



# **Mobile Air Conditioning At The Crossroads**

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The views presented here are the views of the authors alone and do not necessarily represent the views of the U.S. Environmental Protection Agency

# Imagine Affordable Climate Protection

*A global team of industry, government, and public authorities working together to investigate and commercialize new mobile AC technology that helps protect the climate while **rewarding vehicle manufacturers, suppliers, service organizations, and owners.***

# MAC Target of Opportunity

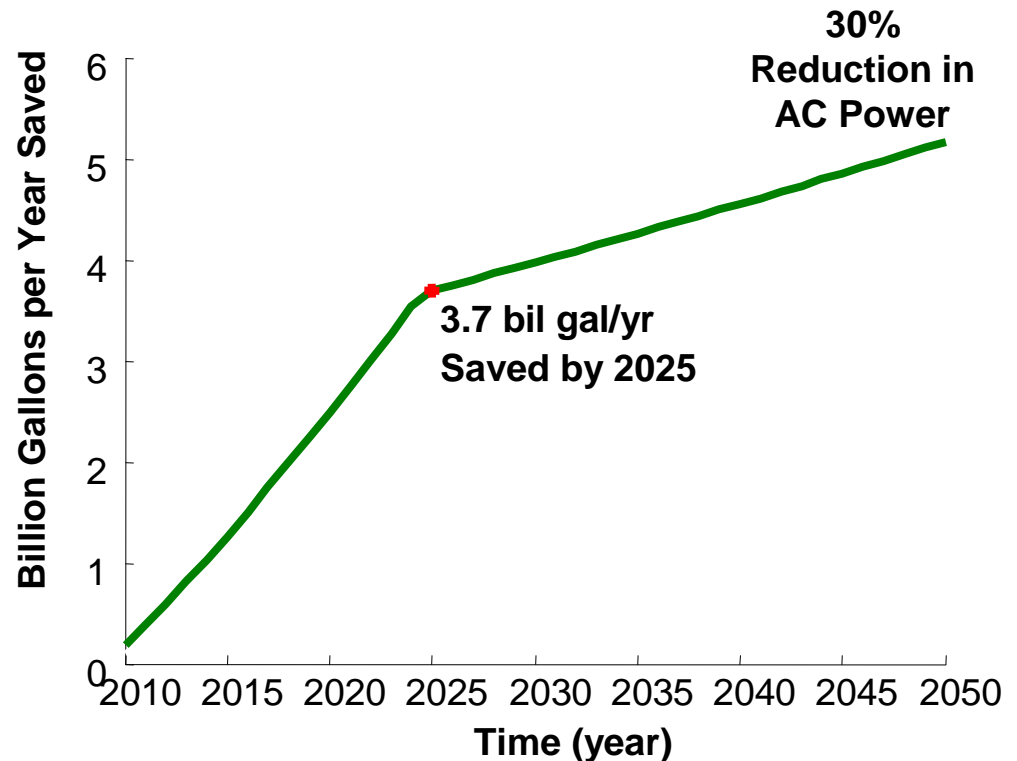
- Significant Greenhouse Gas Emissions
  - 3% to 20% of national fuel use in important markets
- Conspicuous Regulatory Neglect
  - Energy use not yet in US EPA fuel economy label or CAFE
  - **MAC energy ignored in national standards worldwide!**
- Motivated Ozone Protection Champions
  - Intimate Environmental, Technical, & Regulatory Experience
- Path-Finding EC, California Air Resources Board (CARB), and Japan Ministry of Environment Regulations
- Technically Feasible Design, Refrigerant & Service Options

# Vehicle AC Fuel Use (conservative assumptions)

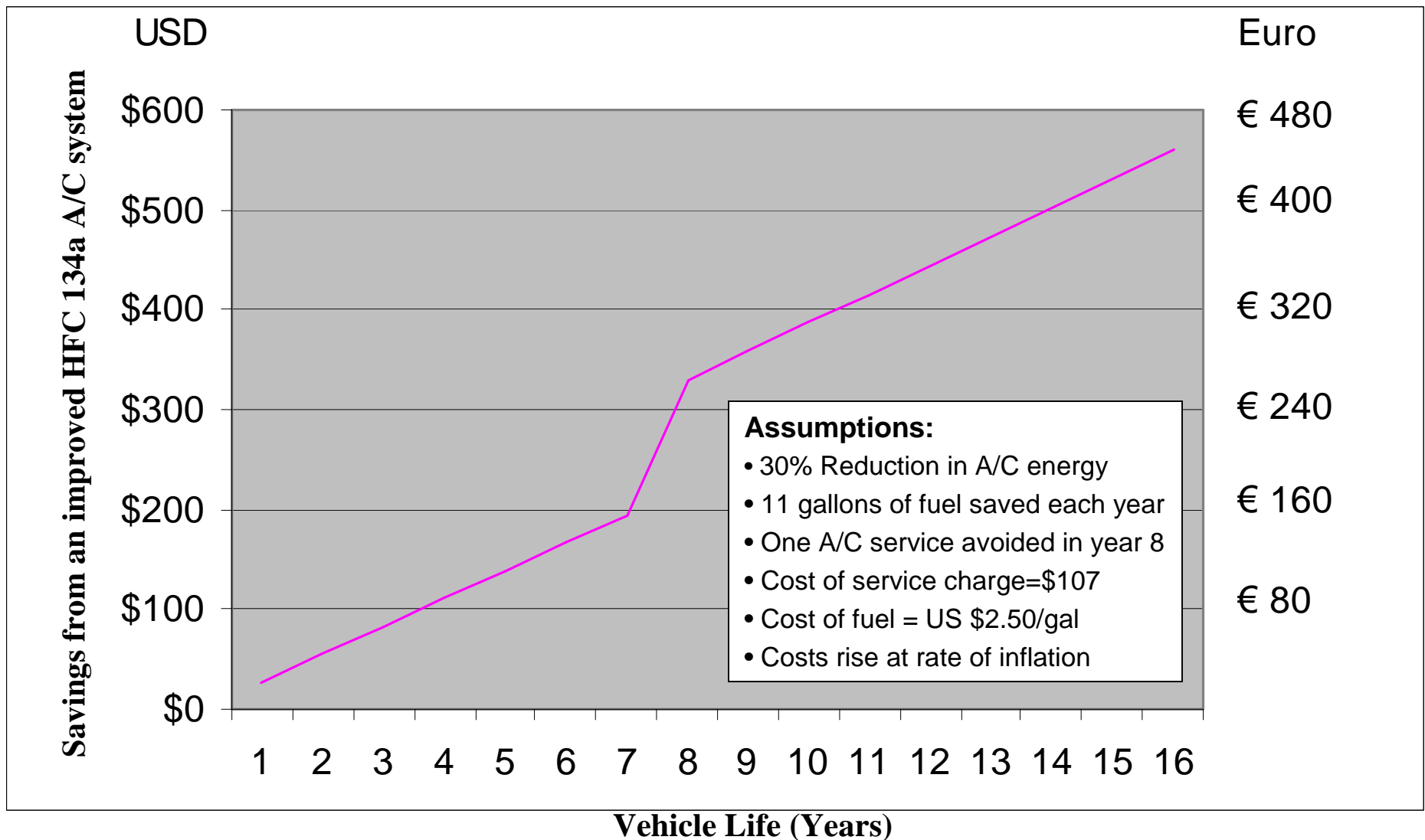
|       | Billions of liters fuel | Billion Kg CO <sub>2</sub> | Percent of fuel use |
|-------|-------------------------|----------------------------|---------------------|
| USA   | 26.8                    | 62                         | 5.5%                |
| EU    | 6.9                     | 16                         | 3.2%                |
| Japan | 1.7                     | 4                          | 3.5%                |
| India | 0.49                    | 1.1                        | 10 to 20%           |

# U.S. Fuel Savings Taking into Account New Technology Penetration

- Assumptions
  - 30% reduction in AC power
  - Power reductions begin in 2010
  - Fleet grows through time (DOE's Vision model)
    - 234 million in 2010
    - 293 million in 2050
  - Fleet turnover in 16 years
  - VMT increases over time
    - 13,500 miles in 2010
    - 19,950 miles in 2050



# Per Vehicle Improved MAC Savings Conservative Assumptions



# EPA Congratulates MAC Community!

- Remarkable global consensus
- Inspired standards development
- Brilliant engineering
- Passionate product promotion
- Clear communication (public & policy makers)
- Poised to go great things

# Thank you

for putting the environment in the driver's seat!

AC Delco  
ACC Climate Control  
AGRAMKOW  
Alsept  
Alliance of Automobile Manufacturers  
Arkema  
Association of International  
Automobile Manufacturers  
Audi  
Australian Department of Environment  
and Heritage  
Australian Federated Chamber of  
Automotive Industries  
Australian Federation of Automotive  
Parts Manufacturers  
Australian Fluorocarbon Council  
Australian Greenhouse Office  
Automotive Aftermarket Industry  
Association  
Behr  
Bergstrom  
BMW  
California Air Resources Board  
CalsonickKansei  
Centro Ricerche Fiat  
Clare Automotive  
DaimlerChrysler  
Delphi Corporation  
DENSO  
DuPont Fluoroproducts  
Eaton  
Escola das Minas de Paris  
Edith Cowan University (Australia)  
Environment Canada  
European Commission  
Fiat Auto  
Four Seasons  
Friends of the Earth  
General Motors  
Goodyear  
Honda  
Honeywell  
Hutchinson FTS

Hyundai  
Indian Institute of Technology Delhi  
Indian Ministry of Environment and  
Forests  
INEOS Ruor  
Institute of Governance and  
Sustainable Development  
International Organization of  
Standardization  
Isuzu  
Japan Automobile Manufacturers  
Association  
Japan Fluorocarbon Manufacturers  
Association  
Japan Industrial Conference for  
Ozone Layer and Climate Protection  
Japan Ministry of Economy, Trade  
and Industry  
Japan Ministry of Environment  
Johnson Controls  
Kia  
Konveks  
Korea Advanced Institute of Science  
and Technology  
Mafow  
Mitsubishi Motors  
Mobile Air Conditioning Partners  
Europe  
Mobile Air Conditioning Society  
Worldwide  
Modine  
Natural Resources Defense Council  
Neutronics  
Nissan  
Obrist  
Parker-Hamilton  
PPG Industries  
PSA Peugeot/Citroen  
Red Dot  
Refrigerant Pedaim Australia  
RTI Technologies  
Sander  
Shelco

Sinochem USA  
Skye International Holdings  
Snap-On Diagnostics  
Society of Automotive Engineers  
Society of Indian Automobile  
Manufacturers  
Solvay Fluorochemicals  
SPX Robinair  
Subaru  
Subroc  
Sun Test  
Suzuki  
TATA Motors  
TEXA, S.p.a.  
Texas Instruments  
The Energy and Resources Institute  
(India)  
TI Automotive  
Toyota  
Tracer Products  
Transpro  
TYC Genera  
Underwriters Laboratories  
United Nations Environment  
Programme DTE  
U.S. Army RDE Command  
U.S. Department of Energy's National  
Renewable Energy Laboratory  
U.S. Environmental Protection Agency  
University of Braunschweig (Germany)  
University of Illinois  
University of Maryland  
UVview Ultraviolet Systems  
Valeo  
Vehicle Airconditioning Specialists of  
Australia  
Visteon Corporation  
Volkswagen  
Volvo Car Corporation  
World Resources Institute  
ZEXEL-Video

Congratulations to the Mobile Air Conditioning Climate Protection Partners for helping us all save money and drive a little cleaner. This global team of corporate, government, and environmental leaders is working together to rapidly improve the efficiency of your vehicle air conditioning systems by at least 30% and reduce refrigerant leakage by at least 50%. Vehicle manufacturers and suppliers are improving existing air conditioning systems and technicians are offering environmentally superior service as the global search for better refrigerants continues. These voluntary actions will ultimately avoid millions of tons of greenhouse gas emissions each year.

Visit our website at [www.epa.gov/cppd/mac](http://www.epa.gov/cppd/mac) and help put the environment in the driver's seat.





# MAC Industry at the Brink

- HFC-134a status quo is unsustainable
- Global consensus on IMAC and new technology
- First choice of CO<sub>2</sub> or proprietary low-GWP option
- HFC-152a closing the lead as if money mattered
- Industry indecision unpersuasive to authorities
- Every indication climate change is THE driver

# Climate Change Driving MACs

- US Supreme Court clear and unequivocal
- US Governors & Mayors regulate with a vengeance
- EC sternly rejects industry request for more time
- CAFE back front & center against all odds
- New MACs can clearly reduce greenhouse gases
- Professional service too good to be ignored
- Time to drive, ride, or get out of the car

# Regulatory Beacons

- Deadlines as if Markets Matter
- Life-Cycle Climate Performance
- EC F-Gas Directive
  - Refrigerant <GWP 150; silent on energy
- CARB Proposed Regulation
  - LCCP with rewards for direct and indirect
- Next Generation Vehicle Performance Integration?

# Global Refrigerant Options

- Baseline
  - HFC-134a (GWP = 1300,  $E_{\text{efficiency}} = 1.0$ )
- EC Directive: 100-year GWP < 150
  - Carbon Dioxide (GWP = 1,  $E_{\text{efficiency}} = .8-.9$ )
  - HC (GWP = 3,  $E_{\text{efficiency}} = 1.0$ )
  - Fluid-H (GWP < 10,  $E_{\text{efficiency}} > 95$ )
  - HCF-152a (GWP = 120,  $E_{\text{efficiency}} = 1.2$  adjusted)
  - Fluid DuH (GWP < 40,  $E_{\text{efficiency}} > 95\%$ )
  
  - I-MAC HFC-134a +30% efficiency; -50% refrigerant emissions

Charge depends on molecular weight, performance depends on ambient temperature

# Summary & Conclusions

- Protect the climate & reduce fuel costs
- Pursue fuel efficiency consensus & technical progress
- Market reliable A/C with life-cycle climate performance
- Satisfy regulatory & market incentives
- Do it for yourself; or let it be done for you
- Keep automotive partners coming back for more

# Barrier Removal Status

- In 2006, EC/US/Japan announced cooperation to remove global barriers to alternative refrigerants
- EPA Team identified US barriers (indicative):
  - Department of Transportation accumulator pressure requirements
  - State bans on toxic & flammable auto A/C refrigerants
  - Occupational Safety and Health Administration (OSHA) requirements for training, personal protective equipment, safe handling, pressure relief devices, equipment inspection, worker exposure, ventilation, and refrigerant storage

# Removing Barriers Through Unprecedented Global Private/Public Cooperation

Barrier Removal Team Chaired by Kristen Taddonio, US EPA

Alliance of Automobile Manufacturers

Audi – Germany

Behr Group - Germany

BMW – Germany & North America

Centro Ricierche Fiat - Italy

DENSO - Japan

Environmental Protection Agency – USA

European Commission

Hydro - Norway

Ingersoll-Rand - Czech Republic

MACS Worldwide - USA

Modine - USA

Obrist Engineering - Austria

Parker Hannifin - Germany

Prospective Technology - USA

PSA Peugeot Citroën – France

Red Dot - USA

Sanden - Japan

Shecco Technology – Norway

Society of Automotive Engineers International

Texas Instruments - Netherlands

TEXA S.p.A. - Italy

Thomas Magnete - Germany

Toyota – Japan & USA

U.S. Army - USA

Volvo - Sweden

VDA - Germany

VOSS Automotive - Germany

Witzenmann - Germany

# Success!

## OSHA, EPA, & SAE Cooperation will Satisfy US Health and Safety Requirements

- SAE J-Standards in progress: “Recommended practice for servicing R744 [CO<sub>2</sub>] & R152a mobile air conditioning systems”
- The SAE Standards will meet Occupational Safety and Health Administration (OSHA) requirements for training, personal protective equipment, safe handling, pressure relief devices, equipment inspection, worker exposure, ventilation, and refrigerant storage



# Success!

## U.S. Department of Transportation Waives Pressure Requirement

- “[Air conditioning systems] are an integral component of a motor vehicle and necessary for the operation of the vehicle”... “Based on the information you provided, the air conditioning system...is not subject to the Hazardous Materials Regulation.”

–John A. Gale, Chief of Standards Development  
US Department of Transportation (DoT) Pipeline and  
Hazardous Materials Safety Administration

11 July 2006

# More Success!

## State Barriers Removed, NHTSA Confirms No Barriers Exist

- CO2 barriers removed in Arkansas, Connecticut\*, D.C., Florida, Idaho, Kansas, North Dakota, Oklahoma, Texas\*, Virginia, Washington, Montana, Arizona
- HFC-152a acceptable in Wisconsin, Montana, Iowa, Arizona, Arkansas, DC, Florida\*
- The National Highway Traffic and Safety Administration (NHTSA) confirmed alternative refrigerants OK under existing rules

\* Usage conditions apply. MAC systems must conform to federal guidelines and SAE recommended practices.

# Remaining Challenges

- EU has yet to confirm no HFC-152a barriers
- Awaiting word on CO2 acceptability from four states: Utah, Indiana, Louisiana, Maryland
- Legislative vote needed to allow flammable refrigerant in the following twelve states: Connecticut, Idaho, Indiana, Kansas, Louisiana, Maryland, North Dakota, Oklahoma, Texas, Utah, Virginia, and Washington
- Contact Kristen Taddonio: **[taddonio.kristen@epa.gov](mailto:taddonio.kristen@epa.gov)** for information on how other states are safely allowing the use of flammable refrigerants

# More MAC Information

- I-MAC 30/50
  - [www.epa.gov/cppd/mac](http://www.epa.gov/cppd/mac); [www.sae.org/news/releases/mobileac.htm](http://www.sae.org/news/releases/mobileac.htm)
- SAE Alternate Refrigerant Symposium: 26-28 June 2006
  - [www.sae.org/events/aars/](http://www.sae.org/events/aars/); [www.sae.org/ac](http://www.sae.org/ac)
- VDA Winter Meetings
  - [www.vda-wintermeeting.de](http://www.vda-wintermeeting.de)
- MAC Summit Proceedings
  - 2003: [www.europa.eu.int/comm/environment/air/mac2003/index.htm](http://www.europa.eu.int/comm/environment/air/mac2003/index.htm)
  - 2004: [www.epa.gov/cppd/2004macsummit.pdf](http://www.epa.gov/cppd/2004macsummit.pdf)
  - 2005: [www.arb.ca.gov/research/macs2005/macs2005.htm](http://www.arb.ca.gov/research/macs2005/macs2005.htm)
  - 2006: [www.mac-summit.com/presentations](http://www.mac-summit.com/presentations)

# Back-up Slides

# I-MAC 30/50

## Government Partners

- Australian Department of Environment and Heritage
- Australian Greenhouse Office
- California Air Resources Board
- Environment Canada
- The European Commission
- Indian Ministry of Environment and Forests
- International Energy Agency
- Japan Ministry of Economy, Trade and Industry
- Japan Ministry of Environment
- United Nations Environment Programme DTIE
- U.S. Army RDE Command
- U.S. Department of Energy's National Renewable Energy Laboratory
- U.S. Environmental Protection Agency

# I-MAC 30/50

## Association and Standards Partners

- Alliance of Automobile Manufacturers
- Association of International Automobile Manufacturers
- Australian Federated Chamber of Automotive Industries
- Australian Federation of Automotive Parts Manufacturers
- Australian Fluorocarbon Council
- Automotive Aftermarket Industry Association
- International Organization of Standardization
- Japan Automobile Manufacturers Association
- Japan Fluorocarbon Manufacturers Association
- Japan Industrial Conference for Ozone Layer and Climate Protection
- Mobile Air Conditioning Partners Europe
- Mobile Air Conditioning Society Worldwide
- Refrigerant Reclaim Australia
- Society of Automotive Engineers
- Society of Indian Automobile Manufacturers
- Underwriters Laboratories
- Vehicle Airconditioning Specialists of Australia

# I-MAC 30/50

## Vehicle Manufacturer Partners

- Audi
- BMW
- DaimlerChrysler
- Fiat Auto
- General Motors
- Honda
- Hyundai
- Isuzu
- Kia
- Mitsubishi Motors
- Nissan
- PSA Peugeot/Citroen
- Renault
- Subaru
- Suzuki
- TATA Motors
- Toyota
- Volkswagen
- Volvo Car Corporation



# I-MAC 30/50

## Supplier Partners

- AC Delco
- ACC Climate Control
- AGRAMKOW
- Airsept
- Arkema
- Behr
- Bergstrom
- CalsonicKansei
- Clore Automotive
- Delphi Corporation
- Denso
- DuPont Fluoroproducts
- Eaton
- Four Seasons
- Goodyear
- Honeywell
- Hutchinson FTS
- INEOS Fluor
- Johnson Controls
- Konvekta
- Maflow
- Modine
- Neutronics
- Obrist
- Parker-Hannifin
- PPG Industries
- Proliance
- Red Dot
- RTI Technologies
- Sanden
- Shecco
- Sinochem USA
- Skye International Holdings
- Snap-On Diagnostics
- Solvay Fluorochemicals
- SPX Robinair
- Subros
- Sun Test
- TEXA, S.p.a.
- Texas Instruments
- TI Automotive
- Tracer Products
- TYC Genera
- UView Ultraviolet Systems
- Valeo
- Visteon Corporation
- ZEXEL-Valeo

# I-MAC 30/50

## Environmental, Research, & Academic NGO Partners

- Centro Ricerche Fiat
- Ecole des Mines de Paris
- Edith Cowan University (Australia)
- Friends of the Earth
- Indian Institute of Technology Delhi
- Institute of Governance and Sustainable Development
- Korea Advanced Institute of Science and Technology
- Natural Resources Defense Council
- The Energy and Resources Institute (India)
- University of Braunschweig (Germany)
- University of Illinois
- University of Maryland
- World Resources Institute