



# HOW TO BRING NATURAL REFRIGERANTS FASTER TO MARKET

SUMMARY  
REPORT

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## **ATMOsphere 2010**

International Workshop  
on Natural Refrigerants

Brussels, Belgium  
27 - 28 September 2010



**ATMO**  
**sphere**  
2010  
faster to market  
natural refrigerants





# **HOW TO BRING NATURAL REFRIGERANTS FASTER TO MARKET**

SUMMARY  
REPORT

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## HOW TO BRING NATURAL REFRIGERANTS FASTER TO MARKET

# WE NEED A ROADMAP ... !

### Marc Chasserot

Chairman ATMOsphere 2010  
Managing Director shecco



...to bring natural refrigerants faster to market.

There is a growing number of organisations around the world working on this important issue of introducing sustainable alternatives to HCFCs and HFCs. ATMOsphere 2010 brought them together to discuss HOW to build this roadmap. The results of which you can find in the following pages. Participants from all around the world joined in the discussions bringing to the table their unique perspectives. This year we wanted interactive debates that will lead to concrete actions. Not just presentations. And judging by the excellent feedback we got, it worked.

People wanted to network and share knowledge regarding carbon dioxide, hydrocarbons and ammonia. Participants talked as "We need" rather than "I need". We really got a sense of community and purpose about what we collectively need to do to get natural refrigerants faster to market and that this is simply the right thing to do. As Chairman of ATMOsphere 2010, I can assure you that we will not stop here. We will talk with partners around the world to ensure that these cutting-edge discussions continue to drive change both within industry and policy.

This report that you are reading right now is one small step towards this roadmap.

Looking forward to building it with you.

Marc Chasserot,

A handwritten signature in black ink that reads 'Marc Chasserot'. The signature is written in a cursive style with a horizontal line underneath.

### About ATMOsphere 2010

International Workshop on Natural Refrigerants - Held on 27 - 28 September in Brussels to help answer one simple question: HOW to bring natural refrigerants faster to market? 170 participants from 30 countries, including 35 moderators and 40 speakers. With 17 interactive groups bringing together all main stakeholders to discuss what policy and industry can do to support the use of carbon dioxide, ammonia and hydrocarbons as refrigerants in developed and developing countries. Three Panel sessions focusing on retail refrigeration, educational aspects and on India as a future market for natural refrigerants.

# SUMMARY

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Marc Chasserot

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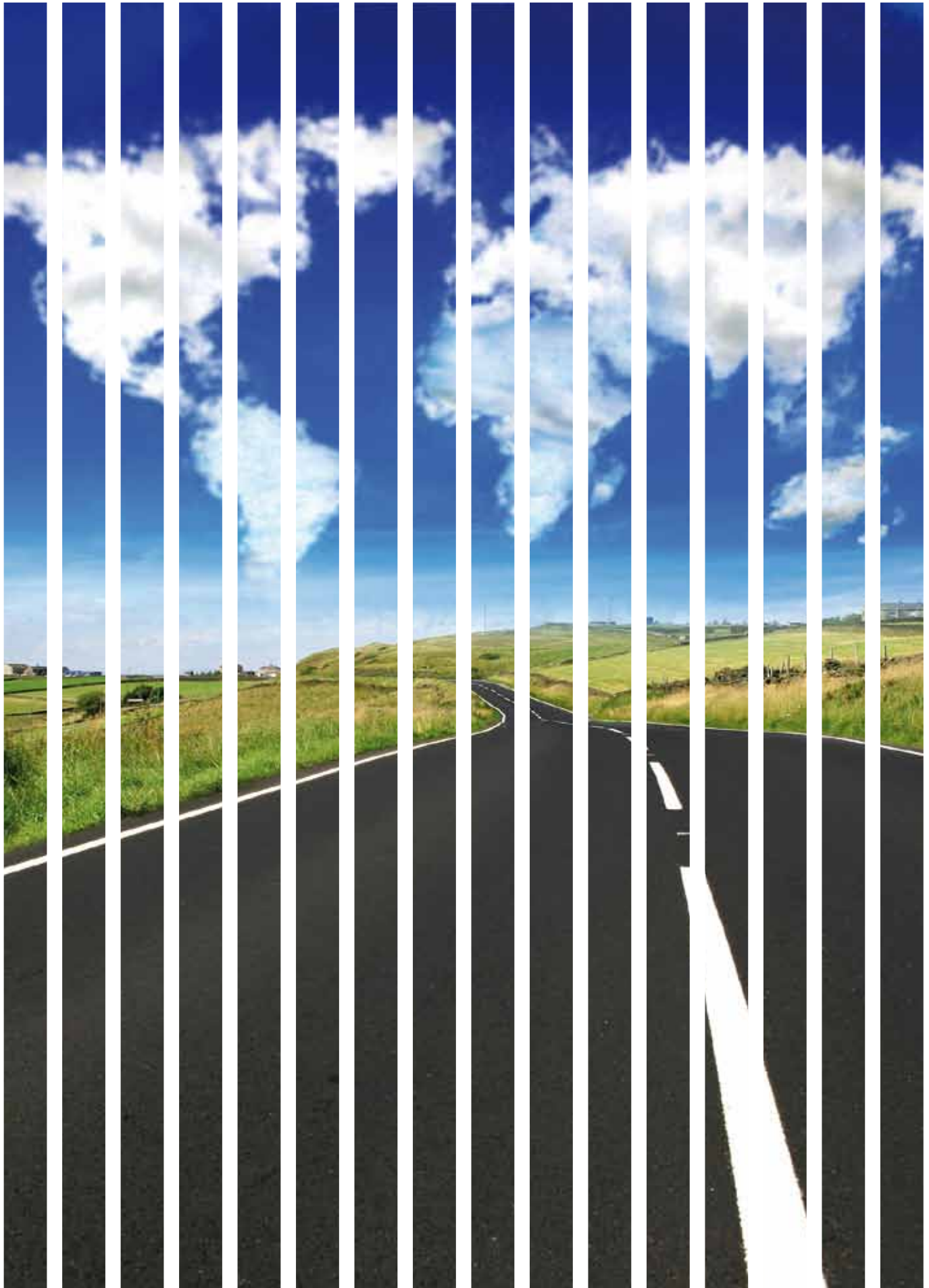
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## HOW TO BRING NATURAL REFRIGERANTS FASTER TO MARKET

# BARRIERS AND SOLUTIONS

### Introduction

### The 4 Factors to Success

Imagine an HFC-free world by the year 2050. What needs to be done to abandon the path of constantly rising emissions from high global warming gases to reach a point where only environmentally benign substances are used to cool and heat our homes, cars, foodstuff, medicines and water? Looking beyond the immediate challenge of a CFC/HCFC phase out in 147 countries, it is emerging as a consensus among developed and developing countries that only globally harmonised action can effectively remove both ozone-depleting and high global warming substances from heating, ventilation, air-conditioning and refrigeration uses. Where both a changing climate and the right of emerging economies to western lifestyles will consistently increase the market demand for air conditioners, fridges, heat pumps and chillers, a "global roadmap" is needed to show the way forward to environmentally and economically beneficial options without synthetic gases. Ammonia, carbon dioxide and hydrocarbons and ultimately air and water, will remain the most viable refrigerant alternatives without known and still unknown risks for humans and the environment.

Given that these "natural refrigerants" are already in established market use, the question is not IF they will come but HOW. The following scheme outlines four main factors to be taken into account when addressing the question of "HOW to Bring Natural Refrigerants Faster to Market":

The four factors of Information, Networks, Competence and Conditions are linked either in a virtuous or vicious circle, depending on the dynamics evolving from concrete steps taken and pressure exerted by politicians, business leaders and the wider public. The close inter-linkage between these factors is further complicated by the time dimension. The adoption of natural refrigerants is closely linked to the general time frame set for a response to the global climate change challenge. Concretely, the historic opportunity for developing countries to leapfrog directly from ozone-depleting substances to natural refrigerants, without entering the same one-way street industrialised nations have already taken with the adoption of HFCs, is of vital importance to the global success of natural refrigerants over the next few decades.

Both industrialised nations, responsible for a major share of greenhouse gas emissions in the past, as well as rapidly growing economies, likely to be responsible for a growing share of global emissions in the future, are now tasked with supporting a refrigerant choice that is closely following the "precautionary principle" in that it is safe for humans and the environment, without the financial risks of another phase out of synthetic gases. Natural refrigerants – carbon dioxide, hydrocarbons and ammonia – can deliver on this principle on a global scale, provided that the community involved in legislating, designing and maintaining HFC-free equipment proactively approaches the following four issues:



### Information

Starting from the very basics, policy makers (national governments, regulatory agencies, National Ozone Unit Officers, supranational and international organisations etc.), the business community and end-users / consumers need to be educated about the existence and most efficient use of natural refrigerants. As was stressed at ATMOsphere 2010, basic information about the suitable applications, the design and installation of equipment, the safe operation of appliances and the properties of natural refrigerants as opposed to synthetic gases is currently lacking, creating challenges in the development of informed decisions about international climate strategies, national standards and personal consumption.

Given that natural refrigerants experts in different parts of the world have developed energy-efficient, safe and economically viable options, the broader public, but most importantly decision makers from industry and policy, need to gain access to reliable and well-founded data and conclusions about the benefits of converting directly from HCFC- or HFC-based applications to natural refrigerants. At the core of this issue lies the adoption of evaluation tools and “open” methodologies to compare the climate performance of natural refrigerants and their synthetic alternatives, as well as credible calculations allowing for a life cycle analysis in terms of cost, energy savings and emissions reductions.

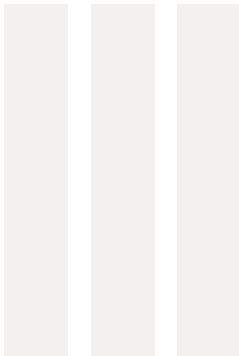
### Networks

Closely linked to the provision of factual information but also to leverage its financial and time resources in an more optimal way, the natural refrigerants community needs to enhance its presence in international climate and ozone talks and during trade shows and stakeholder group meetings deciding about the future of the HVAC&R industry. Scattered information needs to be compiled in a more systematic way, expert knowledge transferred to potential partners and closer ties need to be established between existing markets for natural refrigerants-based equipment and prospective ones. Often opposed to a dominating and financially stronger industry with vested interests in preserving current market shares in the refrigeration business, natural refrigerants proponents are asked to take an interdisciplinary approach, involving in the debate not only legislators but also manufacturers, trainers, academia, consultants and international organisations.

### Competence

Without safe, reliable, efficient and cost-effective alternatives, any early phase - out of fluorinated gases in HVAC&R equipment will not take place. An aspect highlighted by all participants of ATMOsphere 2010 as being of vital importance refers to better and more widespread training schemes for engineers, technicians, installers and maintenance staff involved in the design and operation of natural refrigerants equipment. Another aspect stressed is the availability of safe and energy-saving components and systems in different parts of the world where capacity building and a further increase in R&D activities is crucial to establish a solid technology base from where to adapt systems for different climate conditions, usage patterns and needs of end-users. Once favourable market conditions are put in place, competence is of key importance as technology development will naturally follow the market demand for locally adapted solutions and then draw on developed skills.

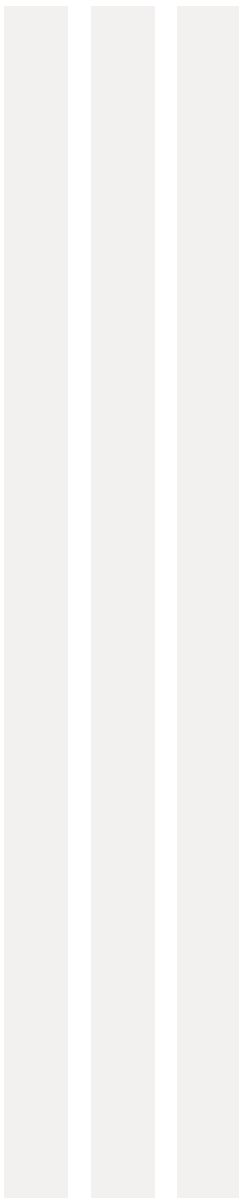




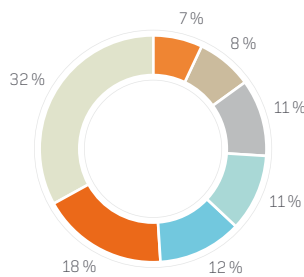
**Conditions**

The speed of a global uptake of natural refrigerant solutions largely depends on the prevailing policy and business climate on a national and international level. Clear signals set by global HFC phase out schemes, rigid taxation and financial incentives, price mechanisms and trading schemes constitute just some of the measures to provide higher investment security for players involved in the natural refrigerants business. Out of the four factors this might be the most challenging one to address, as a global harmonisation of standards, rules and legislation would be needed to ensure a rapid market penetration of natural refrigerants solutions, without taking the risk of carbon leakage and a loss of competitiveness.

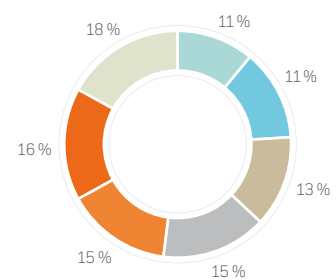
Another important aspect influencing the adoption of natural refrigerants is the voluntary commitment by leading industry players and economically dominant countries to exert pressure on other trading partners to adopt HFC-free equipment, resulting in market dynamics leading to swift change within the industry.



**Stated as the most important barrier**  
(% of respondents)



**Ranking of barriers by importance**  
(weighted responses)



- Funding & Support
- Training & Know-how
- Markets & Marketing
- Psychology
- Technology & Safety
- Supply & Availability
- Legislation

**ATMOsphere 2010 Survey**

To provide a first indication of where to start the journey and which direction to take on a global roadmap for natural refrigerants a survey was conducted involving around 200 participants and other stakeholders from 30 different countries prior to the event. It identified perceived and/or actual barriers to and solutions for the wider uptake of carbon dioxide, ammonia and hydrocarbons in heating, air-conditioning and refrigeration applications. When asked to rank seven types of barriers in terms of significance, 32% of respondents stated "Safety & Technology" as the most important barrier to the uptake of natural refrigerants, while 18% stated "Legislation" and 12% "Markets & Marketing". When weighing the single barriers in terms of their overall importance among the seven categories, "Safety & Technology" and "Legislation" remained at the top of the ranking, this time followed by "Training & Know-How" and "Supply & Availability". However, the most important message to be taken home from this survey is that not a single barrier impedes the use of natural refrigerants but that a variety of challenges are being faced, depending on the country, its policy and most importantly its situation as regards the phase out of ozone-depleting and/or high global warming refrigerants.



### Barriers & Solutions – Detailed Overview

The following listing was compiled following the moderated group discussions at ATMOsphere 2010. It includes main perceived and actual barriers for the market uptake of natural refrigerants in developed and developing countries. For each barrier several solutions were proposed that are likely to alleviate the barrier and/or completely remove it.

#### Technology & Safety



##### Barriers

Public safety concerns / Public perception / Misconceptions / Fear of high pressures and flammability / Accidents.

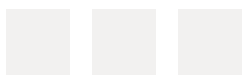
##### Solutions

- Compile safety guidelines, peer - reviewed and endorsed by authoritative bodies and translate these into local languages
- Accumulate and publicise actual evidence plus risk analysis information to show the technical nature of safety issues and the available solutions
- Influence refrigerant gas producers and contractors to encourage manufacturers to submit natural refrigerant equipment to standards and codes committees in order to develop safety standards and codes applicable to them
- Intensify campaigns / awareness raising with industry and policy makers
- Standardise refrigerant containers and their labeling to reduce the number of accidents due to mishandling of equipment
- Strengthen regulatory bodies to ensure refrigerant purity and have a quality system in place.
- Conduct government and industry sponsored studies
- Apply minimal refrigerant charge technologies
- Enhance safe and efficient operation by adding intelligence/electronics to systems
- Ensure third party testing / certification
- Ensure that there is no confusion between natural refrigerants and low-GWP chemical alternatives

##### *Best practices:*

- GTZ hydrocarbon safety handbook
- Demonstration projects where natural refrigerants have been used

#### Legislation & Standards



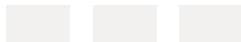
##### Barriers

Highly restrictive, prohibitive national and international standards / Lack of harmonisation of Regulations pertaining natural refrigerants between different locations within the same region / Manipulation of trade and safety standards for commercial ends.

### Solutions

- Base installation permissions on individual risk assessments
- Ensure participation of “pro-natural” stakeholders within the standardisation committees; as a first step “pro - natural” stakeholders would need to become members of their national association getting access also to international associations responsible for standards setting
- Review outdated safety standards to reflect the current safety capacities of equipment using natural refrigerants (e.g. review the 150g hydrocarbon refrigerant limit on the basis of sound science)
- Put in place rigorous control to prevent the manipulation of standards
- Remove regulations within a region that are redundant and not harmonised with the rest of the region ( e.g. harmonisation of standards on ammonia charge limits)

### Training & Know – How



### Barriers

Lack of knowledge by manufacturers, contractors, installers, consultants, servicing companies, policy makers, ozone officers and consultants / Lack of information and training material.

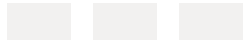
### Solutions

- Set up trial equipment in local training institutes and in-house training centres for hands - on training of technicians
- Provide government support for setting up new centres and extending existing training centres, as well as support of companies willing to train their personnel
- Revisit university and technical schools’ programmes to incorporate elements regarding natural refrigerants in the courses taken by young refrigeration engineers and technicians
- Form partnerships between manufacturers and design firms from countries that have a large number of natural refrigerant installations with companies in areas that do not have a large installation base
- Support mobile trainers reaching out to installers and maintenance staff in their work place (e.g. India mobile schemes)
- Train Ozone officers, technicians in the servicing sector and consultants developing HCFC phase-out management plans (HPMP) in developing countries
- Engage with the local HVAC&R industry associations
- Hold seminars and workshops on specific natural refrigerants and dedicated to specific stakeholder groups
- Disseminate technical information through respected authorities (e.g. local associations, national ozone units)
- Introduce certification schemes for technicians handling natural refrigerants

#### *Best practices:*

- NVKL natural refrigerants training centre in the Netherlands
- Colombia National Ozone Unit has included training for technicians using hydrocarbons in the domestic refrigeration sector
- In Gambia, refrigeration technicians have been trained for retrofitting, grouped into associations nation wide and were supplied with equipment and tools
- Natural refrigerant literature and marketing information on the internet ( [www.R744.com](http://www.R744.com) - [www.hydrocarbons21.com](http://www.hydrocarbons21.com) - [www.ammonia21.com](http://www.ammonia21.com) )
- NARECO<sub>2</sub> CO<sub>2</sub> handbook freely available at ( [www.irefrigeration.eu/nareco2/nareco2.html](http://www.irefrigeration.eu/nareco2/nareco2.html) )

### Markets & Marketing, Funding & Support



#### Barriers

Higher capital cost for natural refrigerant systems and servicing equipment due mainly to lower sales volumes, as well as for the setting up of production of systems.

#### Solutions

- Provide financial incentives for natural refrigerants : subsidies, HFC taxes, deposit schemes, reduced import / sales taxes for natural refrigerant technology
- Require the implementation of natural refrigerants for awarding green building certifications
- Create confidence in future market size and demand from end-users to allow for investment in manufacturing capacity
- Include heat recovery system in commercial refrigeration plants to allow for a quicker payback of the system
- System and component manufacturers to provide longer warranties, proving the reliability of the technology
- Gather clear/independent proof that installations can be operated/installed at the same (or less) cost and that the energy efficiency of those installations is similar (or better) than traditional technology.
- Raise awareness among end-users on environmental and energy benefits of natural refrigerant technologies
- In developing countries, implementing agencies to provide additional funds for facility conversions to natural refrigerants and raise awareness about such opportunities
- Require that part of the available funding under the Montreal Protocol to be dedicated to natural refrigerants
- Provide a mapping tool with possible funding sources worldwide
- Remove perverse incentives provided by the Kyoto Protocol Clean Development Mechanism for the destruction of HFC23 and redirect funds to natural refrigerant projects with real environmental value

#### *Best practices:*

- Norwegian deposit/refund scheme calculated on GWP value, with the refund disbursed for the quantity of HFCs that is delivered to an approved destruction facility
- Denmark's legislation and decision "to bite the bullet" and give ten years notice to industry before banning synthetics
- Requirement of low GWP refrigerant under the UK BREEAM or the US LEED scheme for awarding green building certifications
- The EIA campaign highlighting supermarket refrigeration issues
- 25% additional funding for investment projects in developing countries involving the introduction of low-GWP refrigerants under the Montreal Protocol

### Supply & Availability



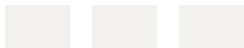
#### Barriers

Lack of local manufacturers of natural refrigerant components, systems and servicing equipment, combined with a fear of dependence on imports, particularly in developing countries / Unavailability of gases for manufacturers willing to explore natural refrigerants, while the process of importing can be very complicated (need approval from authorities) and time consuming.

### Solutions

- Exchange knowledge and internationally support the collaboration with local academics / experts to spread technical awareness
- Prompt international manufacturers to work with local players to make the components and systems available locally
- Get the interest of local industry associations
- Institutionalise the interest in natural refrigerants by informing young engineers and technicians
- Stimulate demand for natural refrigerant technologies by putting in place national incentives such as malus/bonus schemes
- Implement demonstration projects in countries with little experience with natural refrigerants, especially developing countries
- National authorities need to develop industry guidance on how to safely handle/transport/store refrigerants
- In developing countries, agencies to subsidise the cost of servicing equipment

### Psychology



### Barriers

Fear of change / Incurring higher costs / Safety risks / Commercial risks / Fear that the influence of fluorocarbon industry will be detrimental to natural refrigerant technology.

### Solutions

- Intensify awareness raising campaigns with industry, end - users, investors and policy makers through conferences and specialised trade shows
- Put together literature demonstrating the benefits of natural refrigerants and promote case studies
- Develop life cycle cost studies
- Put pressure on end-users from environmental NGOs
- Create a new association representing natural refrigerants
- Establish branding of “ecoproducts” so that buyers across borders recognise natural refrigerants
- Change product labeling to include GWP information
- Eradicate false environmental claims by competing technologies (e.g. misleading labels)

#### *Best practices:*

- UNEP case studies on natural refrigerants
- EIA campaign “Chilling facts” on UK supermarket refrigeration

HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

POLICY  
SESSION

DAY ONE

**Didier Coulomb,**  
International Institute  
of Refrigeration



**Rajendra Shende,**  
United Nations Environment  
Programme



**Philip Owen,**  
European Commission Directorate  
General Climate Action



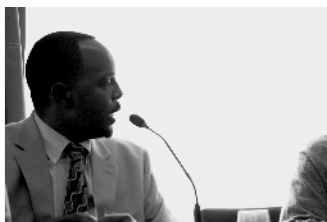
**Lambert Kuijpers,**  
Technical and Economic  
Assessment Panel of the Montreal  
Protocol



**Tonje Haabeth,**  
European Commission Directorate  
General Energy



**Julius Banks,**  
USA Environmental Protection  
Agency



**Janos Maté,**  
Greenpeace



**Didier Coulomb,**  
International Institute  
of Refrigeration

*The International Institute of Refrigeration (IIR) is responsible for promoting knowledge about refrigeration technology and all its applications. It aims at addressing today's major issues, including reduction of global warming and prevention of the ozone depletion. Natural refrigerants get right now the most hits in the IIR on-line database.*

The IIR underlined the need for the refrigeration, heating and cooling equipment to become more sustainable as its growth rate increases worldwide. The IIR has identified Europe and Japan as the most dynamic markets for natural refrigerants.

Three priority areas were suggested by the IIR for a sustainable cooling and heating sector:

- Reduce the energy consumption of the appliances.
- Reduce refrigerant charges & leakages of the cooling gases.
- Promote low-GWP and non-ODS refrigerants.

From the viewpoint of the IIR, natural refrigerants are faced with challenges that market operators and lawmakers need to address together. Firstly, natural refrigerants will have to compete with the next generation of HFCs, called HFOs. Secondly, the regulatory acceptance of hydrocarbon refrigeration in the USA will also determine their success in this major market. Thirdly, natural refrigerants need to win the battle in emerging countries where they can become available at competitive costs. In parallel, the industry of natural refrigerants has to continue drawing international attention to the potential of natural refrigerants and thus achieve funding for large-scale retrofits.

**Rajendra Shende,**  
United Nations Environment  
Programme

*The UNEP DTIE OzonAction Branch assists developing countries and countries with economies in transition to enable them to achieve and sustain compliance with the Montreal Protocol. With the programme's assistance, countries are able to make informed decisions about alternative technologies and ozone-friendly policies.*

Rajendra Shende explained to the ATMOsphere participants that the cooling and heating sector can be a major contributor towards a cool green economy. He emphasised that thanks to the Montreal Protocol, 197 countries have established a ban on HCFC within the next twenty years. UNEP is particularly proud that on the basis of scientific studies, climate change has also been delayed by a decade by the Montreal Protocol.

He presented to delegates his "MP 2.0" concept whereby the Montreal Protocol will become a climate mitigation treaty and will see its remit expanding to also address a ban on F-gases. In this context, the HFC phase-out proposals by the USA and island nations give a strong signal to the industry on the way forward.

UNEP is convinced that in order to bring natural refrigerants closer to end-users, more market awareness-raising will be necessary. This feeling was entirely shared by the audience who also called for the establishment of a natural refrigerants roadmap.

**Lambert Kuijpers,**  
Technical and Economic  
Assessment Panel of the Montreal  
Protocol

*The Technology and Economic Assessment Panel (TEAP) provides, at the request of Parties to the Montreal Protocol, technical information related to the alternative technologies that have been investigated and employed to make it possible to virtually eliminate the use of Ozone Depleting Substances. TEAP provides reports and documents produced by itself and its specific Technical Options Committees and Task Forces.*

TEAP is currently preparing reports related to the conversion from ozone depleting substances to alternatives with low global warming potential. The body will have an immense task to identify these substances for different product categories, bearing in mind that international Treaties have never defined high and low GWP substances. Alongside with this, TEAP will have to consider toxicity and flammability prior to suggesting conversion scenarios. A parameter that TEAP also underlines in order to promote environment friendlier heating and cooling technologies is the improvement of their design and overall energy consumption thereof.

**Philip Owen,**

European Commission Directorate  
General Climate Action

*The EU has adopted an integrated energy and climate change policy, including ambitious targets for 2020. It hopes to set Europe on the right track - towards a sustainable future with a low-carbon, energy-efficient economy - by:*

- *Cutting greenhouse gases by 20% (30% if an international agreement is reached)*
- *Reducing energy consumption by 20% through increased energy efficiency*
- *Meeting 20% of our energy needs from renewable sources*

*The Directorate General for Climate Action is responsible for implementing these policies.*

In the context of the review of the European F-gas Regulation, the European Commission explores what could be in it for natural refrigerants. Conscious about the increased share that synthetic refrigerants' emissions represent in the European market, the European Commission understands the need to encourage a greater use of natural refrigerants in the heating and cooling sector.

How could this be achieved? The European Commission representative suggested the following: By giving industry a long-term planning horizon, innovation can be encouraged and thus alternatives can be brought to the market. He reminded that the F-gas Regulation is a leading driver in reducing emissions and its overall effectiveness will need to be considered in the global context of the Montreal and Kyoto Protocols. This will be particularly challenging given the growing consumption of F-gases, especially in Asian countries.

**Tonje Haabeth,**

European Commission Directorate  
General Energy

*The issues and challenges connected to energy require action at European level; no single national government can address them successfully alone. By working in concert, European Union Member States and European industry develop energy sectors, which best meet the needs of citizens and economy, whilst minimising damage to the environment. The European Commission's Directorate General for Energy (DG Energy) manages work in this area.*

DG Energy has put in place key policies for the promotion of energy efficient products in the EU, namely the ecodesign & energy labeling Directives. The European Commission services realized recently that these policies can also serve to promote low GWP cooling gases in order to take into account the overall environmental impact of energy using products. The industry of natural refrigerants has a window of opportunity open to couple the energy efficiency of heating and cooling equipment with the environmentally-friendly credentials of ammonia, hydrocarbons and carbon dioxide.

**Julius Banks,**

USA Environmental Protection  
Agency

*The U.S. Environmental Protection Agency is an agency of the federal government of the United States charged with protecting human health and the environment, by writing and enforcing Regulations based on laws passed by Congress. The agency conducts environmental assessment, research and education. The agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.*

The EPA is the regulatory body responsible for bringing natural refrigerants to the USA, through the SNAP approval process, driven sector by sector. The following regulatory streams have allowed or are going to open up the market for natural refrigerants:

- Hydrocarbons in household refrigerators and freezers and food retail refrigeration (ongoing)
- CO<sub>2</sub> for supermarket applications
- Industrial refrigeration relying on ammonia

One needs to remember that submissions for the approval of a refrigerant gas in a given application can be introduced with the EPA by all stakeholders - academics, manufacturers and end-users. The EPA does not solicit submissions, it is therefore up to the natural refrigerants industry to request an approval in order for a cooling gas to find its way into the USA market and in other words, to match the USA law with reality.



**Janos Maté,**  
Greenpeace

*Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace. Greenpeace has recently published a report titled "HFCs: A growing threat to the climate - The worst greenhouse gases you've never heard of..."*

The plea of Greenpeace is that where ozone-depleting substances are banned, these should not be replaced by global warming gases. This will be the only way to offset the climate emergency that mankind is facing. The Greenpeace Cool Technologies annual report provides with an update of companies working without HFCs - in almost all industry sectors there are HFC-free alternatives already available. Industry players can therefore be confident that natural refrigerants are a long-term solution.

*"We can end the fluorocarbon era. We can start right now."*

Greenpeace reminded the success story it has built around Greenfreeze - the hydrocarbon domestic refrigerators since 1993. Greenpeace also praised the food industry players that are going HFC-free: Coca Cola, Unilever and Pepsi. In car air conditioning, Greenpeace encourages the conversion of R22 systems to propane and reminded that 7 million cars in the world today run with hydrocarbon air conditioning. Regulations worldwide need to follow suit as currently there are in the world many laws that reflect old technologies and impede progress.

The final plea of Greenpeace is that the developed countries help developing countries to leapfrog global warming gases. This will only be possible if the developing world shows the example and all nations agree on mutual but differentiated responsibilities.

## DAY TWO

**Si Menad Si Ahmed,**  
United Nations Industrial  
Development Organisation



**Ryoichi Yamamoto,**  
Senior Advisor to the Japanese  
Government



**Nidia Pabon Tello,**  
Colombia National Ozone Unit



**Javier Camargo,**  
Multilateral Fund of the  
Montreal Protocol



**Theodoros Skylakakis,**  
Member of the European  
Parliament



**Satu Hassi,**  
Member of the European  
Parliament



**Si Menad Si Ahmed,**  
United Nations Industrial  
Development Organisation

*UNIDO has a unique mandate in the UN system to support sustainable industrialisation. As such, industrialisation without the transfer of environmentally sound technologies has an adverse impact on climate change; thus, to be sustainable, UNIDO advocates the need for large-scale technical assistance and transfer of clean energy technologies and know how.*

UNIDO has been promoting natural refrigerants with its various industrial partners for the past sixteen years. Despite many safety hurdles that the organisation had to overcome, especially in African countries, UNIDO is confident that these have now been dealt with. The introduction of isobutene refrigerators in Egypt, Nigeria and China also indicated progress in the safe handling of natural refrigerants.

Natural refrigerants is not only about technology and safety, it is also about policy that needs to encourage sustainable investments. During ATMOsphere, it was reported that sometimes the industry is willing to engage, but governments do not commit, do not standardise and hence prevent established industry practices from evolving. Right now, time is of essence - for Parties to comply with the Montreal Protocol, they need appropriate resources and funding in a timely manner. The danger of running out of funding, is to opt for HFCs as a temporary solution.

**Ryoichi Yamamoto,**  
Senior Advisor to the Japanese  
Government

*Ryoichi Yamamoto is a professor at the Institute of Industrial Science in Tokyo. Since 2004, he has been a science advisor at the Ministry of Education, Culture, Sports, Science and Technology. Mr Yamamoto is also an honorary chairman of Eco Material Society, Chairman of International Green Purchasing Network as well as Chairman at The Centre for Sustainable Design.*

Professor underlined the importance of the environmental crisis we are facing now and reminded that Japan has committed to a substantial carbon emissions reduction: 25% less emissions by 2020. To promote sustainable heating and cooling equipment, Japan is organising trade fairs on eco-friendly products and an eco-friendly products directory has been compiled to allow buyers to make informed choices. The directory refers in its 2010 edition to the "Natural Five" heating and cooling appliances manufactured by Mayekawa that use natural refrigerants only: carbon dioxide, ammonia, hydrocarbons, water and air. Professor Yamamoto also emphasised the importance of certification and mentioned as examples in Japan the MBCD Cradle to Cradle certification that assesses a product's safety for humans and the environment and provides with guidelines to help business operators to implement the cradle-to-cradle approach. To answer the question "How to bring natural refrigerants faster to market", Professor Yamamoto stated six examples:

- Implement green procurement and green-purchasing laws.
- Promote energy efficient products that rely on natural refrigerants on the basis of eco-design regulations.
- Tax carbon emissions of the heating and cooling equipment.
- Disseminate information through the eco-friendly products exhibitions.
- Promote eco-innovation further.
- Certify domestic refrigerators using natural refrigerants only.

**Nidia Pabon Tello,**  
Colombia National Ozone Unit

*Nidia Pabon has been working at the National Ozone Unit at the Ministry of Environment, Housing and Territorial Development of Colombia since 2003. She has been responsible for the control of trade of ozone depleting substances (ODS), the design of the different measures for the legal framework for the implementation of the CFC phase-out plan and the technical assistance for the disposal of unwanted ODS and equipment with CFC.*

Colombia is currently drafting its national HCFC phase-out management plan that will be submitted to the executive committee of the Multilateral Fund of the Montreal Protocol in November 2010 for approval and funding. To this end, Colombia has designed a strategy to achieve a complete HCFCs phase-out by 2025

with half way reductions in HCFCs consumption of 60% in 2015 and 85% in 2020. In the search for possible substitutes for HCFCs, which can be implemented as long term solutions by end-users, Colombia considers the possibility of carrying out at least two demonstration projects on the replacement of HCFCs by natural refrigerants in one of the end-user sectors with the highest installed loads of HCFC-22 – like shopping centres, supermarkets or hotels. Colombia will also implement hydrocarbons in domestic refrigerators.

The following barriers to natural refrigerants have been identified in Colombia:

- Training & Know-how (engineers education/certification, technical data, meetings, information campaigns)
- Technology & Safety (technical challenges, safety issues)
- Funding & Support (CDM/JI mechanisms, grants, subsidies, tax credits, direct investment)
- Supply & Availability (materials, equipment, components, fluids)
- Markets & Marketing (advertising, competition by chemical refrigerants)

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**Javier Camargo,**

Multilateral Fund of the Montreal Protocol

*The main objective of the Multilateral Fund is to assist developing country parties to the Montreal Protocol to comply with the control measures of the Protocol. The Fund is managed by an Executive Committee assisted by the Fund Secretariat.*

The Montreal Protocol is a universal ozone protection Treaty that offers dual benefits – both for ozone layer protection and the climate. 98% of ozone depleting substances (ODS) have been phased out and the reduction of ozone damaging substances expressed in CO<sub>2</sub>- equivalent emissions represents about 10 gigatonnes per year. The funding provided by the MLF covers only the incremental costs incurred in converting systems to non-ODS technologies. As of July 2010 contributions of the MLF amount to 2.7 billion dollars. The funding by the MLF is based on a country - driven approach, not individual projects. It is therefore important that national administrations increase their focus on natural refrigerants in order for them to be taken into account by the MLF funding. This is all the more relevant because financial and technical assistance by the MLF must be cost-effective and based on environmentally sound alternative technologies or substitutes. The MLF also reminded that projects such as institutional strengthening, technical assistance and network activities are also funded under its remit.

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**Theodoros Skylakakis,**

Member of the European Parliament

*Theodoros Skylakakis is a member of the European Parliament and sits in the Environment, Public Health and Food Safety Committee.*

MEP Theodoros Skylakakis (EPP, Greece) expressed his opposition to the continuation of huge windfall profits in the United Nations Carbon Market HFC-23 projects, which are paid by the European taxpayers and severely distort the international market, at the expense of innovative natural refrigerants. Since July 2010 MEP Skylakakis has been alerting the public opinion about the fact that European consumers are paying an immense amount of money for the destruction of HFC-23. At the same time, HFC-23 in the atmosphere is increasing instead of decreasing.

HFC-23 is a 'super' global warming gas and an unwanted by-product of manufacturing the refrigerant gas HCFC-22. The HFC-23 projects of the UN Clean Development Mechanism (CDM) financially reward the destruction of HFC-23. However as the CDM pays an estimated 65-75 times more for the destruction of HFC-23 than it actually costs, the destruction of HFC-23 becomes more profitable than the production of HCFC-22. Based on current prices in the European market of around 12 €, the Certified Emissions Reductions gained from the destruction of HFC-23 will, in 2012, be worth € 5 billion, whereas the actual value of destruction is just euros € 80 million.

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During ATMOsphere 2010 policy makers and business representatives were reminded that for the purposes of the CDM credits, the natural refrigerants business is totally fit for purpose. Hydrocarbons, ammonia and carbon dioxide used as a refrigerant can make the perfect match for both a green and profitable investment.

*“This is the most potent GHG and I don’t understand why we don’t ban it. Sometimes in life, we can make a very good net that can catch a fly, but an elephant passes unnoticed”*

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**Satu Hassi,**  
Member of the European  
Parliament

*Satu Hassi was Member of the Finnish Parliament for 13 years, since 1991, until her election to the European Parliament in June 2004. In July 2004 Mrs. Hassi was elected Vice-Chair of the Committee on the Environment, Public Health and Food Safety in the European Parliament. She has been the Coordinator of The Greens in the Environment Committee of the European Parliament since 2009.*

In most cases the European Parliament has been the driving force in the European machinery on climate protection. With climate change at our doorstep, it becomes urgent to act on the important carbon emissions source that represents the heating and cooling sector. *“Our children will ask us: Why didn’t you do anything against HFCs, while you knew how damaging they were?”*

Europe must be firm about legislation that has been adopted, such as the MAC Directive that puts a cap on the GWP of refrigerants used in car air conditioners as of 2011. Europe must also be ambitious with legislation that is going to be adopted. The GWP of refrigeration gases can for example be taken into account under the EU eco-design Directive. In the past some companies tried to use their economic weight to boycott European legislation, but subsequently found themselves in a difficult situation. Lobbying policy makers and demonstrating to them that there are environmentally friendly alternatives is desirable.

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HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

EDUCATION  
SESSION

Armin Hafner,  
SINTEF



Mart Peeman,  
Dutch Refrigeration &  
Air-Conditioning Association  
(NVKL)



Daniel Colbourne,  
German Organisation for Technical  
Cooperation (GTZ)



Katja Becken,  
German Federal Environment Agency  
(UBA)



Monika Witt,  
eurammon



Armin Hafner,  
SINTEF

*SINTEF is the largest independent research organisation in Scandinavia. Its Energy Research department offers solutions and services for CO<sub>2</sub> Technology in refrigeration, mobile air conditioning, and heat pump systems.*

There are many different tools for quantifying the environmental impact of refrigeration / heat pumping systems (TEWI, LCA, EIA, LCCP). What is of great importance is that these tools are transparent in terms of the equations and the data used in the calculations so that they accurately reflect the properties of natural refrigerants.

Mart Peeman,  
Dutch Refrigeration &  
Air-Conditioning Association  
(NVKL)

*NVKL is the Dutch association for companies active in refrigeration and air-conditioning encompassing 500 member contractors and suppliers. It has founded the first European training centre for natural refrigerants.*

Natural refrigerants need much higher level of knowledge. In the Netherlands, less than 10% of contractors are equipped. Hence, education is the highest priority in the uptake of natural refrigerant technology. To this end, NVKL has developed three education modules pertaining to natural refrigerants, including a module aiming to grow interest and knowledge on natural refrigerants, a module providing theoretical knowledge on system design and safety, as well as a module encompassing practical exercises on CO<sub>2</sub>, NH<sub>3</sub> and propane systems in operation as well as training and learning on environmental safety.

The centre is equipped with a training unit that consists of:

- NH<sub>3</sub>/CO<sub>2</sub> cascade system, capacity 50 kW
- NH<sub>3</sub> pump system with cold room
- Flooded NH<sub>3</sub>/CO<sub>2</sub> cascade condenser
- CO<sub>2</sub> pump system with a cabinet for CO<sub>2</sub> as coolant
- CO<sub>2</sub> compressor system at -350/-80C freezing room at -300C
- Emergency cooling system with propane

Daniel Colbourne,  
German Organisation for Technical  
Cooperation (GTZ)

*GTZ Proklima has been working on reducing and subsequent phasing-out of ozone depleting substances in developing countries. It advises governments on drafting local Regulations and setting policies to comply with all international environmental agreements, assists companies in replacing ozone depleting technologies with environmentally friendly and economically attractive alternatives. GTZ has recently released a set of Guidelines for the safe use of hydrocarbons.*

Much of the information relating to the safe use of hydrocarbons is widely dispersed or difficult to find, hence why GTZ Proklima has coauthored with TÜV Süd a handbook for engineers, technicians, trainers and policy makers on the safe use of hydrocarbon refrigerants for climate - friendly cooling.

Technicians, manufacturers, suppliers, consultants and end users, use safety issues as an “excuse” to not use hydrocarbons, an excuse that the handbook aims at addressing and eliminating. The purpose of the handbook is to provide stakeholders with comprehensive information on using hydrocarbons safely.

When putting together such handbooks, it is important to:

- Demonstrate that all the information is “there”
- Ingrain knowledge in technicians, enterprises, etc.
- Show how to think more broadly, long term, integrate safety concept into all activities
- Provide information in different languages (handbook to be translated into Chinese and possibly in Spanish, Russian etc)

**Katja Becken,**

German Federal Environment  
Agency (UBA)

*The UBA is the Germany central federal authority on environmental matters. Its mandates is to provide scientific support to the Federal Government, implement environmental laws and provide the public with Information about environmental protection.*

The UBA has concluded from studies that halocarbon free refrigerants can be used in most applications, providing a great opportunity to reduce carbon emissions. Additional measures are necessary to push the market for natural refrigerants including the circulation of information and training.

Existing barriers to natural refrigerants include the lack of knowledge, higher investment costs, concerns regarding safety risks, restrictive legislation and standards and inadequate education of technicians. Solutions to these barriers include the provision of information to policy makers and users among others, establishing improved comparative tools, focusing on life cycle cost, reducing costs, providing financial support and incentives, providing information on safety and developing technical solutions, as well as changing the content of teaching, supporting retraining and establishing training centres.

However, HFCs will soon not be called HFCs anymore, but low GWP alternatives. The promotion of "low" GWP refrigerants as environmentally sound refrigerants is a potential future barrier to natural refrigerants. The natural refrigerants industry will need to avoid confusion between them and the new generation of low GWP synthetic refrigerants.

**Monika Witt,**

eurammon

*eurammon is a joint initiative by companies, institutions and individuals committed to increasing the use of natural refrigerants.*

With the bi-annual Natural Refrigeration Award, eurammon provides encouragement to young scientists working on sustainable refrigeration and air conditioning by recognising the best scientific thesis in the field of natural refrigerants. In 2010 the third edition of the eurammon award took place.

The following actions are recommended by eurammon to remove barriers to natural refrigerants:

- Provide information regarding advantages and challenges to natural refrigerant technologies
- Develop innovative products by ongoing research
- Undertake excellent training for installers and operators

HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

# RETAILERS' SESSION

**Philippe Delpech,**  
Carrier Commercial  
Refrigeration



**Paul Rowsome,**  
Carrefour



**Rene van Gerwen,**  
Unilever



**Andrea Voigt,**  
European Partnership for Energy and  
the Environment (EPEE)



**Christoph Brouwers,**  
Carrier Commercial Refrigeration



**Jürgen Süß,**  
Danfoss





*The 1973 crisis can be considered as the milestone when developed economies' growth engines switched from energy-intensive industries to more knowledge-based and high-tech industries. Similarly, the 2008 crisis may be considered in the future as a key moment for green technologies development that gave us the opportunity to establish CO<sub>2</sub> technology as an efficient and environmentally friendly solution in refrigeration.*

*When you know, according to the UK's Environmental Investigation Agency, that the annual chemical leaks of the UK Food Retail industry alone is equivalent to the CO<sub>2</sub> emissions of 400,000 return flights between London and Sydney, then you realize that things have to change! Technology is today available to eliminate CO<sub>2</sub> emissions due to refrigerant leaks. We only need to speed up implementation.*

**Philippe Delpech**

Philippe Delpech is President of Carrier Commercial Refrigeration.

Carrier is the world's leader in high technology heating, air-conditioning and refrigeration solutions and experts provide sustainable solutions, integrating energy efficient products, building controls and energy services for residential, commercial, retail, transport and foodservice customers.

Paul Rowsome,  
Carrefour

*Carrefour is the world's second-largest retailer and the largest in Europe. It has over 15,500 stores, either company-operated or franchises. It operates in three major markets: Europe, Latin America and Asia and has a presence in 34 countries.*

Carrefour has set the target of limiting emissions of its operations by 30% by 2020 compared to 2002. More than 40% of emissions comes from refrigerant leaks, while in countries with low carbon electricity generation such as France, leakages may account for 70% of total emissions.

The group has so far piloted 14 stores with CO<sub>2</sub> cascade refrigeration systems and has adopted a policy of implementing CO<sub>2</sub> technology to all new frozen cooling systems. In warmer climates, CO<sub>2</sub> does not seem to be a good solution for positive cooling temperatures and for this purpose Carrefour has implemented two indirect systems with water. For freezing purposes, however, CO<sub>2</sub> works well also in warmer climates. Natural refrigerants need to also be considered when in view of the roof top systems for the air-conditioning of stores, even if air-conditioning accounts for less carbon emissions compared to refrigeration.

An area where a lot needs to be done to allow for a wider adoption of natural refrigerants is the training of the technicians carrying out the servicing and maintenance of the retail refrigeration systems in the longer term. The retail sector needs to rely on qualified personnel to ensure an adequate maintenance at manageable cost.

Rene van Gerwen,  
Unilever

*Unilever brings together 400 brands of home, personal care and food products. It is a global market leader in ice cream. Since 2003, it has been working with Greenpeace, UNEP and other multinational FMCG companies under the Refrigerants, Naturally! initiative to promote refrigeration technologies for point-of-sales equipment that avoid the use of climate-damaging HFCs.*

Unilever aims to double its size while reducing its environmental impact. In refrigeration, the two priority areas include ice cream cabinets and industrial refrigeration plants. Regarding the first, 20-40 % of the total global warming impact of the company's ice cream supply chain is related to cabinets. To reduce its impact Unilever will roll out about 500,000 hydrocarbon ice cream cabinets by the end of 2010.

Barriers to the widespread use of hydrocarbons for small commercial equipment include:

- **Availability**  
In certain regions it is difficult to obtain hydrocarbon gases
- **Service and Maintenance**  
The lack of qualified service and maintenance personnel
- **Legal restrictions**  
In countries like the US, the use of hydrocarbons is restricted. Several international standards restrict hydrocarbon charge quantity in cabinets up to 150g

Ammonia is the refrigerant of choice in almost all process refrigeration plants & cold stores of Unilever in its 80+ sites with large industrial refrigeration (1/3 in Asia/Africa, 1/3 in Europe, 1/3 in Americas).

Barriers to the widespread use of ammonia for industrial refrigeration equipment include the lack of standard equipment and associated higher costs, the lack of competent companies / personnel in many countries for the design, installation and maintenance of systems and inadequate technical & safety standards or unnecessary stringent legal restrictions. To overcome these, vocational training and certification on a national/regional basis need to be initiated and improved. Active involvement in international standardisation bodies and committees is also needed.

**Andrea Voigt,**

European Partnership for Energy and the Environment (EPEE)

*EPEE is an HVACR industry association supporting the promotion of energy efficiency and the freedom of refrigerant choice.*

EPPE has carried out an eco-efficiency study to evaluate and compare case by case the current and future relative performance and impact of refrigeration technologies in terms of both financial and environmental impact on a global life cycle basis. CO<sub>2</sub> technology has been found to perform best at ambient temperatures < 15°C. Other means of tackling direct emissions are through making systems tight, using low GWP refrigerants that are already available and adopting a case by case approach to decide which refrigerant is best.

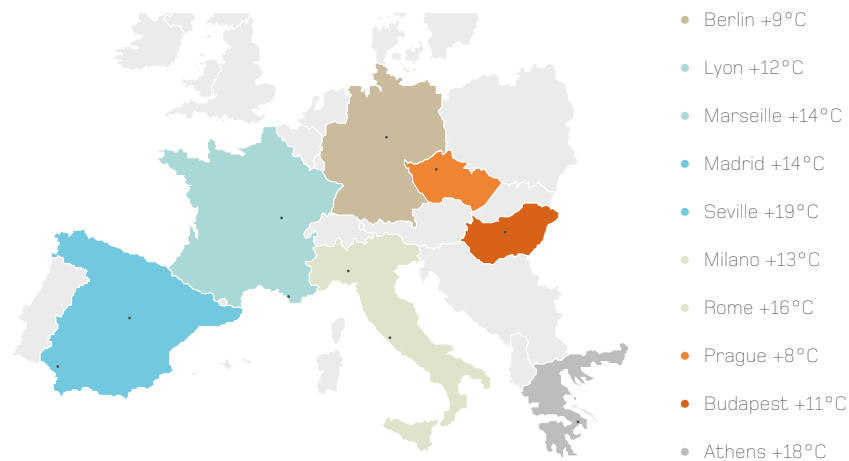
Currently, CO<sub>2</sub> systems encompass an environmental advantage compared to HFC systems studied but also a financial disadvantage. However, system efficiency improvements with the expected maturity of CO<sub>2</sub> technology will bring CO<sub>2</sub> technology on par with HFC based systems in terms of costs within the next three to five years.

**Christoph Brouwers,**

Carrier Commercial Refrigeration

*Carrier is the world's largest provider of heating, ventilation, air-conditioning and refrigeration solutions. As of September 2010, the company had 150 direct expansion CO<sub>2</sub> transcritical (CO<sub>2</sub>OLtec) commercial refrigeration systems in operation.*

Carrier's transcritical CO<sub>2</sub> retail refrigeration solution (CO<sub>2</sub>OLtec) is attractive in terms of energy performance at average annual ambient temperatures up to +15 °C. In other words, in Europe CO<sub>2</sub> in commercial refrigeration is an attractive solution for mild and cooler climates as locations north of Marseille in France. Indeed, energy performance comparisons between CO<sub>2</sub> and advanced HFC commercial refrigeration installations by a German retailer have revealed equal performance of the different systems. This brings us to the question of "Why to move to CO<sub>2</sub> as refrigerant?" in retail refrigeration. Because, carbon dioxide as a refrigerant has the most attractive minimal global warming potential, which leads to the best total equivalent warming impact (TEWI) performance compared to any other alternative available today.

**Jürgen Süß,**

Danfoss

*The Refrigeration and Air Conditioning division of the Danfoss group is specialised in automatic controls, compressors, electronic sensors and valves including for the use of natural refrigerants.*

To push for natural refrigerants Danfoss suggests doing the following:

- Liability:**
- Eliminate liability barriers in a responsible way
- Technology:**
- Apply minimal refrigerant charge technologies
  - Set highest system efficiency standard based on technologies using natural refrigerants
  - Enhance safe (and efficient) operation by adding intelligence / electronics to systems

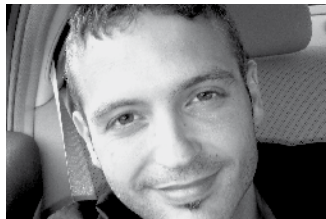
HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

# REFRIGERATION WORKSHOP

Volkmar Hasse,  
German Organisation for Technical  
Cooperation (GTZ)



Giacomo Pisano,  
Dorin



Luca Costantini,  
BLUPURA



Raphael Gerber,  
Frigo-Consulting



**Volkmar Hasse,**

German Organisation for Technical  
Cooperation (GTZ)

*GTZ Proklima has been working on reducing and subsequent phasing-out of ozone depleting substances in developing countries. It advises governments on drafting local Regulations and setting policies to comply with all international environmental agreements, assists companies in replacing ozone depleting technologies with environmentally friendly and economically attractive alternatives and supports vocational training.*

GTZ Proklima has worked to gather reliable information on the cost of converting to hydrocarbon refrigerants and the associated CO<sub>2</sub>-eq cost-effectiveness through analysing costs of demonstration projects already carried out. The costs associated with the change of refrigerant comprise three aspects, including investment costs (product development, production line, internal training), product costs (materials, safety devices) and in-use cost (energy consumption, refrigerant, technician tooling), with the latter one representing less than 1% of total costs.

The study was concerned with two different types of products, namely room air conditioners and stand-alone commercial refrigeration. The average investment cost per unit has been estimated at \$13 for room air conditioners and \$11 for stand alone commercial refrigeration. Product costs has been estimated at +\$4/unit for converting air conditioners from R22 to R290 (propane) and at -\$29/unit for converting air conditioners from R410A to R290. For stand-alone commercial refrigeration product costs have been estimated at +\$6/unit when converting from R134a to R290 and at +\$1/unit when converting from R404A to R290. Overall, shifting to hydrocarbons has been found to provide excellent cost-effective emissions reduction.

It is thus surprising that hydrocarbons have not been taken up more widely though this is anticipated to change. Already GREE Electrical Appliances Inc. (China) is getting ready to produce state of the art R290 split air conditioners. Actions that could help bringing natural refrigerants faster to market include accumulating and publicising economic evidence on the advantages of producing hydrocarbon equipment as well as risk analysis information showing the technical nature of safety issues and available solutions.

**Giacomo Pisano,**

Dorin

*Dorin entered the field of refrigeration in 1932 with its first open-drive compressor range. The first CO<sub>2</sub> transcritical type was commissioned in 1999. Today, Dorin produces more than 70,000 compressors per year.*

Carbon dioxide is nowadays considered one of the most viable alternatives to HFC refrigerants in the RAC industry. The reduction of capital and running costs of systems is one of the main ways forward in bringing CO<sub>2</sub> technology faster to market. To this end Dorin has developed a new range of CO<sub>2</sub> compressors covering all retail applications from small cold rooms to super- and hypermarkets.

Some barriers to natural refrigerants that need to be overcome include poor component industrialisation that implies higher capital cost and poor training of commissioning and service engineers. Means to overcome these barriers include educational campaigns, increasing the number of training centres and putting in place governmental incentives that would allow for bigger volumes to be generated, effective product industrialisation to be reached and thus system capital cost to decrease.

**Luca Costantini,**

BLUPURA

*BLUPURA is an Italian manufacturer of high quality and high design drinking watercoolers. It is the first watercooler manufacturer in the world to use compressors with natural refrigerant gases (R290) with zero impact on global warming.*

The company follows a real eco-friendly philosophy: the cold water produced by their watercoolers is not only a cheap, efficient and safe alternative to bottled water, but Blupura is also the first watercooler manufacturer in the world to use compressors with natural refrigerant gases (HC – R290) with zero impact on global warming. The watercoolers are ideal for anywhere there is a need for large volumes of cold water (e.g. restaurants, hotels, schools, hospitals).

By the end of 2010 the company expects to have supplied approx. 1.000 R290 watercoolers, exporting 75% outside Italy and mainly to Germany, Denmark, Norway and Holland, but also to South Africa and Australia. The watercoolers have received certification from INTERTEK, a worldwide group of testing laboratories for a number of industries and the world's largest testing, inspection and certification company.

Raphael Gerber,  
Frigo-Consulting

*Frigo-Consulting AG is mainly active in the field of commercial and industrial refrigeration systems with focus on sustainable engineering and subcritical and transcritical R744 systems.*

Looking back at more than 10 years of experience with CO<sub>2</sub> as a refrigerant and more than 20 years of experience in supermarket refrigeration Frigo-Consulting strongly believes that CO<sub>2</sub> is a very good solution in commercial refrigeration. Today, in Switzerland there are around 300 subcritical CO<sub>2</sub> and 100 transcritical CO<sub>2</sub> installations running. The industry has moved on from doing basic engineering to gathering lots of experience from the field and optimising the technology.

Although a rediscovered technology, CO<sub>2</sub> has the potential of a young technology; there is lots of space for innovations and potential for the technology and the market. To give an example of the progress of components, CO<sub>2</sub> compressors by Dorin have improved in efficiency significantly. Some examples of how to improve the efficiency of transcritical systems at the core (just looking at the refrigeration pack) include:

- Adiabatic or wet heat rejection (water spray)
- Multiple expansion and compression (flash-tank, parallel compression)
- Work extracting expansion (ejector, expander)
- Subcooling the liquid CO<sub>2</sub>
- Clever controls
- Heat transfer (microchannels)

To bring natural refrigerants faster to market:

- Find partners: many of the innovations have only been possible because different parties committed to step forward. Sometimes it needs a bit of time to establish good relationships, but it pays off
- Go green: examine the ratio between life cycle cost and ecological benefit. The company has found this tool very helpful to assess whether CO<sub>2</sub> is actually the best choice in a specific application
- Do not underestimate technical solutions
- Think long term: even if the operators start to realise the importance of energy efficiency
- Show advantages: Information is essential, as sometimes customers just don't know the advantages

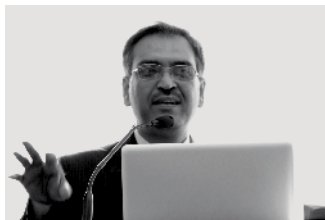
HOW TO BRING  
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# INDIA SESSION

**Rajendra Shende,**  
United Nations Environment  
Programme (UNEP)



**Anshu Kumar,**  
Anadi Environment Training  
& Consultancy



**Souvik Bhattacharyya,**  
Indian Institute of Technology,  
Kharagpur



**Philippe de Rougemont,**  
Noé 21



**Rajendra Shende,**  
United Nations Environment  
Programme (UNEP)

*UNEP provides leadership and encourages partnership in caring for the environment by inspiring, informing and enabling nations and peoples to improve their quality of life without compromising that of future generations.*

Chaired by Rajendra Shende, the panel concluded that India would be ready to decisively act if the right framework conditions would be provided. Several industry initiatives and publicly funded projects have already been put into place to address the rising greenhouse gas emissions from the heating, cooling and refrigeration sectors. Examples include the global commitment by The Coca-Cola Company to only use CO<sub>2</sub> as a natural refrigerant in vending machines and similar targets by Pepsi Co. to focus on hydrocarbons or CO<sub>2</sub> in this equipment for certain countries. At the same time the Jump Start programme, initiated by the European Commission in cooperation with UNEP, started a series of awareness-raising campaigns and workshops in India to draw attention to the "low GWP stimulus" and the timely introduction of sustainable HVAC&R solutions.

The panel emphasized that refrigerant decisions would need to be made based on informed choices despite the pressure of time. Although changing the mindset of Indians would not be difficult when based on convincing arguments in favour of sustainable refrigerants, Shende urged involved parties to ensure these arguments would be long-lasting ones, warning against another change of course in the future.

**Anshu Kumar,**  
Anadi Environment Training  
& Consultancy

*Anshu Kumar is involved in Ozone saving activities in India. He has trained over 3000 RAC technicians in the Northern part of India for good service practices and the adoption of new refrigerants. As a trainer, he has also coached more than 4500 sales person to save energy by adopting Star Label for products like refrigerators & air - conditioners.*

Anshu Kumar – working closely with UNDP, UNEP, UNICEF and GTZ on training initiatives – stressed the essential role of training for the adoption of more sustainable refrigerant solutions in India, especially of natural refrigerants. Flexible and hands-on training courses have enabled engineers in the HVAC&R servicing sector to apply good practices in handling natural refrigerants and to cope with new demands of handling refrigerants and retrofit. The supply shortage of natural refrigerants in India, the low price of competing HFCs, inappropriate local refilling practices, a low confidence level of local servicing businesses, missing standard tools and equipments, and the lack of feedback after two or three months of implementation are some of the major obstacles the Indian servicing industry is currently facing.

Solutions to some of these shortcomings can be found in the following measures:

- Online training schemes and better training material as regards the properties, handling and storage of natural refrigerants; training videos showing good servicing practices; circulation of free magazines to RAC engineers and local associations.
- Mobile training schemes with trainers travelling to the servicing garages and providing on-site training for technicians.
- Updated vocational, NVQ & TE curricula; implementing more effective training of trainers schemes; upgrade refrigeration engineers training centres.
- Awards and visibility for technicians adopting good servicing practices; official accreditation and certification of technicians having undertaken a two days intensive training course about real-life installation and maintenance of natural refrigerants equipment.

**Souvik Bhattacharyya,**  
Indian Institute of Technology,  
Kharagpur

*Souvik Bhattacharyya's current research interests are heat transfer enhancement, thermodynamic optimisation, natural refrigerants and natural circulation loops. Fellow of the Indian National Academy of Engineering, he is also a member of the Section Committee of the Academy and is an expert member on the department of Science of Technology, Fast Track Project Committee.*

Bhattacharyya introduced the audience to research initiatives focused on natural refrigerants at the Indian Institute of Technology, Kharagpur. Started in 2003, 32 research papers on natural refrigerants for simultaneous heating and cooling have so far been published in the International Journal of Refrigeration. However, penetration of natural refrigerants remains low in India. A survey conducted by Bhattacharyya among consultants, experts and researchers from India's leading Institutes of Technology,



as well as industry players, provided an optimistic outlook. All respondents were aware of the fact that India would need to switch to natural refrigerants and 72% agreed that India would need to leap frog over the use of HFCs directly to natural refrigerants. A large majority (81%) even knew that solutions already existed and 62% believed that CO<sub>2</sub>-based supermarket systems could become a reality in India. Asked for specific barriers, respondents ranked refrigeration and safety engineering highest, followed by supply and availability of components and systems and commercial reasons (investment, profit, financial incentives). Regulatory and market barriers were not considered as important as in other, mostly industrialised countries. Greatest potential can be found in the hotel industry and supermarkets, with the latter for now being only a small market in India where family-owned small fresh food stores would still hold the largest market share. However, air-conditioning in stores and cascade ammonia-CO<sub>2</sub> refrigeration systems could promise a higher market penetration provided that global consumer brands would implement their natural refrigerant strategies in all world markets, including India. Bhattacharyya proposed the following tools to accelerate the use of natural refrigerants:

- Demonstration projects by UN agencies and global suppliers.
- Awareness-raising campaigns among academics and the wider public.
- Introduce natural refrigeration content in universities' syllabus.
- Support from government by introducing direct incentives for green refrigeration.

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Philippe de Rougemont,  
Noé 21

*Noé21 is an independent non-governmental organisation founded in 2003 and based in Geneva, whose mission is to identify, evaluate and promote solutions to climate change, with a constructive approach.*

The new chapter of the Noé21 F-gas campaign will focus on India to promote the uptake of fluorocarbon-free cooling technologies by supermarket chains. The project, currently in the planning stage, will closely follow the concept of the "Chilling Facts" campaign initiated by the Environmental Investigation Agency (EIA) in the UK to monitor and publicise the commitment and failure of food retailers to phase out F-gases in their cooling and refrigeration equipment. To help the process of changing perceptions and implementing change in the Indian food retail market, Noé21 called on ATMOsphere 2010 participants to work closely with them and indicate successful installations that have already demonstrated their efficiency and reliability at ambient temperatures of more than 30°C over several consecutive days per year.

HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

# HEAT PUMPS WORKSHOP

Alexander Cohn Pachai,  
Johnson Controls



Kenneth Hoffmann,  
Star Refrigeration



Merle Rocke,  
EcoThermics Corporation



Alexander Cohr Pachai,  
Johnson Controls

*Johnson Controls is one of the leading companies of refrigeration and chiller solutions based on natural refrigerants. Ammonia heat pumps are one of the natural refrigerant-based products of JCI.*

Heat pumps can be used for several applications, such as hot water production for cleaning and heating within the food industry, condenser heat reclaim from refrigeration systems, drying processes etc. When using ammonia as a refrigerant, single-stage large capacity heat pumps can convert waste heat of 20 to 40°C and supply hot water up to 65-70°C. Two stage ammonia heat pumps can on the other hand be used for heating and air conditioning purposes in applications where both heating and cooling are required. The combination of a boiler with a two stage ammonia heat pump often offers the most economical solution, though requires careful planning. In countries where the electricity price is more than 3 times the gas or oil price, heat pumps driven by combustion engines should be considered. The use of combustion engines means that the water temperature can be increased above 65°C to 75°C or 80°C depending on inlet temperature. Some of the barriers for the introduction of NH<sub>3</sub> heat pumps include:

- The general misinformation about ammonia
- The smallest part of the people in the industry work with ammonia
- The opposition use all opportunities to scare customers away from NH<sub>3</sub>
- Seen as being too expensive
- "The business is too good to be true"

Kenneth Hoffmann,  
Star Refrigeration

*Star Refrigeration is a total solutions provider, active from design through to commissioning and maintenance of cooling and heating systems. Star Refrigeration has conducted an extensive study about the economic benefits of high temperature ammonia heat pumps.*

Two cases of applying an ammonia heat pump for district heating and a chocolate factory have been presented, the former achieving a Coefficient of Performance (COP) of 3.0 and the latter one of 3.9. Energy efficiency and carbon footprint comparison between the ammonia heat pump and an R134a unit has been carried out, pointing to significant energy cost and emissions savings of ammonia heat pumps. Additional benefits include savings on maintenance costs, with 80,000 hours between overhauls and low wear and tear on components. The reason for higher investment costs of ammonia heat pump systems is the fact that they are usually being compared to poorly designed systems using traditional refrigerant (HFCs). With ammonia however, one cannot "afford" designing poor quality systems due to safety reasons. Offering longer warranties for natural refrigerant equipment can reassure end-users about its durability and reliability. Exploring new opportunities for the applications of ammonia heat pumps (e.g. desalination of water) could see a wider deployment of the ammonia technology.

Merle Rocke,  
EcoThermics Corporation

*EcoThermics Corporation is leveraging core competencies in high-pressure fluid dynamics and thermodynamics to develop a CO<sub>2</sub> compressor.*

The first step in eliminating barriers and expedite the transition to natural refrigerants is the availability of viable alternative components (compressors, components and the like). The company has developed a new CO<sub>2</sub> compressor that improves the energy efficiency and performance of heat pumps. The axial compressor design is compact with high power density, while the novel design for ease of manufacturability will make this unit highly cost-competitive. Durability and performance results from over 2000 hours of lab testing reinforce this conviction.

CO<sub>2</sub> heat pumps in the US have a great potential especially considering the fact that 44% of boilers in the US are electric, with a Coefficient of Performance of just 1. However, some hurdles for the uptake of CO<sub>2</sub> technology remain in the US, including:

- U.S. governmental legislation still several years behind Europe/Japan
- Lack of knowledge by customers and distribution channel
- Inertia of current technologies & widespread resistance to change

HOW TO BRING  
NATURAL REFRIGERANTS  
FASTER TO MARKET

# AC / MAC WORKSHOP

**Brent Hoare,**  
Green Cooling Association



**Jan Boone,**  
Mayekawa



**Nicholas Cox,**  
Earthcare Products



**Brent Hoare,**  
Green Cooling Association

*The Green Cooling Association has been formed to promote the interests of the natural refrigerants industry in Australia, with a special focus on improving energy efficiency as part of delivering climate friendly HVAC&R solutions.*

According to scientific findings, the production and consumption of HFCs could be responsible for up to 45% of worldwide CO<sub>2</sub>-eq emissions by 2050 hence why a transition to natural refrigerants is sought. Training constitutes an essential prerequisite for this transition. In Australia, the Refrigeration and Air Conditioning Contractors Association of New South Wales (RACCA NSW) has worked in partnership with the regional Technical and Further Education College (TAFE) to develop and deliver accredited training programmes for technicians on CO<sub>2</sub> and hydrocarbons. It has also run awareness sessions on natural refrigerants, obtained equipment operating on natural refrigerants for regional TAFE campuses through industry donations and upskilled TAFE NSW teachers to deliver safety awareness and systems training in natural refrigerants.

Regarding mobile air conditioning (MAC), many TAFE colleges in Australia now teach the safe use of hydrocarbons as part of their normal training for tradesmen/apprentices. Since 1990 over 200 tonnes of hydrocarbons have been sold in Australia to the MAC re-gas market, avoiding over 800,000,000kg of CO<sub>2</sub> emissions. At least one small scale vehicle OEM uses HyChill hydrocarbon refrigerant in their production. Another is seriously considering the issue because of the excellent results being achieved by one of their distributors who converts the systems to hydrocarbons prior to delivery, a practice followed by a number of OEM distributors. Other applications of natural refrigerants in Australia include the mining sector, with a number of mining operators having a policy that HFCs are prohibited from their site in all vehicles and all must be converted to hydrocarbons. The Australian market has seen new and converted transport refrigeration systems to hydrocarbons (350 systems on the roads), as well as the availability of hydrocarbon air-conditioning systems and hot water systems.

South East Asian countries such as Indonesia, Malaysia, the Philippines and Singapore have seen a great number of conversions of air conditioning systems in commercial buildings to hydrocarbons as well as car air-conditioners.

A key barrier to the wider adoption of natural refrigerants is false claims often on labels of HFC equipment claiming to use "environmentally friendly" gases.

**Jan Boone,**  
Mayekawa

*Mayekawa was founded in 1924 and is today one of the world's largest industrial refrigeration companies. It actively promotes the "Natural Five" refrigerants, including ammonia, CO<sub>2</sub>, hydrocarbon gases and their various blends, air and water.*

Mayekawa develops and manufactures a wide range of refrigeration systems that can be applied for heating, drying, hot water supplying, air conditioning, cooling, chilling and freezing covering a multitude of temperatures from -100°C to +200°C completely by "chemical refrigerant free" technology. More recently, the company has developed a new series of adsorption heat pumps using a new type of adsorbent, namely zeolite.

In industrial refrigeration applications the use of natural refrigerants can be widened and that of HFCs eliminated through:

- Promoting natural working fluids aggressively in the proven industrial field
- Introducing natural working fluids in the commercial and consumer field
- Tightening of Regulation on HFCs and encouraging the funding for the prevalence of refrigeration systems using natural refrigerants

Nicholas Cox,  
Earthcare Products

*Nicholas Cox is considered a leading authority on environmentally friendly refrigeration and air conditioning. A fellow of the Institute of Sales and Marketing Management, he was awarded a graduate ship of the City and Guilds of London Institute for his work on how industry could better utilise natural refrigerants and energy efficiency. He has advised both the UK Government and the EU Commission on environmental aspects of refrigeration and air conditioning.*

Significant life cycle cost savings in the magnitude of 27% can be achieved by employing hydrocarbon (R290) air cooled chillers instead of R134a ones. For example, an R290 chiller of 650kW cooling capacity has been catering efficiently for the comfort cooling needs of the Church House, Westminster, London. Air cooled water chillers with hydrocarbon refrigerants are much easier to adopt for standards in external installations rather than internal ones and given their energy savings it is surprising that they have not been adopted more widely.

A significant breakthrough within last year leading to higher efficiency of hydrocarbon chillers has been the use of inverters on screw compressor with hydrocarbons. However, there is the potential to do even better, as even better efficiencies can be achieved with water cooled chillers. The challenge then becomes on how to use hydrocarbons in applications where normally water cooled chillers are used. One way would be to have an open air "plant room", though the best way forward are prefabricated chiller plantrooms, i.e. the more work you can do offsite the better.

Besides chillers, hydrocarbon refrigerant blends offer great opportunities as HFC replacements in a wide range of applications. For example, R432A, an R1270/E170 (80.0/20.0) hydrocarbon blend, can serve as HFC R407C replacement (NPB -44°C), while three different hydrocarbon blends are proposed as replacements for HCFC123, a refrigerant used particularly in hot ambient temperatures for air conditioning. Overall, hydrocarbons offer an infinite number of possibilities when blends are considered, as there is infinite number of permutations.







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**How to bring  
natural refrigerants  
faster to market**

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