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Greenhouse Gas Emissions and Abatement Opportunities in Do-it-Yourself Recharging of Leaky Motor Vehicle Air Conditioning Systems in California

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California Air Resources Board

California Environmental Protection Agency
AIR RESOURCES BOARD

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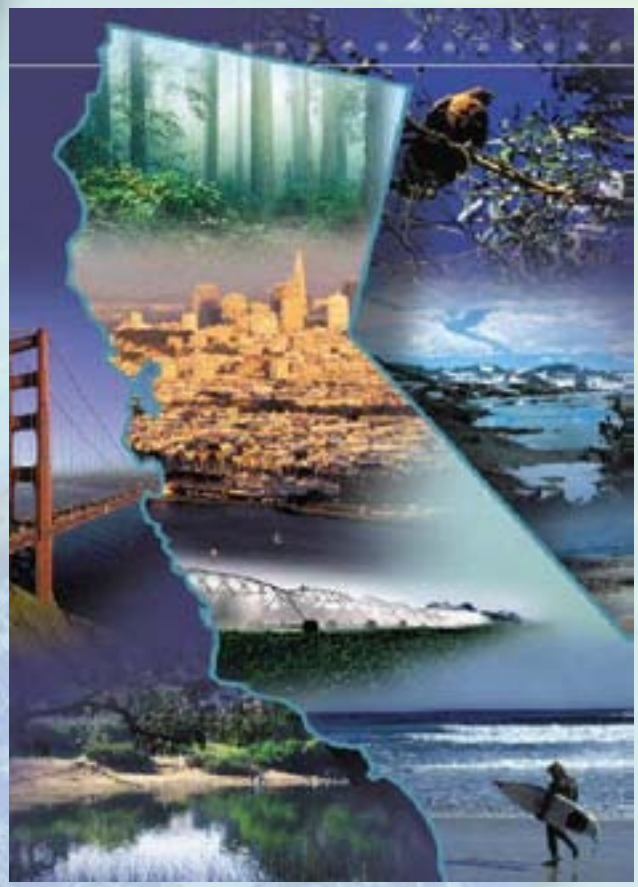
Paris School of Mines

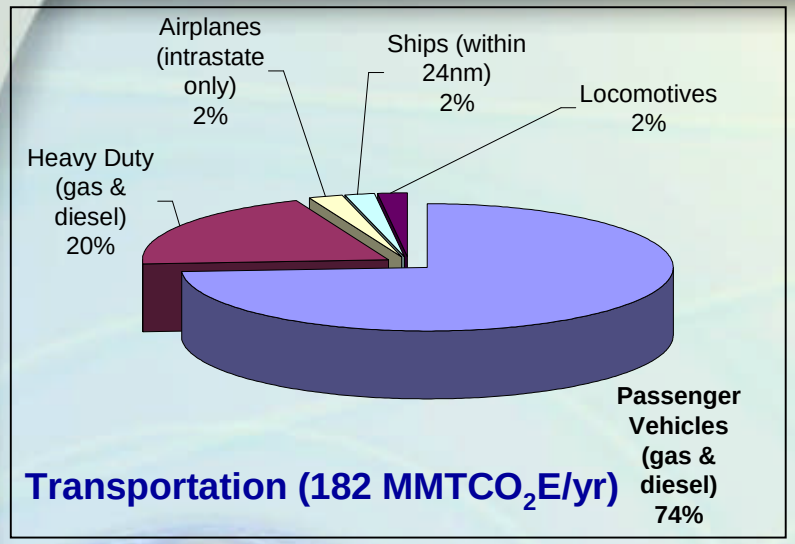
MINES PARIS ARMINES
ParisTech
CENTRE ENERGETIQUE ET PROCEDES

The California Global Warming Solutions Act of 2006 (Assembly Bill 32)



- Reduce GHG emissions to 1990 levels by 2020
- Path towards 80% below 1990 by 2050
- Multi-year, multi-agency program across all sectors
- Consider traditional performance-based command-and-control measures
- Consider alternative mechanisms such as cap & trade and incentives

California GHG Emissions (480 MMTCO$_2$E, 2004)

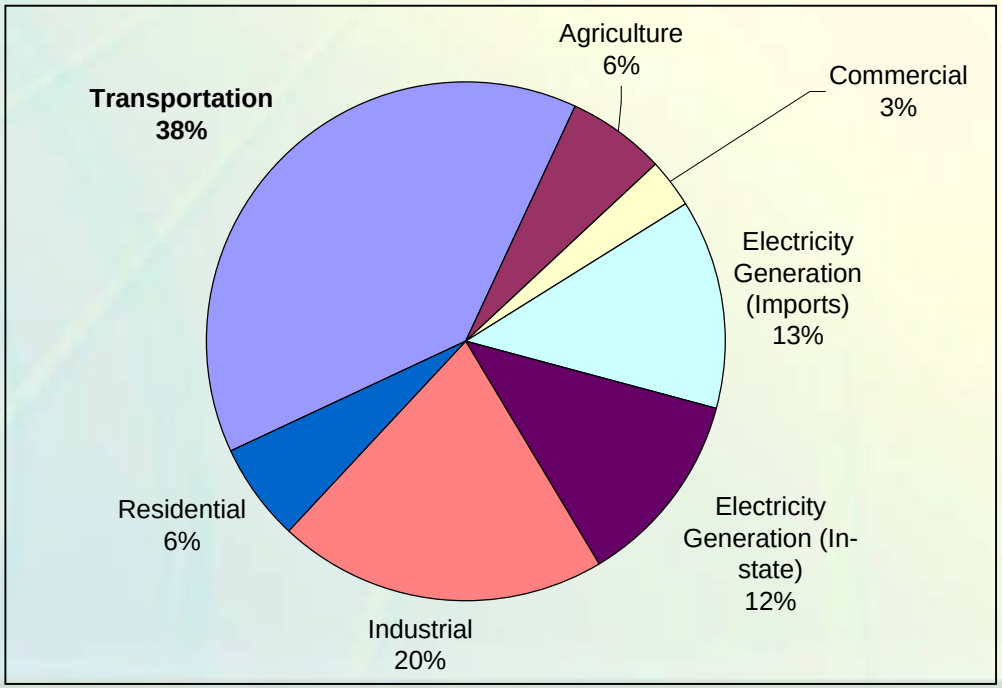


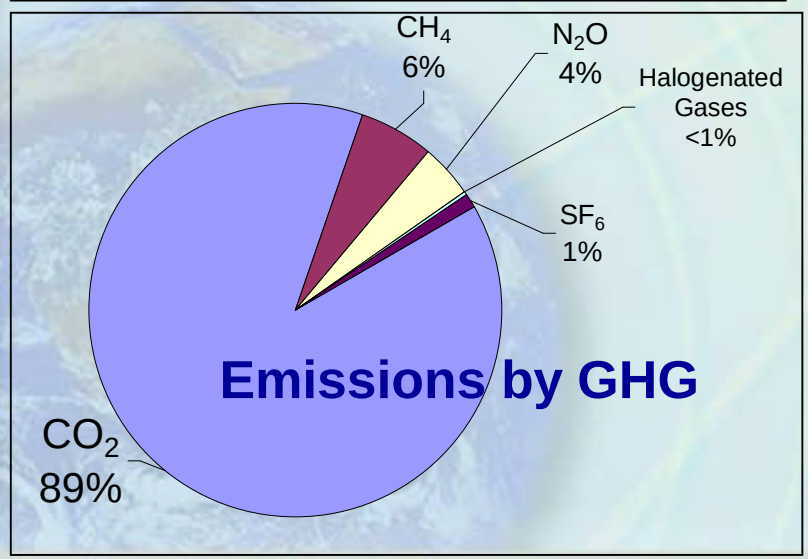
Transportation (182 MMTCO$_2$E/yr)

Key interest:

High GWP refrigerants used in transportation, commercial, and residential applications

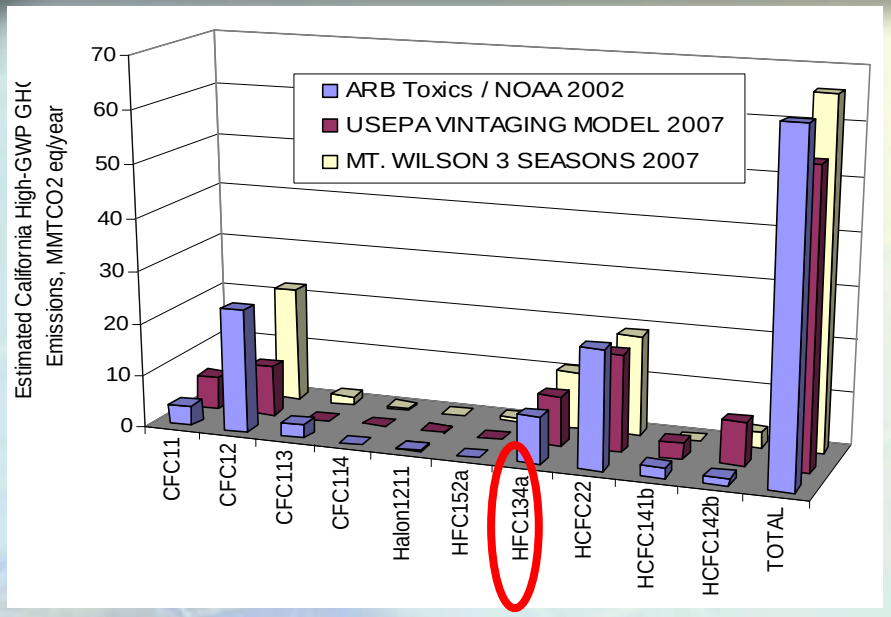
GHG Emissions by Sector

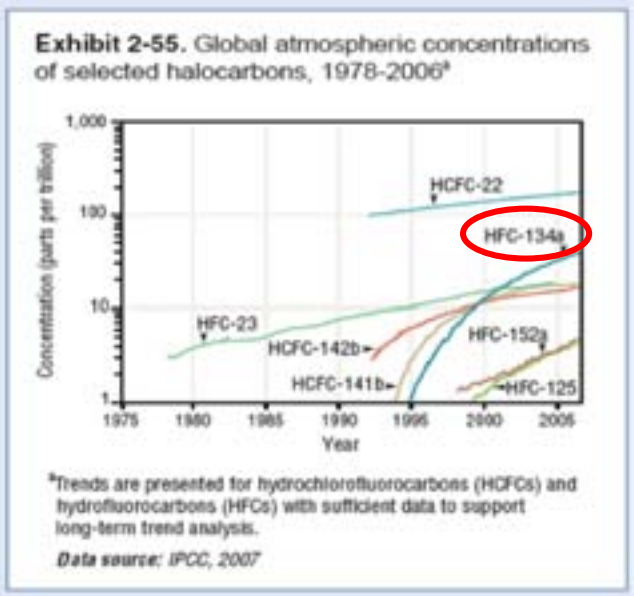




Emissions by GHG

HFCs Emissions & Ambient Concentrations Growing Rapidly





Source: U.S. EPA. EPA's 2008 Report on the Environment (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/045F.

Estimated CA HFC-134a Emissions from Mobile Sources Based on USEPA Vintaging Model Estimates ($MMTCO_2E/yr$)

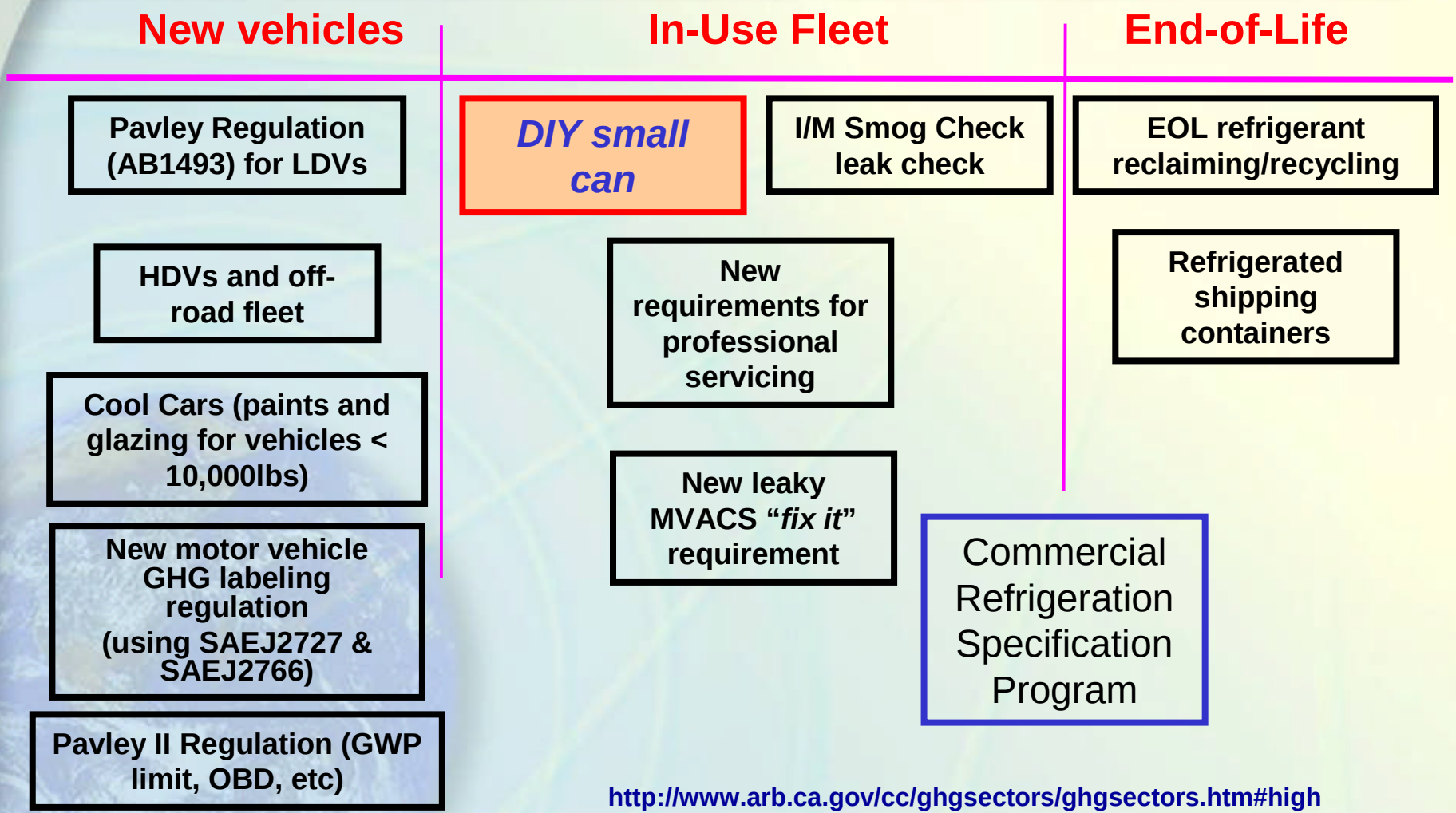
2006	2020	2030
9	12	15

Mobile HFCs are almost 60% of total HFC emissions in California*

*U.S. EPA's Vintaging Model, 2005

California's Climate Protection Plan:

Cradle-to-Grave Suite of Measures for HFC-134a Emission Reductions



http://www.arb.ca.gov/cc/ghgsectors/ghgsectors.htm#high

DIY Recharging Using HFC-134a in Small Cans

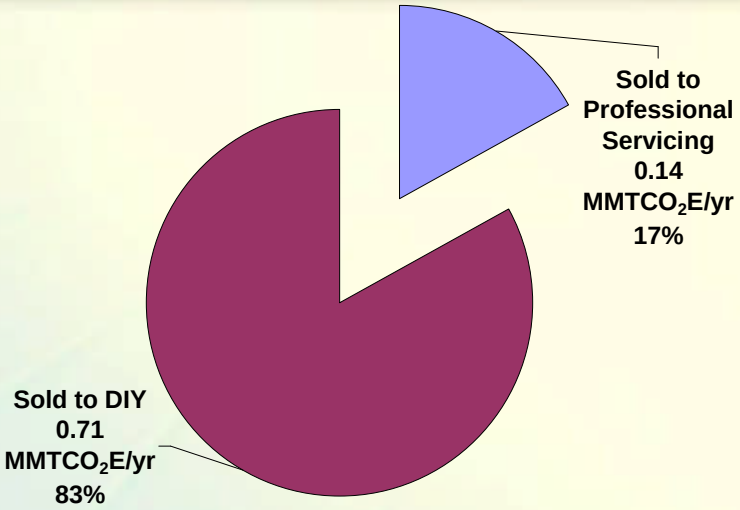
- Do-it-Yourselfers (DIY) recharge MVAC by adding HFC-134a from small cans, incurring emissions in various ways
- New regulation for refrigerant cans needed by 1/1/2010 under California's Global Warming Solutions Act of 2006 (AB 32)
  - AB 32 Early Action Plan*
- CARB commissions research by CEP/Paris School of Mines**
- French field team deployed in California (Northern and Southern)
  - To study DIY practices (50 events)
  - And professional practices (50 shop visits)
  - And conduct mini-SHED leak measurements of cans and California MVACs
- Additional complimentary studies by CARB and Industry will inform policy direction

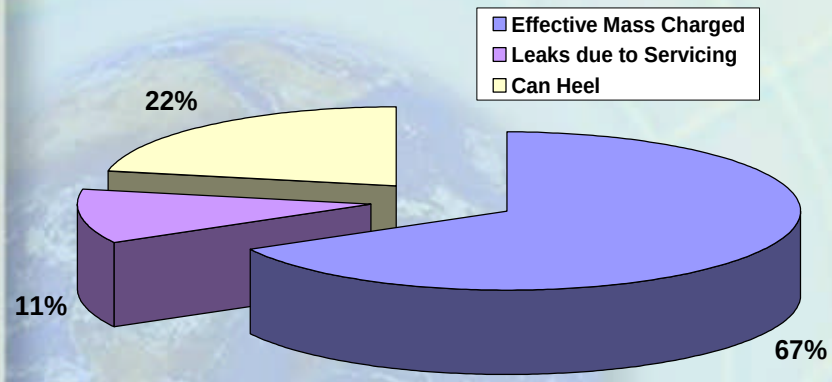
* http://www.arb.ca.gov/cc/ccea/meetings/ea_final_report.pdf

** http://www.arb.ca.gov/cc/hfc-mac/documents/IntermediateReport_SmallCans_011008.pdf

Business as Usual
DIY Emissions Apportionment

- **2 million cans/yr sold in California - 0.85 MMTCO2E/yr***
- **Total Emissions - 0.71 MMTCO$_2$E/yr** (HFC-134a sold in small cans to DIY)



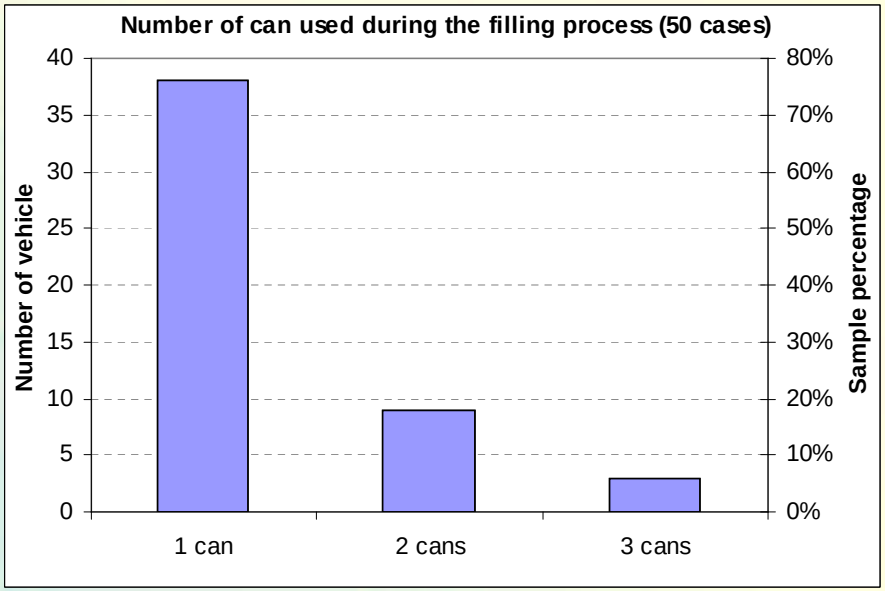


- **Immediate Emissions (0.23 MMTCO$_2$E/yr)**
  - 0.15 MMTCO$_2$E/yr
  - 0.08 MMTCO$_2$E/yr
- **Delayed Emissions (0.48 MMTCO2E/yr)**
  - 67% charged to vehicle
  - Eventually leaks out since there is usually no repair

* CARB's consumer product survey 2006

A/C Recharging Activity in California

- 1.2 million DIY operations[1,3]
- Most use one can
- 18% DIY consumers are low income[2]
- 25% of DIY leak 60% of immediate emissions[3]
- No A/C servicing for the first 7 years[4]
- After 7 yrs, recharge A/C once per year[3]
- Average vehicle lifetime in California is 16 years[5]
- Professional shop tops off or repairs
- Some go with no AC and no longer emit refrigerant



Sources:

1. ARB Consumer Product Survey for 2006
2. Frost and Sullivan Study by ARPI
3. ARB Sponsored Study on DIY by CEP/Paris School of Mines
4. I-MAC Study
5- Pavley (AB1493) regulation

HFC Emission Abatement Opportunities

- **CARB's original proposal:**
  - Ban retail sales of HFC-134a in small cans
  - Similar to State of Wisconsin (1992)
  - In concert with Europe's F-gas Directive (2007)
- **Industry proposal:**
  - Self-sealing valves on cans
  - Voluntary deposit and recycling program
  - Improved labeling on cans

HFC Emission Abatement Opportunities (cont'd)

- **Alternative regulatory approach – *first reduce, then offset***

- **DIY practice HFC emission reductions:**
  - Requirement for self-sealing valves
  - Requirement for enhanced recycling program
    - mandatory targets
    - increased deposit incentive at set intervals until target recycling rate is met
  - Meaningful consumer education program
  - Additional rulemakings for professional A/C servicing
  - Additional rulemakings for leaky MVACSs "fix it" requirement

- **Carbon mitigation fee:**
  - First, achieve maximum feasible emission reductions that are cost-effective
  - The, mitigate climate impact of remaining uncontrolled emissions
  - Can be directed to mitigation projects within or outside the sector
  - Can be an alternative or a supplement

Preliminary Benefit Analysis

Mitigation Approach	Remaining Emissions $MMTCO_2E/yr$	Emission reduction potential ($MMTCO_2E/yr$)
BAU	0.71	NA
Can Ban	0.24	0.47
Industry Proposal	0.52	0.19
Alternative Approach	0.29	0.42
Carbon Mitigation Fee	---	Up to 0.85

Closing remarks

- California's Climate Protection Plan kicked off for HFCs
- Reductions needed from HFC for mobile applications
- Emissions due servicing of MVACSs by DIYer are completely unnecessary
- Prompt control required under California's AB 32 Early Action Plan
- Multiple options for effective control exist
  - Ban is possible
  - Other options also effective: better cans, deposit & return program, meaningful consumer education
- Rule making for small cans by 1/1/2009
- Additional rulemakings needed for professional A/C servicing and leaky MVACSs
- Other measures to follow seeking superior MVACSs with best lifecycle climate performance

What will small cans contain in 2020?

- HFO-1234yf (GWP<5) is a leading contender
- CO_2 is a reality, but not for DIY recharge
- HFC-152a (GWP=120) still in the running?
- others?

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Ranking of Refrigerants

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Environmental ranking of refrigerants is of need in many instances. The aim is to assess the relative environmental hazard posed by 40 refrigerants, including those used in the past, those presently used, and some proposed substitutes. Ranking is based upon ozone depletion potential, global warming potential, and atmospheric lifetime and is achieved by applying the Hasse diagram technique, a mathematical method that allows us to assess order relationships of chemicals. The refrigerants are divided into 13 classes, of which the chlorofluorocarbons, hydrofluorocarbons, hydrochlorofluorocarbons, hydrofluoroethers, and hydrocarbons contain the largest number of single substances. The dominance degree, a method for measuring order relationships among classes, is discussed and applied to the 13 refrigerant classes. The results show that some hydrofluoroethers are as problematic as the hydrofluorocarbons. Hydrocarbons and ammonia are the least problematic refrigerants with respect to the three environmental properties.

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