov
- After webcast, submit questions/comments by November 10 at:
<https://ww2.arb.ca.gov/hfc-reduction-measures-rulemaking>



Outline

- Background
 - Why regulate hydrofluorocarbons (HFCs)?
 - How will CA meet the SB 1383 emission reduction target?
 - Kigali Amendment Emission Reduction Analysis
 - Federal SNAP Program & Litigation
- Rulemaking 1: California adoption of U.S. EPA SNAP provisions
- Rulemaking 2: SLCP Strategy
- Public Comment

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Why Regulate Hydrofluorocarbons (HFCs)?

- HFCs are potent short-lived climate pollutants (SLCPs)
- High Global Warming Potentials (GWP)*
- The fastest growing source of GHGs

Just 1 pound of R-404A or R-507 (GWP > 3,900)

⇒ **4,200 vehicle miles**

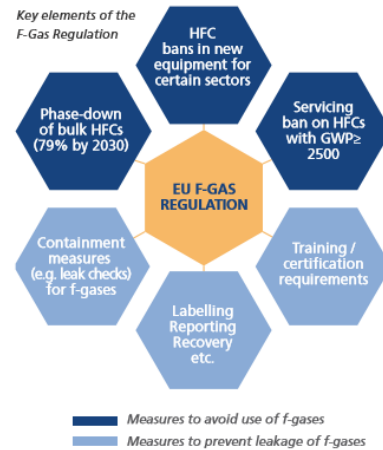


**GWP is the total contribution to global warming resulting from the emission of that gas relative to carbon dioxide, by weight, over any given time period (usually 20 or 100 years).*

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International HFC Phasedown Efforts

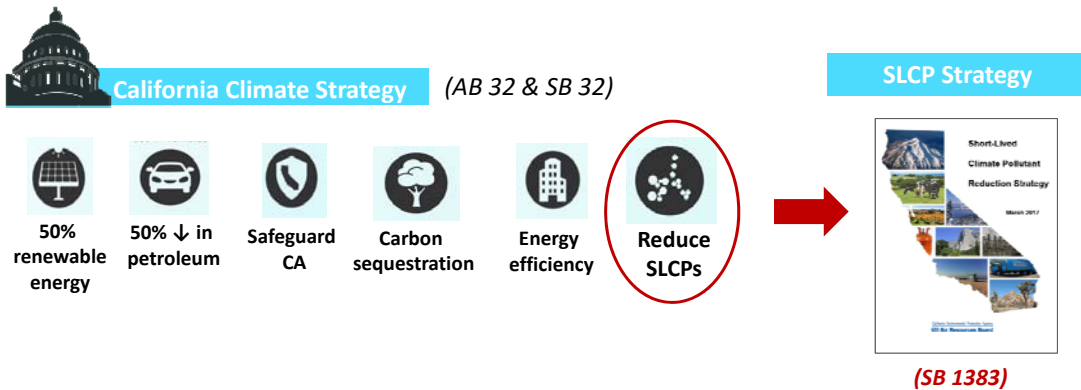
- Kigali Amendment to Phasedown HFC Production & Consumption Globally
- European Union F-Gas Regulation
 - By 2030, cut EU's F-gas emissions by 2/3^{rds} over 2014 levels.
- Canada
 - Adopted equivalent of SNAP requirements, and measures to phasedown consumption of HFCs
- Australia
 - Implementing a domestic phasedown beginning January 2018



[Source: "F-Gas Regulation, Shaking up the HVAC&R Industry", shecco, 2016] 5

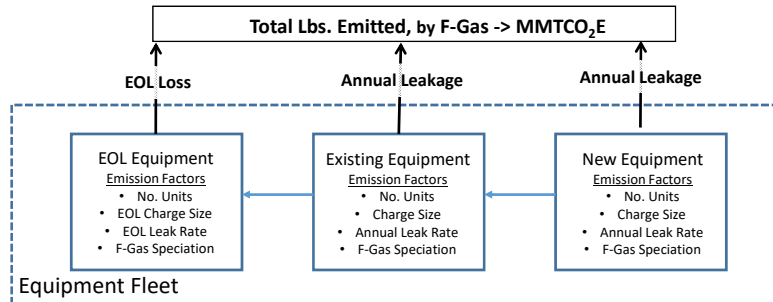
Reducing HFC Emissions is part of CA's Climate Strategy

SB 1383 – 40% reduction in HFCs from 2013 levels by 2030



How does CARB Estimate HFC Emissions in CA?

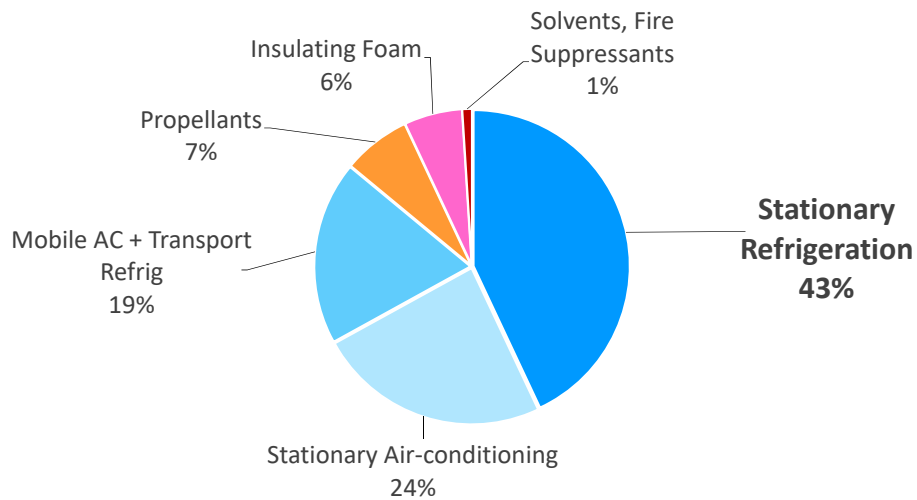
For a Given Year...



- Emissions = (End-of-Life Loss) + (Annual Leakage)
- Based on U.S. EPA Vintaging Model
- Data sources include:
 - CARB Refrigerant Management Program
 - CARB-funded research projects (eight)
 - UN Environment Programme Reports
 - Gallagher, et al., 2014. Environmental Science & Technology

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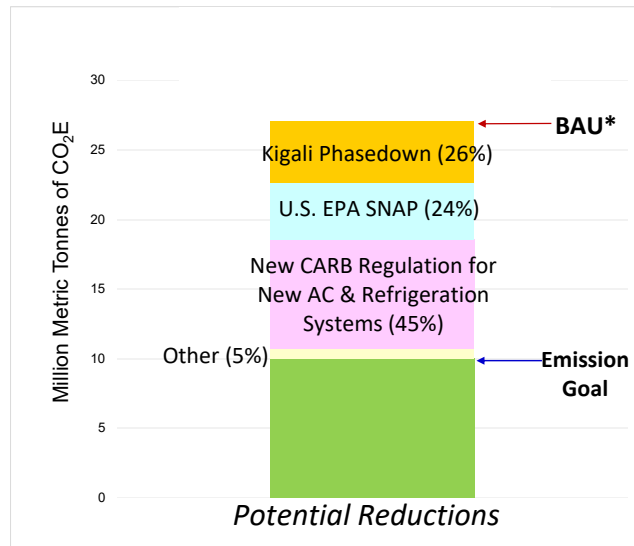
California HFC Emissions Sectors (2013)



[Source: CARB GHG Inventory 2016]

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How will CA achieve the required HFC Emission Reductions by 2030? - International, National, and State Measures Needed



*BAU includes reductions expected from current ARB measures.

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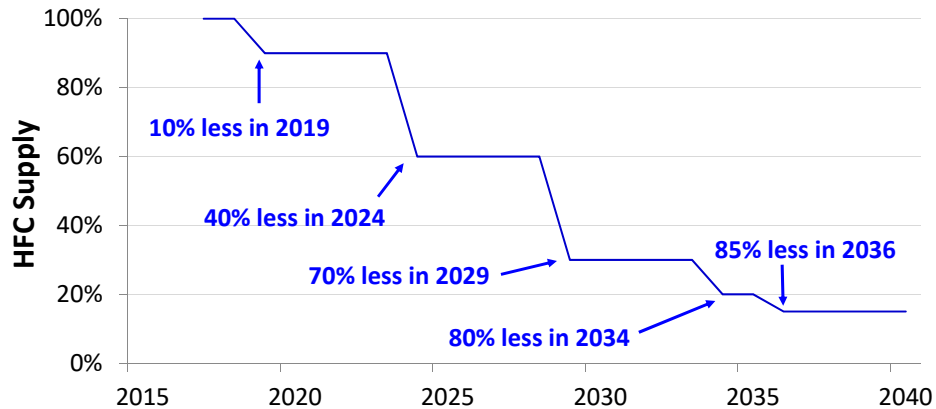
Why Doesn't California Rely on the Global Phasedown Only?

CARB Analysis:
Impact of the Kigali Amendment on HFC
Emissions Reductions in California

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Kigali Phasedown

Phasedown Schedule for the U.S.



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Kigali Amendment Impact on California

- Modeled Four Phasedown Scenarios:
 - Two based on historical emissions reductions from the CFC and HCFC phasedowns
 - Bounded by “Best Case” and “Worst Case”
- Methodology peer-reviewed by experts from
 - Anthesis Consulting Group
 - Chemours
 - ICF International
 - Lawrence Berkeley National Laboratory
 - United Nations Environment Programme
 - U.S. Environmental Protection Agency



Kigali Amendment Signed in Rwanda, October 2016

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Phasedown Analysis Conclusion:

California cannot meet its HFC reduction goals by relying only on the Global Phasedown



Additional HFC reduction measures are needed

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Rulemaking 1:

California Adoption of U.S. EPA SNAP Provisions

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Background - U.S. EPA SNAP Program

- Significant New Alternative Policy (SNAP) Program
- Publishes lists of “acceptable” or “unacceptable” ODS and ODS replacements
- SNAP Rules 20 & 21 prohibit high-GWP HFCs by end-use

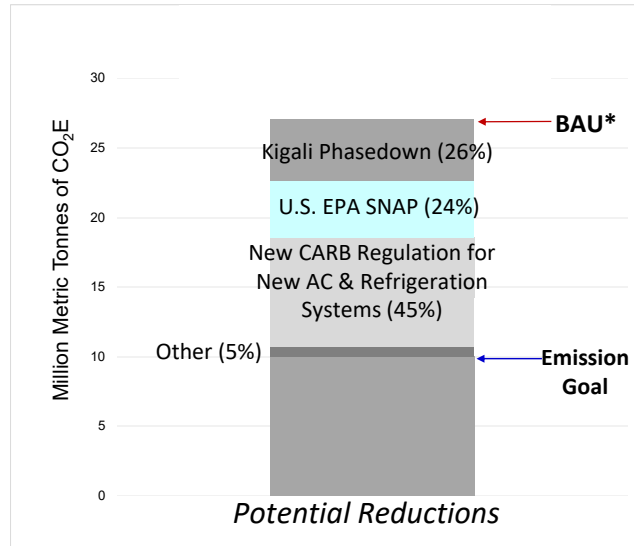
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Background - Status of SNAP Rules 20 & 21

- Litigation – Challenge to Rule 20
 - Mexichem Fluor vs. U.S. EPA (Aug 8, 2017)
 - Vacated Rule 20
 - Rule 21 also at risk
 - Strong dissenting opinion – definition of “replacement”
 - Request for appeal
- Why is it important for CARB to act?
 - Provide regulatory certainty
 - Protect emission reductions
- If final court decision upholds all of Rule 20, CARB would rely on Federal SNAP regulations

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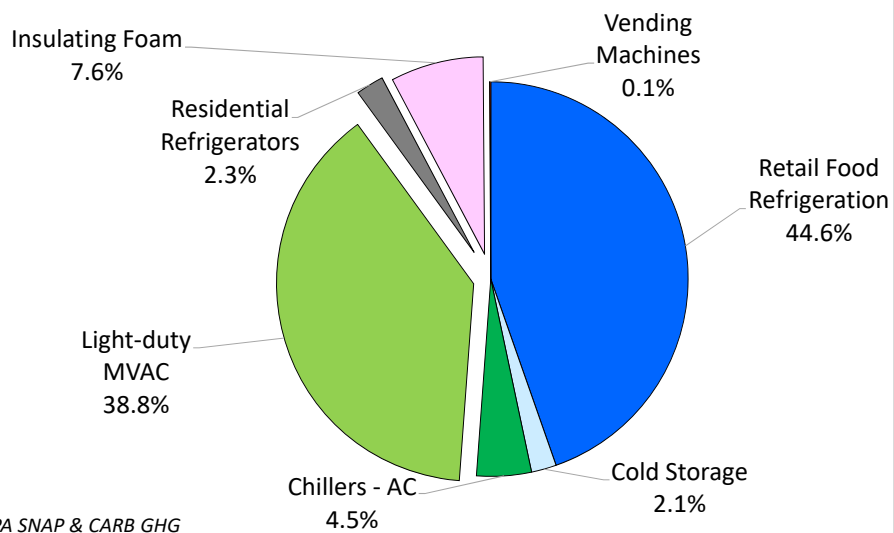
How will CA achieve the required HFC Emission Reductions by 2030? - International, National, and State Measures Needed



*BAU includes reductions expected from current ARB measures.

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2017 HFC Emissions from Sectors covered by SNAP Rules 20, 21



[Source: U.S. EPA SNAP & CARB GHG Inventory 2016]

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Proposed Provisions for Adoption in CA - Restrictions on Refrigerants in Refrigeration and AC

- Adopt provisions from U.S. EPA SNAP Rules 20 and 21 by reference
- Initial Focus on stationary refrigeration and AC:
 - Supermarket Systems (new & retrofit)
 - Remote Condensing Units (new & retrofit)
 - Stand-alone (self-contained) refrigeration
 - Refrigerated Vending Machines
 - Retail food – refrigerated food processing and dispensing equipment
 - Cold Storage
 - Chillers

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Selected Provisions for Adoption in CA – Rule 20

End Uses	Status Change to Unacceptable	Effective Date	SNAP Rule
Refrigeration and Air Conditioning – Retail Food Refrigeration			
Supermarket Systems (Retrofitted)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	July 20, 2016	Rule 20
Supermarket Systems (New)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	January 1, 2017	Rule 20
Remote Condensing Units (Retrofitted)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	July 20, 2016	Rule 20
Remote Condensing Units (New)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	January 1, 2018	Rule 20
Stand-Alone Units (Retrofit)	R-404A, R-507A	July 20, 2016	Rule 20

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Selected Provisions for Adoption in CA – Rule 20 (Continued)

End Uses	Status Change to Unacceptable	Effective Date	SNAP Rule
Refrigeration and Air Conditioning – Retail Food Refrigeration			
Stand-Alone 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-24 (2002 formulation), RS-44 (2003 formulation), SP34E, THR-03	¹ January 1, 2019 ² January 1, 2020	Rule 20
Refrigeration and Air-Conditioning—Vending Machines			
Vending Machines (Retrofit)	R-404A, R-507A	July 20, 2016	Rule 20
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, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-426A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), SP34E	January 1, 2019	Rule 20

¹For stand-alone medium-temperature units with a compressor capacity below 2,200 Btu/hour and not containing a flooded evaporator.

²Stand-alone medium-temperature units with a compressor capacity equal to or greater than 2,200 Btu/hour and stand-alone medium-containing a flooded evaporator and for stand-alone low-temperature units

Selected Provisions for Adoption in CA – Rule 21

End Uses	Status Change to Unacceptable	Effective Date	SNAP Rule
Air Conditioning			
Centrifugal Chillers (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-236fa, HFC-245fa, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-434A, R-438A, R-507A, RS-44 (2003 composition), and THR-03	January 1, 2024	Rule 21
Positive displacement chillers (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 composition), SP34E, and THR-03	January 1, 2024	Rule 21
Refrigeration			
Cold storage warehouses (new)	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)	January 1, 2023	Rule 21

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Potential Enforcement Approaches

- Record Keeping
- Reporting
- Auditing
- Labeling

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Comments on Draft Regulation

- Draft Regulation is available – appreciate comments by November 10, 2017. Submit comments at:
<https://ww2.arb.ca.gov/hfc-reduction-measures-rulemaking>
- Comments after presentation are welcome

Individual meetings with CARB also encouraged

Webcast viewers can submit questions and comments to:
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Next Steps - Timeline

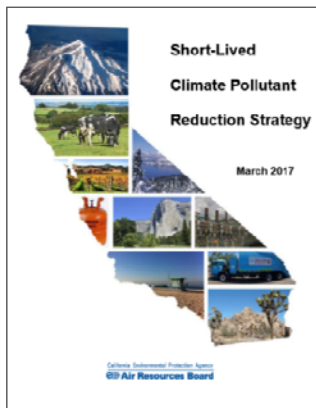
Adopt SNAP Provisions by Reference	
Public workshop	October 2017
Staff Report (ISOR)	January 2018
45-Day public comment opens	February 2018
Board Meeting	March 2018
Regulation Effective Date	Mid to Late 2018

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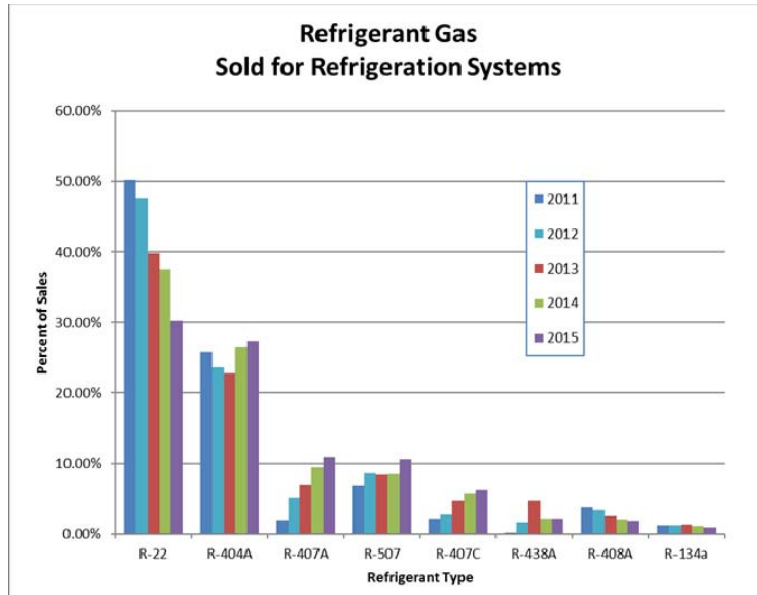
Part II of Presentation:

Rulemaking 2: SLCP Strategy to Reduce HFCs



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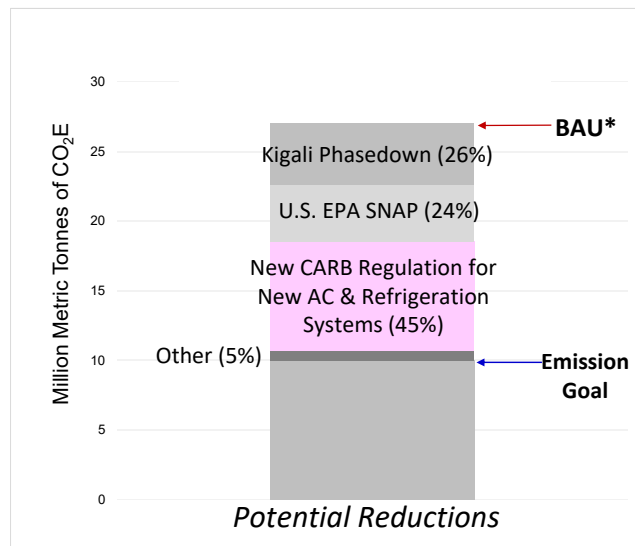
Refrigerant Sales Trends in California (ODS down, HFCs up)



[Source: Distributor data reported to CARB]

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How will CA achieve the required HFC Emission Reductions by 2030? - International, National, and State Measures Needed

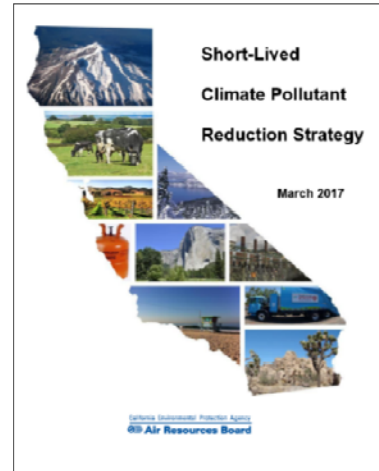


*BAU includes reductions expected from current ARB measures.

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CARB SLCP Measures

- Short-Lived Climate Pollutant Strategy adopted by the Board on March 23, 2017
- Prohibitions on high-GWP refrigerants in new equipment
- Restricting sales of very-high GWP refrigerants
- Amendments to existing Refrigerant Management Program



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Stationary Refrigeration Measures

In 2021: Refrigerants with a GWP of 150 or greater prohibited in new refrigeration systems containing 50 or more pounds of refrigerant.

In 2021: Refrigerants with a GWP of 1500 or greater prohibited in new refrigeration systems containing 20 pounds to 50 pounds of refrigerant.

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Stationary Air-Conditioning Measures

In 2021: Refrigerants with a GWP of 750 or greater prohibited in new air-conditioning systems containing 2 or more pounds of refrigerant.

Chiller Measures

In 2021: Refrigerants with a GWP of 150 or greater prohibited in new chillers (refrigeration or air-conditioning).

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Sales Restrictions on Refrigerants

In 2020: No production, import, sales, distribution, or entry into commerce of refrigerants with a GWP of 2500 or greater.

In 2024: No production, import, sales, distribution, or entry into commerce of refrigerants with a GWP of 1500 or greater.

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Rationale and Cost

Why the start date of 2021 for new measures?

Technology and Feasibility:

Low-GWP refrigeration is currently available

Lower-GWP AC is available in many countries already, lagging in the U.S. due to codes and standards, not technical limitations

Cost: Stationary Refrigeration initial cost approximately 10-20 percent higher

Stationary AC initial cost may be up to 5-10 percent higher.

Savings: Several low-GWP refrigerants cost less than HFCs

Energy efficiency can increase using low or lower-GWP refrigerants

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Challenges

Refrigeration: Local permitting agencies must be educated on low-GWP refrigerants

Air-conditioning: Codes and standards are the biggest challenge

Low and lower-GWP Refrigerants and Systems, both Refrig and AC:

- Higher initial Cost (currently)
- Ongoing energy efficiency concerns – in all but the hottest climates low-GWP refrigeration is at parity or better energy efficiency
- Shortage of technicians trained to install/maintain low-GWP systems

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Codes and Standards

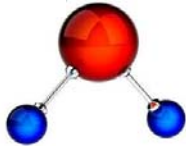
- Some lower-GWP refrigerants require updates to building codes and industry safety standards before they can be used
- Updates to codes and standards generally have set timelines that need to be met
- Timelines may be able to be accelerated through intervening code cycles or addendums
- CARB is contributing to a \$5.8M research study to inform codes and standards bodies that are determining the risks of lower-GWP refrigerants

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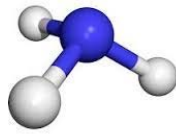
If California prohibits high-GWP refrigerants, which refrigerants can be used?

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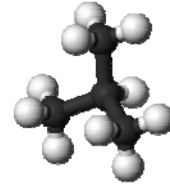
Low-GWP Refrigerants < 150 GWP for Refrigeration



Carbon Dioxide
(GWP = 1)

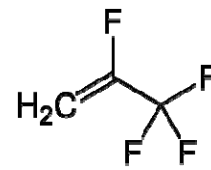


Ammonia (GWP = 0)



Hydrocarbons: Propane,
Isobutane (GWP < 4)

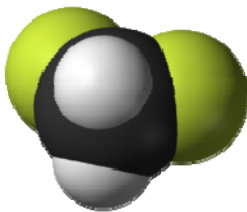
Hydrofluoro-olefins (HFOs) are HFCs that have unsaturated bonds and break down quickly in the atmosphere resulting in no ozone-depleting and little global warming.



HFOs (GWP = < 10)

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Lower-GWP Refrigerants < 750 GWP for Air-Conditioning



HFC-32 (GWP = 675)

R-446A	R-447A
R-447B	R-452B
R-454B	R-457A
Others	

HFO-HFC Blends (GWP < 750)

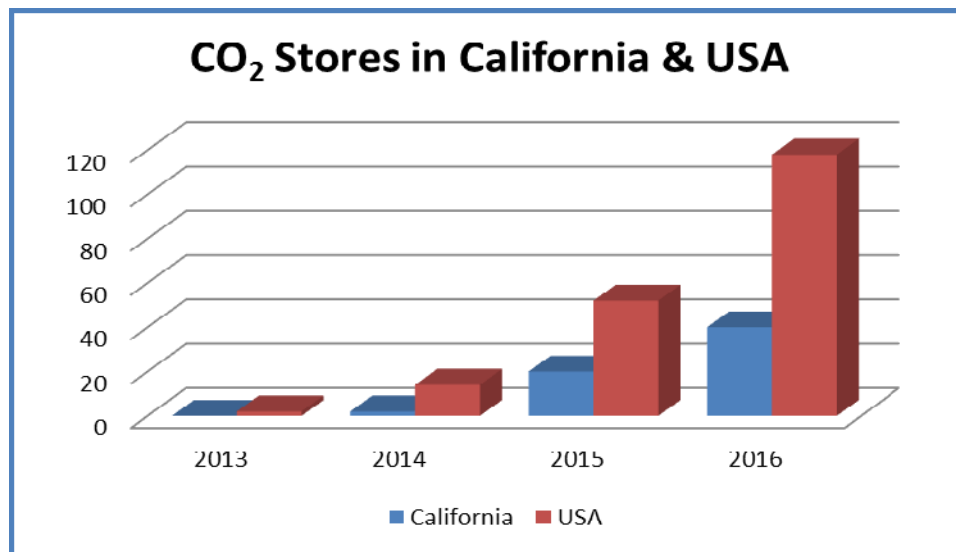
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Example Low-GWP Groceries (2016):

Company	City	Technology	Year	Number
Albertsons	Carpinteria	NH ₃ /CO ₂ hybrid	2012	1
Whole Foods Market	Dublin	NH ₃ /CO ₂ hybrid	2015	1
Whole Foods Market	Berkeley, San Jose, LA	CO ₂ transcritical	2014, 2016	3
Trader Joe's	So Cal	CO ₂ transcritical	2016	4
Whole Foods Market	Santa Clara	Propane/CO ₂ hybrid	2016	1
ALDI	So Cal	CO ₂ transcritical	2016	29
TOTAL				39

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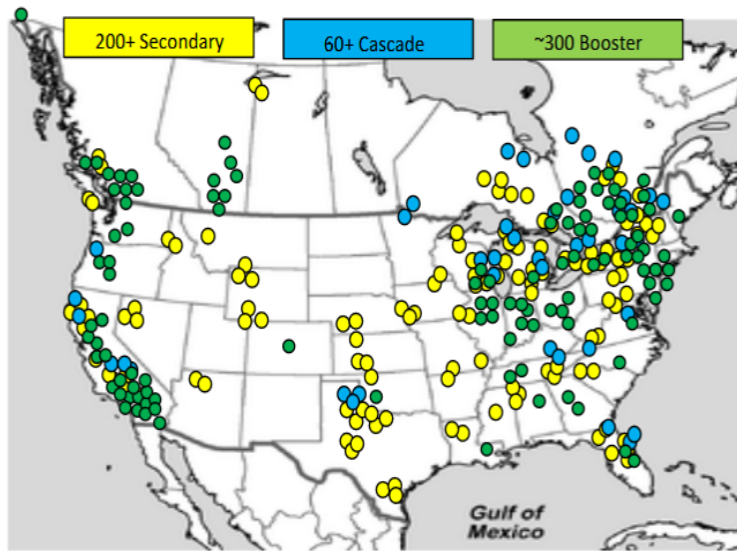
Growth in full CO₂ Groceries (to 2016)



[Source: shecco, 2016]

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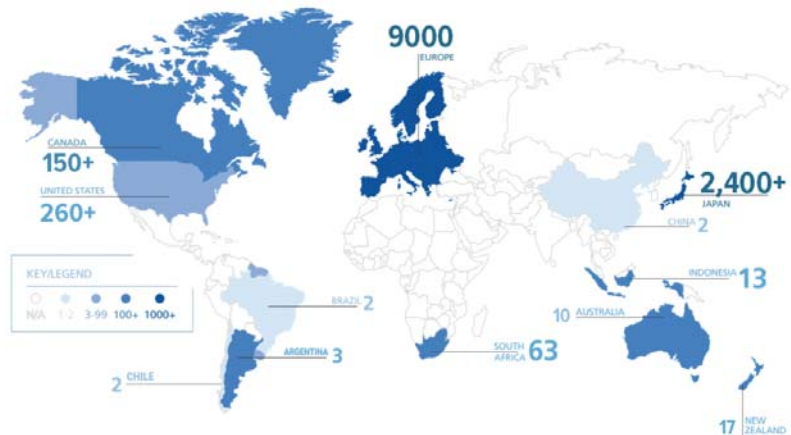
CO₂ Applications: Transcritical (Booster), Hybrid HFC-CO₂ (Secondary and Cascade)



Source: Hillphoenix 2017

The global transition to low-GWP refrigerants is underway...

- European Union (EU) is currently implementing more ambitious HFC reduction measures than CA is proposing
- Many retailers in the US have already adopted low-GWP refrigeration – initial results are good
- Low-GWP refrigeration technology is growing quickly across all climate zones, including high ambient temperatures



Transcritical CO₂ Stores Across the Globe (Feb 2017)

[shecco, Atmosphere America 2017]

Potential Incentive Opportunities

- **Greenhouse Gas Reduction Funds (GGRF)**
 - Included in Triennial Investment Plan for Fiscal Years 2016-2019 and Governor's Proposed Budget for FY 2016-2017
- **Utility Incentive Programs**
 - Ongoing collaboration with utilities
 - Worked with Sacramento Municipal Utility District (SMUD) to create new first-of-kind program: <https://smudorgdev.smud.org/en/business/save-energy/rebates-incentives-financing/refrigeration/replace-your-refrigerant-system.htm>

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Potential Enforcement Approaches

- Record Keeping
- Reporting
- Auditing
- Labeling

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Next Steps - Timeline

	SLCP Measures
Public workshops and Stakeholder meetings	Winter 2017 – Summer 2018
Staff Report (ISOR)	October 2018
45-Day public comment opens	October 2018
Board Meeting	December 2018
Regulation Effective Date	Mid-2019

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Overview of CARB Rulemaking

- **Regulation Development**
 - Stakeholder Engagement
 - Internal Consultation (Economics, Enforcement, Small Businesses, Enviro Justice, CEQA)
- **Notice Package**
 - Economic Impact Assessment (Form 399)
 - Staff Report (Initial Statement of Reasons - ISOR)
 - Proposed Regulation Order
 - 45-Day Notice
- **45-Day Public Comment Period**
- **Board Hearing**
- **Changes: 45-Day Notice or 15-Day Changes**
- **Final Information Digest, Final Statement of Reasons (FSOR), Regulation**
- **Adoption**

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Public Comment



We appreciate your feedback

- Approach to adopting SNAP provisions
- Comments on draft regulation language (adoption of SNAP provisions) by Friday, November 10
- SLCP Measures
- Submit comments at:
<https://ww2.arb.ca.gov/hfc-reduction-measures-rulemaking>
- During this meeting, webcast viewers can submit questions and comments to: sierrarm@calepa.ca.gov