

SAE Alternate Refrigerant Symposium 2006
June 27-29, Phoenix, AZ

***New Proposed HFC
Reduction Measures for
California***

Richard Vincent, Alberto Ayala, and Richard Corey

Research Division

California Air Resources Board

ABSTRACT

In 2004, the California Air Resources Board (CARB) adopted limits on greenhouse gas (GHG) emissions from new light-duty vehicles of model years 2009 and later. The limits apply to the total of four emitted GHG species, including HFC-134a that leaks from mobile air conditioning systems (MACS). As part of their compliance, auto manufacturers can, but are not required, to use low-GWP refrigerants in new vehicles or to improve the leak-tightness of new systems that will use HFC-134. Research, development, and demonstration efforts are underway in the US and Europe for tighter AC systems and systems that use alternate low-GWP refrigerants.

Building on prior work and in response to Governor Schwarzenegger's goals for reducing greenhouse gas emissions in California, CARB has identified, among others, five additional possible measures to reduce HFC emissions from vehicular and commercial refrigeration systems. These include: (1) ban the retail sale of HFCs in small (mostly 12-oz.) cans in 2009, (2) require that only low-GWP refrigerants be used in new vehicular systems, (3) place specifications on new commercial refrigeration, (4) add refrigerant leak-tightness to the "pass" criteria for vehicular inspection and maintenance and adopt an "inspect & repair" measure for the commercial systems, and (5) enforce the federal ban on releasing HFCs. This presentation will discuss these new proposed California climate protection efforts.

Acknowledgements

Collaborators in CARB's *Refrigeration Research Team*:

- Dr. Whitney Leeman, PhD, EnvE
- Dr. Tao Huai, PhD, ChemE

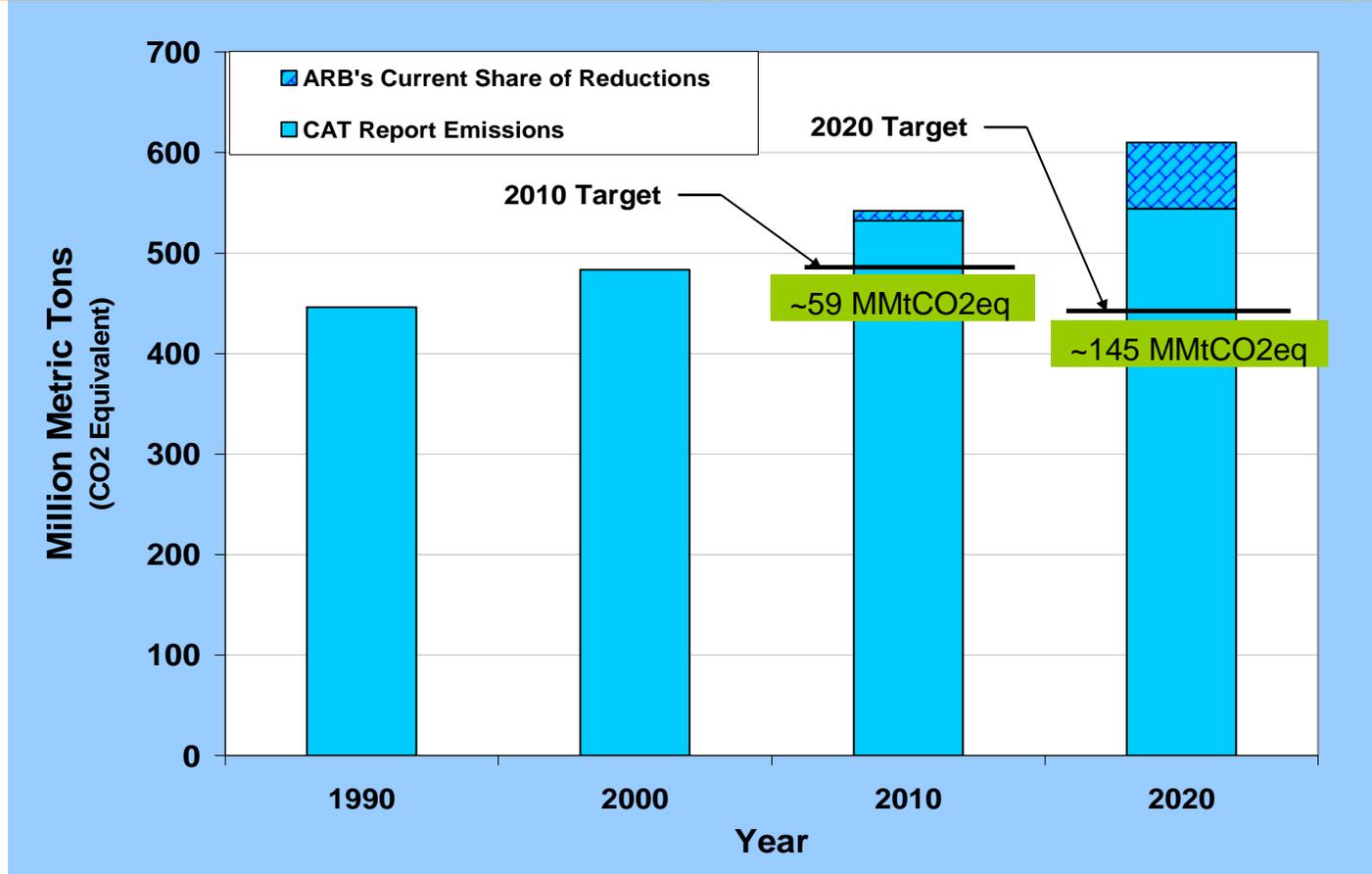


"The debate is over. We know the science. We see the threat. And we know the time for action is now."



UN World Environment Day
San Francisco, June 1, 2005

California's Climate Change Emissions and Targets



Inventory Source: California Energy Commission

California's Climate Action Plan, March 2006

California Environmental Protection Agency

California Air Resources Board

California Integrated Waste Management Board

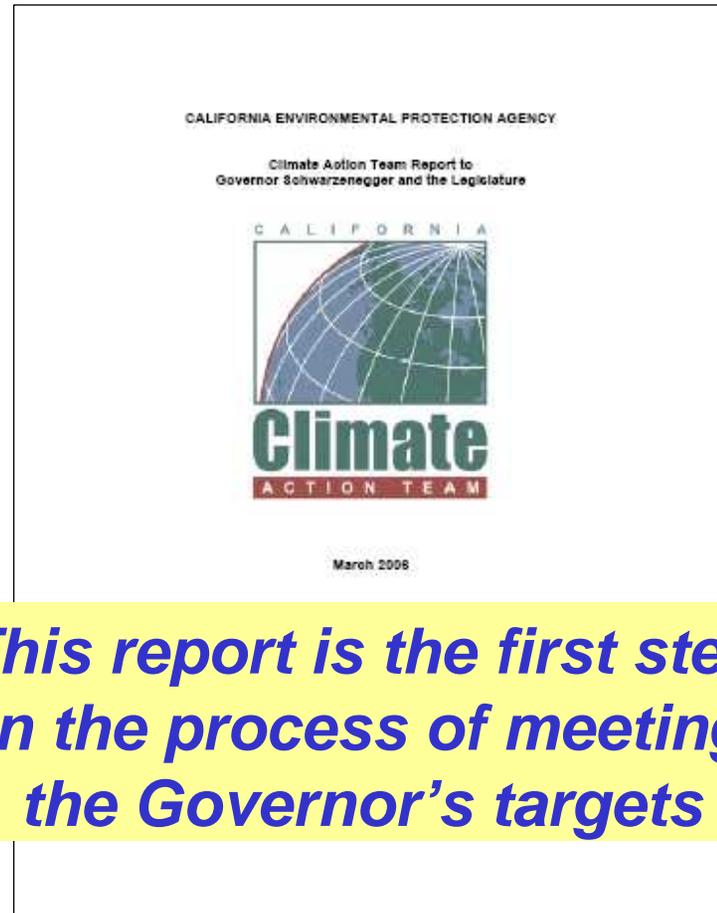
California Public Utilities Commission

California Resources Agency

California Energy Commission

California Business, Transportation, and Housing Agency

California Department of Food and Agriculture



This report is the first step in the process of meeting the Governor's targets

Where are we now?

- Climate Action Plan demonstrates that reaching targets is feasible
- Strategies to meet targets are beneficial to the State (ie., *create jobs*)
- Specific detail in strategies is preliminary
- Strategies will require further refinement with stakeholder input to evaluate/develop/implement as appropriate
- Public process for transparency in place
- Examining need for development of legal authority

Anatomy of the Climate Action Plan

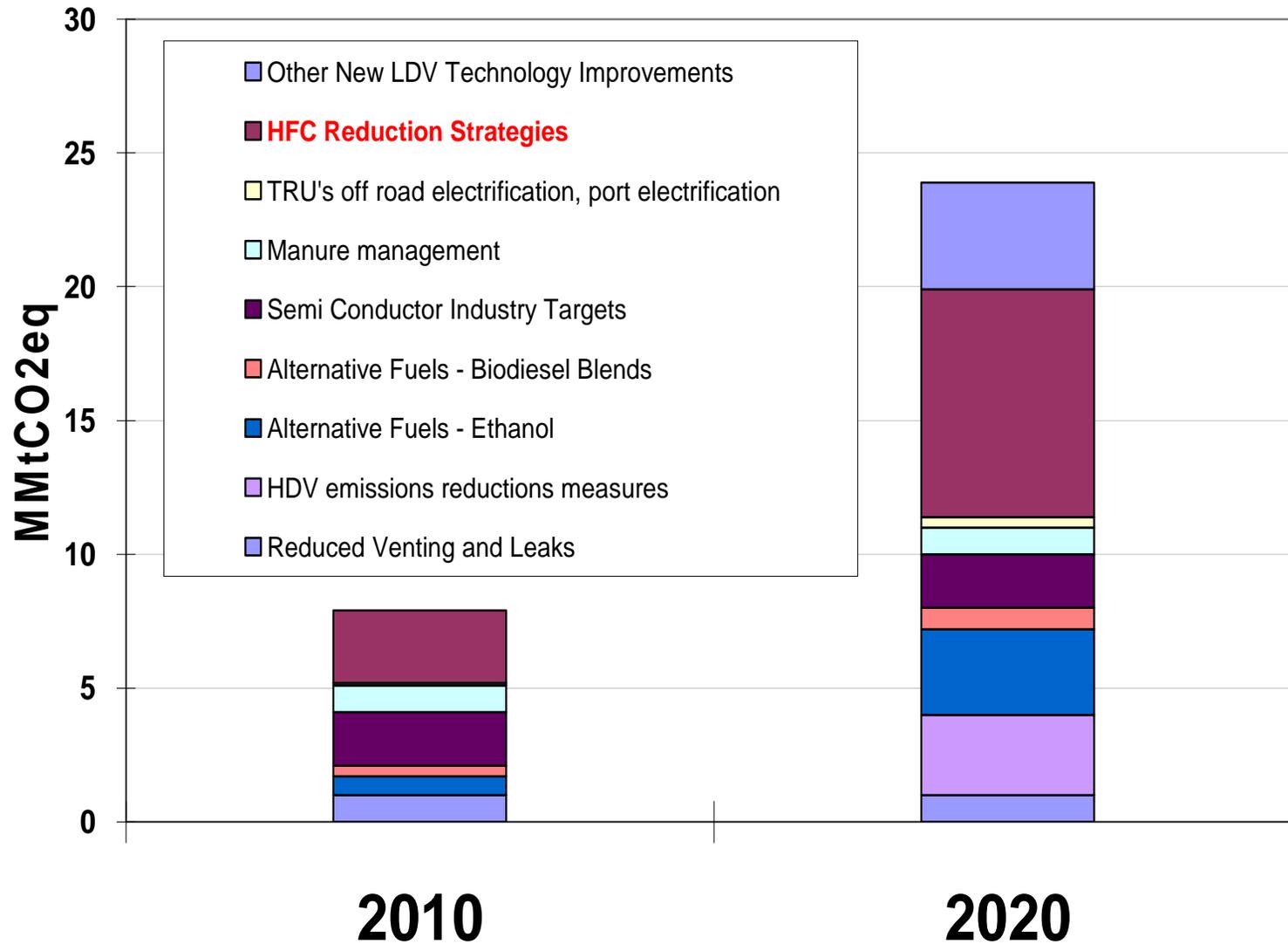
Climate Change Emission Reductions	2010	2020
(Million Metric Tons CO ₂ Equivalent)		

• Air Resources Board		
• Vehicle Climate Change Standards	1	30
• Diesel Anti-Idling	1	1.2
• Other New Light Duty Vehicle Technology Improvements	0	4
• HFC Reduction Strategies	2.7	8.5
• Transport Refrigeration Units, Off-Road Electrification, Port Electrification (ship to shore)	<1	<1
• Manure Management	0	1
• Semi Conductor Industry Targets (PFC Emissions)	2	2
• Alternative Fuels: Biodiesel Blends	<1	<1
• Alternative Fuels: Ethanol	<1	<3.2
• Heavy-Duty Vehicle Emission Reduction Measures	0	3
• Reduced Venting and Leaks in Oil and Gas Systems	1	1
• Hydrogen Highway	Included*	
• Integrated Waste Management Board		
• Achieve 50% Statewide Recycling Goal	3	3
• Landfill Methane Capture	2	3
• Zero Waste—High Recycling	3	

*The benefits of the Hydrogen Highway have been captured in other programs such as the Vehicle Climate Change Standard and Green Buildings Initiative.

• Department of Forestry		
• Forest Management	1-2	2-4
• Forest Conservation	4.2	8.4
• Fuels Management/Biomass	3.4	6.8
• Urban Forestry	0	3.5
• Afforestation/Reforestation	0	12.5
• Energy Commission		
• Building Energy Efficiency Standards in Place	1	2
• Appliance Energy Efficiency Standards in Place	3	5
• Fuel-Efficient Replacement Tires & Inflation Programs	1.5	1.5
• Building Energy Efficiency Standards in Progress	TBD	TBD
• Appliance Energy Efficiency Standards in Progress	TBD	TBD
• Cement Manufacturing	<1	<1
• Municipal Utility Energy Efficiency Programs/Demand Response	1	5.9
• Municipal Utility Renewable Portfolio Standard	<1	3.2
• Municipal Utility Combined Heat and Power	0	<1
• Municipal Utility Electricity Sector Carbon Policy	3	9
• Alternative Fuels: Non-Petroleum Fuels	TBD	TBD
• Building Energy Efficiency Standards in Place	1	2
• Department of Water Resources		
• Water Use Efficiency	0.4	1.2
• Accelerated Renewable Portfolio Std to 33% by 2020 (includes load-serving entities)	5	11
• California Solar Initiative	0.4	3
• Investor-Owned Utility (IOU) Energy Efficiency Programs (including LSEs)	4	8.8
• IOU Additional Energy Efficiency Programs/Demand Response	NA	6.3
• IOU Combined Heat and Power Initiative	1.1	4.4
• IOU Electricity Sector Carbon Policy	1.6	2.7
• Business Transportation and Housing		
• Measures to Improve Transportation Energy Efficiency	1.8	9
• Smart Land Use and Intelligent Transportation	5.5	18
• Department of Food and Agriculture		
• Conservation Tillage/Cover Crops	TBD	
• Enteric Fermentation	<1	<1
• State and Consumer Services Agency		
• Green Buildings Initiative	0.5	1.8
• Transportation Policy Implementation		Under Review

New Proposed CARB GHG Emission Reduction Strategies



Inspection & Maintenance
Consider refrigerant leak test for veh I/M program
and similar measure for commercial ref systems

**Non-professional
Use of Refrigerants**
Retail sale of HFCs

**Low GWP
Refrigerants for
MACSS**
Consider for new LD and
HD vehicles

**CARB's New
Proposed
HFC
Reduction
Strategies¹**

**Mitigate EOL
Emissions**
Enforce the federal
bans on refrigerant
releases

Commercial Refrigeration
Explore improvement potential for
direct and indirect emissions

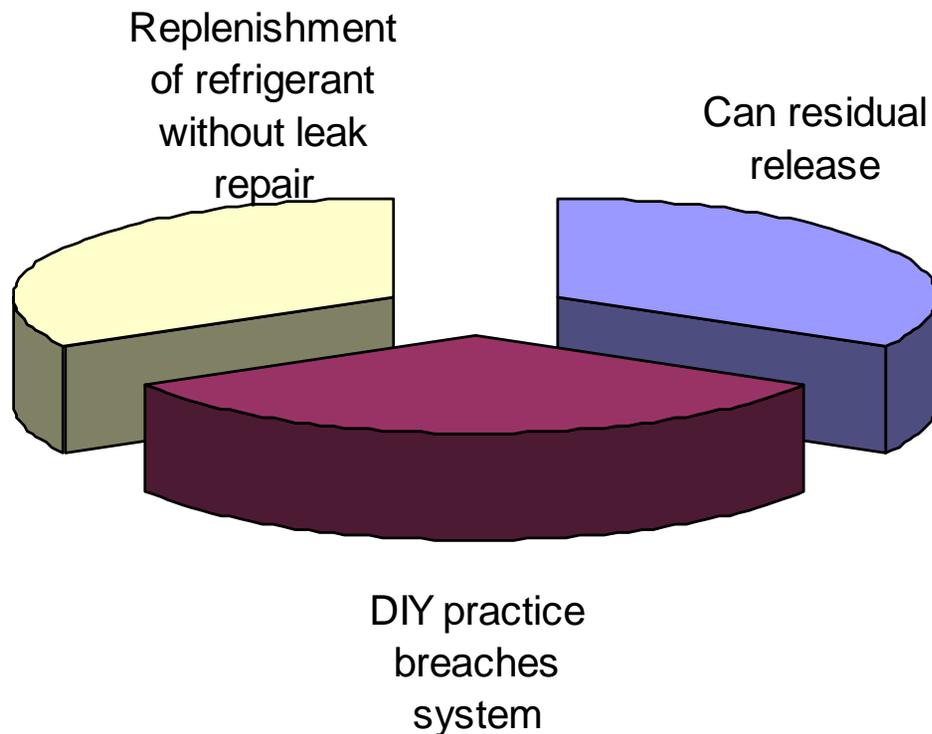
¹One out of 33 new strategies described in the Climate Action Team Report to the Governor and Legislature, March 2006

1. Non-professional use of refrigerants

- Consider impact of non-professional servicing of MACSs
- Consider impact of use of refrigerants available at retail
 - Interest in understanding DIY and can heels
- Planning to initiate extramural research to support strategy refinement
- Building on US EPA's work underway, where CARB is one partner
- Industry's input will be fully considered as part of strategy development

1. Non-professional use of refrigerants (retail sale)

Three mechanisms for refrigerant loss to the air due to DIY practice and use of small cans



Assumptions and Approximations

- Based on available data from USEPA, MAC Society, and CARB
- Includes LDVs and HDVs
- ~0.2 MMtCO₂eq reduction potential in 2010
- ~2 MMtCO₂eq reduction potential in 2020

2. Low GWP Refrigerants in New MACSs

- Build on California's AB1493 accomplishments
- Promote use of low GWP refrigerants for LDVs and for HDVs
 - Improved MACS technology concepts developed for LDVs can be extrapolated to HDVs
- Global success for advancing superior MACS will continue to inform and benefit California's efforts
- 1 MMtCO₂eq reduction potential in 2020

2. Heavy-Duty Vehicle Air Conditioning System Improvements

- Following research by European Union with great interest
 - Leakage rate measurement research in Europe can inform California quantification of emission benefit
 - CARB exploring methodologies for determining HDV emissions (i.e., top-down and bottom-up approaches)
- Reduce direct emissions with proven approaches
 - Short pipes/hoses, improved hose material
 - Less number of connections/valves
- Reduce indirect emissions with proven approaches
 - Advanced compressors and controls
 - Reduced cabin heat load (insulation and glass improvement)

3. Reducing GHG Emissions from Retail Food Refrigeration

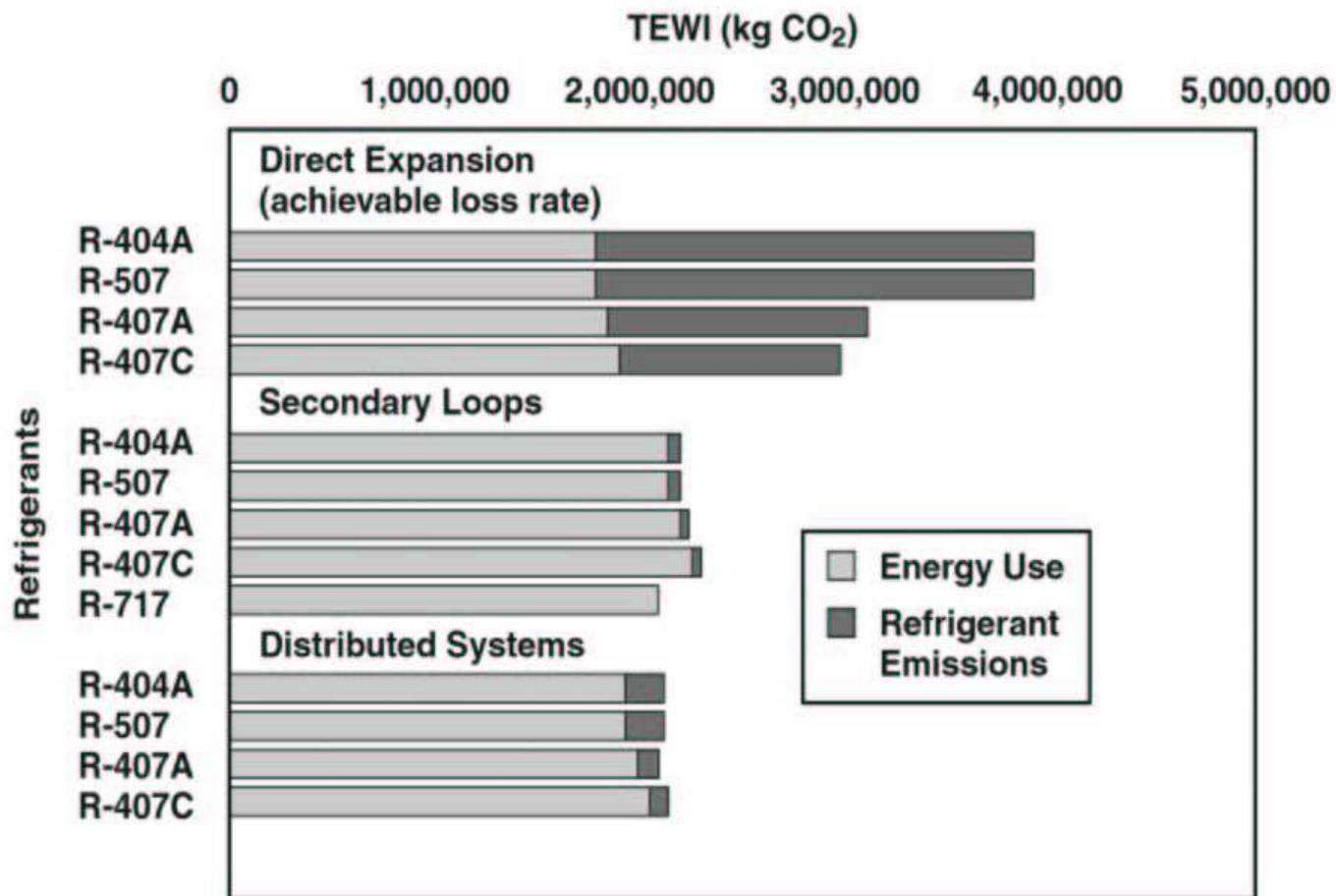
For Commercial Refrigeration, Direct and Indirect Emissions Intimately Linked

- Direct Emissions: High GWP refrigerant emissions from leaks, venting (Maintenance, End-of-Life)
 - Leakage and venting control a “*must*”
- Indirect Emissions: CO₂-equivalent emissions due to energy requirements of equipment
- High GWP refrigerants often yield higher energy efficiencies than low GWP refrigerants
 - Analysis requires consideration of LCCP
- HFCs vs. ODSs
 - USEPA estimates that approximately 50% of retail food refrigeration systems still utilize high GWP, ODS refrigerants
 - SCAQMD data also suggests many systems still employ CFCs and HCFCs

3. Reducing GHG Emissions from Retail Food Refrigeration (cont'd)

Comparison of Advanced Technologies with Baseline DX System:

Total Equivalent Warming Impact (TEWI) for Low Temperature Supermarket Refrigeration in North America¹



¹ IEA Annex 26: Advanced Supermarket Refrigeration/Heat Recovery Systems, Van Baxter, Oak Ridge National Laboratory, April, 2003.

3. Reducing GHG Emissions from Retail Food Refrigeration (cont'd)

- California must promote advanced system designs
 - Low-charge multiplex systems, distributed systems, secondary loop systems, and advanced, self-contained systems
 - Advanced systems employ lower charges, have lower leakage, and offer energy savings
- South Coast Air Quality Management District Rule 1415 is template for Inspection and Repair Program
 - Annual reporting requirement for users of ODS refrigerant (≥ 50 lbs)
 - Must fix leaks within two weeks of detection
 - Inspection of compliance by certified auditor

4. Inspection and Maintenance

- For MACS, consider integration into existing I&M program to ensure (1) a leak-free MACS or (2) an empty and inoperable MACS
- A new program with similar goals for commercial refrigeration as discussed (i.e., SCAQMD Rule 1415)
- Assumptions for MACS based on previous CARB research (MACS leakage reduction of 50% or MACS vehicle lifetime reduction of 20%)
- Assumptions for commercial refrigeration based on available information from USEPA, SCAQMD, Industry
- GHG emission reduction benefits for these measures are on the order of 1 MMtCO₂-eq

5. Mitigate End of Life Release of Refrigerant

- This measure seeks to curtail unlawful refrigerant releases during servicing and dismantling
- Reliance on existing federal ban
- Measure considers MACS and commercial refrigeration
- Strategy's emission reduction potential on the order of 0.1 MMtCO₂-eq in 2010 and 2020 for MACS
- CARB and US EPA to work cooperatively
- Explore mutually beneficial options for improvement

Final Remarks

- GHG emission reductions targets are technically feasible, cost-effective, and beneficial for our State
- California proposes sensible mitigation approaches for refrigeration sector with real, quantifiable, enforceable GHG emission reduction benefits
- Strategies are not the “*sunscreen and hats*” fixes for ozone depletion of the past
- All options are on the table (ie., voluntary, incentive, and regulatory programs)
- Historically, our process suggests that stakeholder input will play a prominent role. CARB remains in “*cooled solidarity*” with all stakeholders