



The Mobile Air Conditioning Climate Protection Partnership

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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

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 ₂	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%

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.***


Thank you
for putting the environment in the driver's seat!

AC Delco
ACD Climate Control
ACQUACORV
Airtop
Alliance of Automobile Manufacturers
Altera
Association of International Automobile Manufacturers
Audi
Australian Department of Environment and Heritage
Australian Federated Chamber of Automobile Industries
Australian Federation of Automotive Parts Manufacturers
Australian Fluorocarbon Council
Australian Greenhouse Office
Automotive Aftermarket Industry Association
Bafy
Berglitz
BMW
California Air Resources Board
Caterpillar
Celanese
Celanese Fiat
Cofe Automotive
DaimlerChrysler
Delphi Corporation
DENSO
Duroflor Products
Eaton
Ecole des Mines de Paris
Edith Cowan University (Australia)
Environment Canada
European Commission
Fiat Auto
Ford Select
Friends of the Earth
General Motors
Globevent
Honda
Horaywell
Hufschmidt FTS

Hundai
Indian Institute of Technology Delhi
Indian Ministry of Environment and Forests
INCOE/Race
Institute of Governance and Sustainable Development
International Organization of Standardization
Ipsos
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
Jatroco Controls
Kia
Korveks
Korea Advanced Institute of Science and Technology
Mabtec
Mitsubishi Motors
Mobile Air Conditioning Partners
Murphy
Mobile Air Conditioning Society
Mordax
Modra
Natural Resources Defense Council
Neutronics
Nissan
Oxiris
Parker Hannifin
PRG Industrie
PSA Peugeot/Citroen
Rad DDE
Refrigerant Reclaim Australia
RTI Technologies
Sanyo
Shcoo

Sinochem USA
Skye International Holdings
Snap-On Diagnostics
Society of Automotive Engineers
Society of Indian Automobile Manufacturers
Solvay Fluorochemicals
SPX Poolstar
Subaru
Suzuki
Sun Test
Suzuki
TATA Motors
TEXA S.p.A.
Texas Instruments
The Energy and Resources Institute
TIDEL
TI Automotive
Toyota
Tosol Products
Trenpro
TRC Genes
Underwriters Laboratories
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
University of Braunschweig (Germany)
University of Illinois
University of Maryland
Umwelt Ultraschall Systems
Valeo
Vehicle Airconditioning Specialists of Australia
Wipac Corporation
Volkswagen
Volvo Car Corporation
Waste Resources Institute
ZEXEL-Valeo

Congratulations to the Mobile Air-Conditioning Climate Protection Partners for helping us all save money and drive a little cleaner. The 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 techniques 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/opa/amac and help put the environment in the driver's seat.



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

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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

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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

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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

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Environmental, Research, & Academic NGO Partners

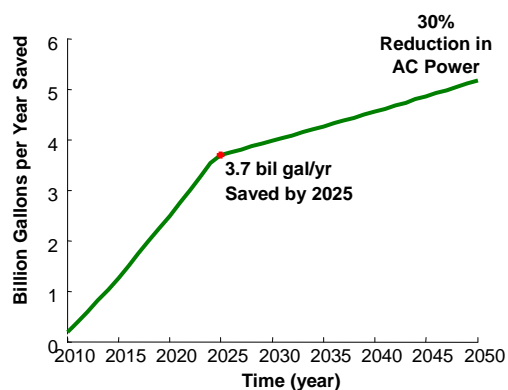
- Centro Ricerche Fiat
- Ecole des Mines de Paris
- Edith Cowan University (Australia)
- Friends of the Earth
- Indian Institute of Technology Delhi
- Institute of Governance and Sustainable Development
- Korea Advanced Institute of Science and Technology
- Natural Resources Defense Council
- The Energy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

Partnership Science

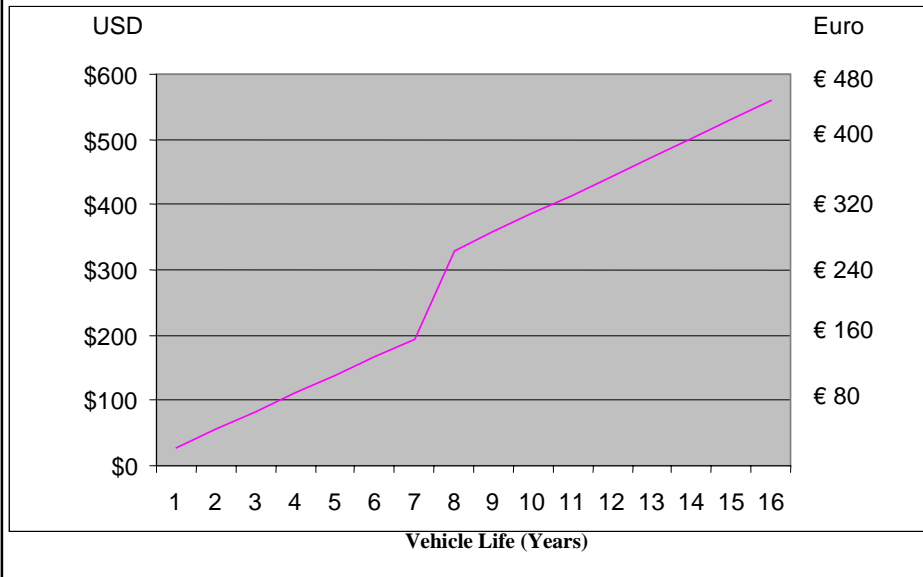
- Serious Homework—collaboration, persuasion...
- Strategic Intervention—engineering level
 - Environment, Engineering Excellence, & Respect
- Quid Pro Quo—regulatory navigation
 - Performance not Prescription: LCCP
 - Technical Feasibility
 - Logistics and Infrastructure
 - Education and Incentives

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



Regulatory Beacons

- **Life-Cycle Climate Performance**
 - Refrigerant, energy, manufacturing, & disposal emissions including weight differences, if any
- **EC F-Gas Directive**
 - Refrigerant <GWP 150; silent on energy
- **CARB Proposed Regulation**
 - Premised on 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, $E_{\text{efficiency}}=1.2$)
 - DuPont, INEAS, SinoChem (???) I-MAC
- I-MAC HFC-134a +30% efficiency; -50% refrigerant emissions

Charge depends on molecular weight, performance depends on ambient temperature

The Devil is in the CO₂ Details

- Can systems satisfy leak-free reliability?
- Will production systems be energy efficient?
- Can service technicians detect leaks at <10ppm in ambient 300-500ppm CO₂?
- Will governments and industry identify and remove toxicity, pressure vessel, transport, and storage regulations that restrict CO₂?
- Will the global infrastructure organize to service the first few vehicles shipped worldwide?
- Will customers embrace the new technology?

Remove Barriers to EC Refrigerants

- EPA/EC/CARB/Japan have agreed to remove barriers to refrigerants allowed by the EC F-gas Directive
- Implementing consensus safety guidelines in design, manufacture, operation and service
- Modeled after rules implemented in sectors safely using the same chemicals
- EPA's Kristen Taddonio is developing consensus for prompt review and acceptance by safety and environmental authorities worldwide

Indicative Challenges

- DOT component design requirements
- US State-level toxicity & flammability bans
- EU Pressure Equipment Directive (PED)
- Japan's High Pressure Gas Law

Indicative Solutions

- Safety & design criteria for pressurized components
- Servicing & handling modeled after fire protection industry standards for CO₂ and after fuel and welding standards for HFC-152a

Strategy for One Global Standard

- Implement HFC-134a I-MAC 30/50 worldwide
- **Resolve fuel efficiency impact on small vehicles**
- Take CO₂, HFC-152a to the next level and globally support first commercial introductions
- Open access to Cost-Effective Environmental Designs
- Adjust pace of EC HFC-134a phaseout so alternatives equal or better I-MAC HFC-134a LCCP performance
- Introduce alternatives where and when proven safe, environmentally superior, and cost-effective over a lifetime of ownership

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
- Keep automotive partners coming back for more

More MAC Information

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

2007 Meetings & Events

- JSAE Automotive Air-Conditioning Symposium 2007
23-25 January 2007, Tokyo Japan
- Mobile AC Society Worldwide Convention and Trade Show
1-3 February 2007, Phoenix USA
www.macsw.org
- VDA Winter MAC Meeting
14-15 February 2007, Saalfelden Austria
www.vda-wintermeeting.de
- Technological Innovations in AC & Refrigeration
8-9 June 2007, Milano Italy
www.centrogalileo.it/milano/CONGRESSODIMILANO2007english
- SAE Phoenix Forum
19-21 June 2007, Phoenix