

GUIDE 2013

NATURAL SOLUTIONS

FOR DEVELOPING COUNTRIES

INCLUDING UNIDO ATMOSPHERE SUMMARY REPORT



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



NATURAL SOLUTIONS FOR DEVELOPING COUNTRIES

INCLUDING UNIDO ATMOSPHERE
TECHNOLOGY SUMMIT REPORT

This report was prepared by:

**United Nations Industrial Development Organization
shecco SPRL**

The following companies have provided support for drafting this report:

Carel, Danfoss, Dybvad Stal Industri DSI, Johnson Controls, Linde, Mayekawa

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GLOSSARY

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	ODP	Ozone Depletion Potential
CFC	Chlorofluorocarbon	ODS	Ozone-depleting Substance
CO ₂	Carbon dioxide	PU	Polyurethane
COP	Coefficient of Performance	RAC	Refrigeration and Air-Conditioning
EPA	Environmental Protection Agency	RAC	Room Air Conditioner
F-Gas	Fluorinated Gas	SME	Small and Medium Sized Enterprises
GEF	Global Environment Fund	SNAP	Significant New Alternatives Policy
GHG	Greenhouse Gas	TEWI	Total Equivalent Warming Impact
GWI	Global Warming Impact	UNDP	United Nations Development Programme
GWP	Global Warming Potential	UNEP	United Nations Environment Programme
HCFC	Hydrochlorofluorocarbon	UNIDO	United Nations Industrial Development Organization
HC	Hydrocarbon	UNFCCC	United Nations Framework Convention on Climate Change
HFC	Hydrofluorocarbon	XPS	Extruded Polystyrene Foam
HPMP	HCFC Phase-Out Management Plan		
HVAC&R	Heating, Ventilation, Air-Conditioning, Refrigeration		
IPCC	Intergovernmental Panel on Climate Change		
LCA	Life Cycle Assessment		
LCCP	Life Cycle Climate Performance		
LCD	Liquefied Carbon Dioxide		
MAC	Mobile Air-Conditioning		
MCII	Multilateral Fund Climate Impact Indicator		
MEP/FECO	The Ministry of Environmental Protection of China		
MLF	Multilateral Fund for the Implementation of the Montreal Protocol		
MPB	Montreal Protocol Branch, UNIDO		
NH ₃	Ammonia		
NOU	National Ozone Unit		

WELCOME MESSAGE BY UNIDO



As one of the implementing agencies of the Montreal Protocol, UNIDO has always been committed to promoting sustainable solutions for companies in the refrigeration, air conditioning and foam sectors that are transitioning away from ozone depleting substances. Natural refrigerants and foam blowing agents with low global warming potential are of paramount importance in this transition.

To facilitate the exchange of knowledge that will help drive the uptake of low GWP technologies, the UNIDO ATMOSphere Technology Summit was organised to provide businesses and policy makers from Article 5 (developing) countries of the Montreal Protocol and countries with economies in transition with practical solutions for overcoming the challenges in the introduction of alternative substances.

The wide range of presentations and discussions at the Summit represent a significant step towards better understanding the needs as well as opportunities when opting for natural refrigerants and foam blowing agents with low global warming potential.

We hope that the lessons learnt from the Summit as well as the findings from the survey for stakeholders in Article 5 countries, which are summarised in this publication, will pave the way towards more sustainable and greener industries worldwide.

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*Sidi Menad Si Ahmed, Director, Montreal Protocol Branch, UNIDO
Organiser of UNIDO ATMOSphere 2013*



WELCOME MESSAGE BY SHECCO



For more than a decade, shecco has been working together with the heating, refrigeration and cooling industry to introduce technology solutions that would not only alleviate the environmental burden from direct and indirect greenhouse gas emissions, but that more importantly would highlight the business case for all those involved in a transition towards a “green economy”. shecco strongly believes that natural substances, either used as refrigerants or foams, constitute a long-term viable solution for developing countries not requiring any further move towards substances with known and unknown ecological impact. Aiding countries to “leap-frog” to climate and ozone friendly technologies using air, ammonia, carbon dioxide, hydrocarbons and water refrigerants can add further impetus to the outstanding role the Montreal Protocol has played in phasing out ozone-depleting substances and reducing the consumption of fluorinated gases.

We were honoured to jointly organise the UNIDO ATMOSphere Technology Summit and to conduct a global survey with the United Nations Industrial Development Organization in an attempt to continue discussions on how to fully exploit the benefits of utilising natural refrigerants and HFC-free foams in developing countries.

The following GUIDE was drafted based on the results of the UNIDO ATMOSphere Technology Summit and the survey designed to investigate the potential of Natural Substances. A summary introduction to natural substances is followed by success stories in developing countries, as well as an overview of some of the most pressing challenges impeding a more rapid transition away from ozone-depleting substances directly to natural ones.

shecco is looking forward to initiate a dialogue with all involved parties that we hope will continue long after UNIDO ATMOSphere has finished, leading to measurable and favourable results for the economy and the environment likewise.

—
Marc Chasserot, Managing Director, shecco
Organiser of UNIDO ATMOSphere 2013



THE FUTURE WILL BRING GREATER FOCUS ON NATURAL SUBSTANCES

The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production and consumption of numerous substances responsible for ozone depletion. Such substances are used in various applications and their phase out concerns several industrial sectors, including the Heating, Ventilation, Refrigeration and Air Conditioning (HVAC&R) and the foam sectors. Even though the Montreal Protocol was not developed to address the challenge of climate change, it has successfully reduced the amount of greenhouse gases being emitted into the atmosphere, as the technology introduced to replace Ozone Depleting Substances (ODS) is generally more energy efficient and has a reduced global warming potential (GWP). It is estimated that since the late 1980s the Montreal Protocol has reduced greenhouse gas emissions by around 8 Gt CO₂eq annually.

Hydrofluorocarbons (HFCs) were developed as zero Ozone Depletion Potential (ODP) alternatives but, in effect, have emerged as “transitional substances” in applications where new technology now offers low- or no-GWP options. In fact, without action, the increased use of HFCs as replacements to ODS could add annual greenhouse gas emissions of between 3.5 and 8.8 Gt CO₂eq by 2050, comparable to the total current annual emissions from transport.

Thus mankind risks undoing the enormous environmental benefit achieved by the phase out of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) since the late 1980s¹.

“The challenge is to phase out HCFCs while avoiding high-GWP HFCs and while achieving high energy efficiency using technology that is safe and environmentally acceptable”, states the UNEP May 2011 Progress Report of the UNEP Technology and Economic Assessment Panel².

The same progress report notes that “low-GWP options continue to be commercialised for all applications with few uses still depending on HCFCs and high-GWP HFCs. Low-GWP refrigerants and foam blowing agents are being rapidly announced and commercialised by companies with operations in both developed and developing countries”.

Against this backdrop of increasing availability of low-GWP replacements as well as the urgency to address climate change, there is a growing momentum for further action. Minimising the climate impact of replacement technologies is receiving more attention by Montreal Protocol Parties when setting out their HCFC phase out management plans.

This GUIDE aims to support this growing momentum by introducing viable ways of utilising the benefits of natural low-GWP substances in the HVAC&R and the foam sectors that can achieve both direct emissions savings and energy efficiency, while at the same time ensuring a successful “leapfrogging” directly from HCFCs to low-GWP options.

1. UNEP (2011), HFCs: A Critical Link in Protecting Climate and the Ozone Layer, http://www.unep.org/dewa/Portals/67/pdf/HFC_report.pdf

2. Progress Report of the Technology and Economic Assessment Panel, May 2011, Volume 1 http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/TEAP_Progress_Report_May_2011.pdf

ABOUT THIS GUIDE

The main objective of this GUIDE is to share relevant experiences in the refrigeration, air-conditioning and foam sectors in which low-GWP technologies are employed, especially natural refrigerants and foam-blowing agents. This is especially important from the perspective of the current phase-out of HCFCs in Article 5 countries, as prescribed in the phase-out deadlines of the Montreal Protocol. With that purpose in mind, this GUIDE seeks to identify and describe barriers as well as good practices in the uptake of natural substances. By sharing such experiences, this GUIDE will be important in raising awareness amongst interested parties in the industry, governmental, academic and non-profit spheres in regards to challenges and opportunities when leapfrogging from HCFCs to low-GWP alternatives.

This GUIDE is based on two main pillars:

- 1) Experiences shared and lessons learnt from the UNIDO ATMOSphere Technology Summit held on 3-4 June 2013 at the UNIDO headquarters. The conference focused on technology solutions for the refrigeration and air-conditioning sectors, as well as for the foam sector. It aimed at addressing topics of particular concern to developing countries and generated lively debates between speakers and audience members.
- 2) Findings from the online survey jointly launched by UNIDO and shecco. The survey addressed stakeholder groups involved in the HCFC phase-out in developing countries and economies in transition. It received responses from 82 countries. This survey was important in capturing and computing the opinions and trends amongst different stakeholders throughout the entire globe.

These two sources of information complement each other and are essential in understanding the market concerned, as well as in discussing opportunities and prescribing solutions. The GUIDE covers the following topics:

- **Natural Refrigerants & Foam-Blowing Agents:** An introduction to the most commonly used natural refrigerants and foam-blowing agents including ammonia, carbon dioxide, hydrocarbons, water and air in the HVAC&R sector today.
- **Surveys:** A summary of the main barriers, drivers and trends concerning the uptake of HFC-free foams and refrigerants in developing countries, based on a 2013 UNIDO survey and an 2012 UNEP survey. Survey results are presented throughout the entire GUIDE to complement findings from the UNIDO ATMOSphere Technology Summit and the individual barrier sections.
- **Success Stories of Natural Substance Use:** An overview of best-practice examples of natural refrigerants and foam-blowing agents to be followed in industrial refrigeration, light commercial and commercial refrigeration, domestic refrigeration, and the heating and foam sectors in developing countries.
- **UNIDO ATMOSphere Technology Summit:** A review of key presentations and panel discussions from the joint UNIDO-shecco event in June 2013 that generated lively debates between speakers and the audience. The event brought together system and component suppliers, end-users, national and international policy representatives, non-profit

organisations, and the academic sector. It identified major market trends, opportunities, and the share of natural refrigerants and foam-blowing agents in developing countries. A special reference is made to natural substance-based projects of UNIDO in Article 5 countries.

- **Barriers for the uptake of natural substances in developing countries:** An analysis of the main technology, market and policy barriers for the adoption of natural substances in developing countries is provided. For each section a general introduction is followed by specific barriers identified and concrete solutions found. Survey results complement each section with latest data for the following issues:
 - Awareness
 - Training & certification
 - Safety & technology standards
 - Regulation & policy frameworks
 - Financial incentives & costs
 - Technology & market availability
 - Refrigerant selection methodology
- **Case Studies:** 50 case studies are presented in an easy-to-access format providing a short overview of best-practice examples in developing countries. The section is sorted by the main type of barrier addressed by the example. Within each barrier category, cases are listed by alphabetical order for the countries involved.

SORTING SYSTEM FOR APPLICATIONS & SUBSTANCES

For sections on the UNIDO ATMOSphere Technology Summit, the various Surveys, and the Case Studies, the application and the type of natural substance involved are indicated above the relevant section:



Heating



Refrigeration



Air Conditioning & Cooling



Foams



Carbon Dioxide



Hydrocarbons



Ammonia



Water



Air

WORLD REGIONS



For sections on the UNIDO ATMOSphere Technology Summit, the various Surveys, and the Case Studies a coloured world map will indicate the region addressing a certain barrier, or the applicability of findings for a certain region.

NATURAL REFRIGERANTS & FOAM-BLOWING AGENTS

Natural refrigerants have been in use since the 19th century. As a general differentiation, “natural refrigerants” are substances that exist naturally in the environment, while “non-natural refrigerants” or “synthetic refrigerants” are man-made chemicals, not naturally occurring in nature. The most commonly used natural refrigerants today are ammonia (NH₃, R717), carbon dioxide (CO₂, R744), and hydrocarbons (HCs), such as propane (R290), isobutane (R600a), and propylene, also known as propene (R1270). Water and air are also used, to a lesser extent, for example in adsorption chillers and deep-freezing applications. Both hydrocarbons and carbon dioxide can be used in foam applications as blowing agents.

ABOUT THE “NATURAL FIVE”

The “natural five” – air, ammonia, carbon dioxide, hydrocarbons and water – have distinct characteristics that make them viable options for a wide range of heating, cooling and foam applications.



Ammonia (ODP= 0 / GWP= 0): Ammonia is a colourless gas at atmospheric pressure. With zero ozone-depleting and global warming potential, as well as a short atmospheric lifetime, it does not

form any by-products or decomposition products with negative environmental impact. It is compatible with some, but not all, commonly used refrigeration system lubricants. Despite its undisputed energy efficiency benefits, the use of ammonia is restricted in certain applications and geographic regions, due to its toxicity and flammability. It is therefore mostly used in less populated areas or outside confined spaces. In recent years, advances have been made to minimise the NH₃ charge, by using it together with other refrigerants - such as CO₂ - in secondary systems, by using advanced safety systems, or by using ammonia absorption technology.

Ammonia is one of the most commonly applied refrigerants in fisheries, the food & beverages industry, industrial transport refrigeration (cargo ships), cold rooms and special applications (such as ice rinks, deep mining and laboratories). It is also suitable for supermarket central refrigeration units as well as in district heating and cooling for public and office buildings. Large ammonia chillers are used in airports and hospitals.



Carbon dioxide (ODP= 0 / GWP= 1): Carbon dioxide as a gas is colourless, odourless, and heavier than air. With a Global Warming Potential = 1, CO₂ is the reference value for comparing a refrigerant's direct impact on global warming. Carbon dioxide carries an A1 safety classification (the same as most fluorocarbon refrigerants), indicating that it has low toxicity and is non-flammable, as defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers ASHRAE under Safety Standard 34. CO₂ refrigerant is sourced as a by-product from a number of production methods. With a long atmospheric lifetime, CO₂ does not lead to any by-product formation with serious environmental impact. When used as a refrigerant, carbon dioxide typically operates at a higher pressure than fluorocarbons and other refrigerants. While this presents some design challenges, it can be overcome in systems designed specifically to use CO₂. Carbon dioxide is compatible with some, but not all, commonly used refrigeration system lubricants.

CO₂ can be adopted in a large variety of heating and cooling systems, such as mobile air-conditioning (MAC) in passenger cars and buses, vending machines and coolers, central refrigeration systems for food retail applications, cold storage warehouses and the food processing industry, heat pump water heaters and space heating, as well as transport refrigeration like refrigerated trucks and trailers.

Foams: CO₂ as natural blowing agent can be used in various types of foam production like rigid polyurethane (PU) spray foams used in pipe and appliance insulation. CO₂ also has applications in flexible polyurethane foams in slabstock and boxfoam and in PU integral skin. Many large manufacturers have successfully used the technology for decades worldwide.

HC

Hydrocarbons (ODP= 0 / GWP <4): The group of HCs (such as propane R290, isobutane R600a, and propylene R1270) does not form any by-products or decomposition products in the atmosphere. Hydrocarbon refrigerants are flammable and, as a result, carry an A3 ASHRAE safety classification, which means they are in the higher range of flammability. HCs are often subject to stricter safety requirements concerning the quantities permitted in occupied spaces. They are fully compatible with almost all lubricants commonly used in refrigeration and air conditioning systems. HC refrigerants can be applied either in systems designed specifically for their use, or as replacements in a system designed for a fluorocarbon refrigerant. This makes them a cost-competitive solution also for developing countries. If a hydrocarbon refrigerant is to be used in a system designed for a different refrigerant some modifications will be required to ensure compatibility. However, the greatest potential for hydrocarbon refrigerants lies in systems specifically designed for their use.

Today, HCs are used in mostly domestic and light-commercial refrigeration and air-conditioning systems worldwide. R600a is used in more than 650 million home fridges and freezers worldwide, while R290 has become an attractive solution in ice cream freezers & cabinets, commercial freezers & refrigerators (such as walk-in-freezers, meat freezers and salad coolers), ice cube machines, bottle coolers, vending machines, or cascade supermarket refrigeration systems etc. R290 can also be applied in air-conditioning equipment for commercial and domestic buildings.

Foams: Hydrocarbons have also gained popularity in the foam sectors. In developed countries, cyclopentane is used as a standard solution in the insulation of domestic refrigerators and freezers. HCs have been used in several foam sub-sectors, including domestic appliances (mainly in refrigerator production), water heaters, polyurethane (PU) sandwich panels, PU boardstock and some PU integral skin applications. The use of hydrocarbons as blowing agents has experienced a continued growth globally. In the production of extruded polystyrene foam (XPS boards) (construction sector) hydrocarbons already comprise more than half of the global market. Many governments of Article 5 countries prefer HCs in the rigid foam sector and refrigerator manufacturing as alternatives to CFCs, HCFCs, and HFCs.

H₂O

Water (ODP= 0 / GWP= 0): Water (R718) is one of the oldest substances used for refrigeration applications. Also known as dihydrogen monoxide, water or water vapour is one of the Earth's most abundant elements. R718 is an odourless, colourless, non-toxic, non-flammable, non-explosive, easily available substance that is also the cheapest refrigerant. Regarding challenges, an obvious limitation is the high freezing rate at atmospheric pressure. Water may also lead to corrosion and oxidation of many metals, and is more reactive than other refrigerants. In refrigeration applications, water requires state-of-the-art technol-

ogy. Its use as a refrigerant has been mostly limited to applications above 0°C, such as compression chillers with steam injection compressors, absorption systems built around a binary fluid or/with lithium bromide as the absorbent, and adsorption systems using the mineral zeolite as the adsorber.

Absorption and adsorption chillers based on water technology are used in facilities such as hotels, museums, movie theatres, convention centres, data centres, and airports around the world.

O₂

Air (ODP= 0 / GWP= 0): Air is a refrigerant that is environmentally benign, cheap, totally safe, and non-toxic. It was used on refrigerated cargo ships already around the turn of the last century. Air cycle units, compared to vapour-compression units, can also produce a much higher temperature difference between the hot and cold sides. As a result, very cold air can be produced for near-cryogenic processes.

Air has been used commercially for aircraft cooling for a long time. In spite of the low Coefficient of Performance (COP), air is used because of the specific operating conditions of aircraft (e.g., availability of compressed air and ram effect) and stringent specifications (e.g., low weight, small size, absolute safety and zero toxicity). Air has also been used as a refrigerant for residential and automobile air conditioning and cooling. In some refrigeration plants, air is used in the quick freezing of food products, and for ultra-low temperature special applications.

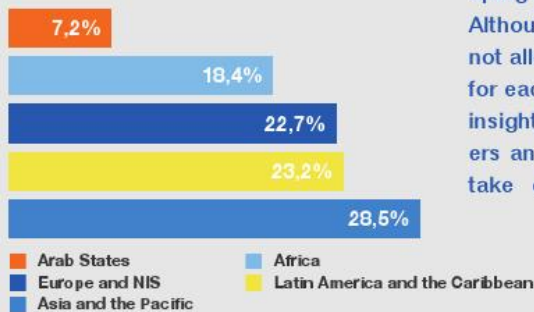


SURVEYS: OVERVIEW



A survey was jointly conducted by **UNIDO** and market development company **shecco**, between 23 May and 30 July 2013. A total of 207 responses were recorded from 82 countries on the specific topic of natural substances as an alternative to HCFCs. It was designed to collect input from countries faced with the search for HCFC alternatives. UNIDO and shecco invited all participants of the UNIDO ATMOSphere Technology Summit as well as other industry, end-users, associations, policy makers, NGO and researchers from developing countries to take the survey.

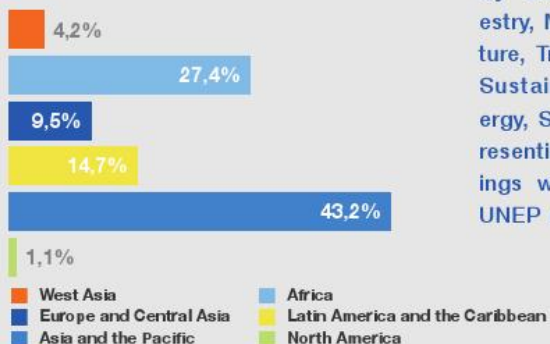
Although the data collected does not allow for a statistical inference for each country, it provides a first insight into the overall global drivers and trends concerning the uptake of HFC-free foam-blowing agents and refrigerants.



The survey captured mostly responses from Asia and the Pacific region, followed by Latin America and the Caribbean, and Europe and the Newly Independent States (NIS). Africa and the Arab States were less represented among respondents.

Another global survey which will be important in this analysis was conducted from May to July 2012 on behalf of the United Nations Environment Programme (**UNEP**) among National Ozone Units (NOUs). NOUs were encouraged to express their opinions based on the priority needs of their country regarding the establishment of HCFC Phase-out Management Plans (HPMP), identify barriers and solutions for the uptake of HCFC alternatives, and evaluate the capacity of selected stakeholder groups in the transition away from HCFCs.

A total of 95 respondents participated, mostly National Ozone Units and Ministry officials (Land, Water, Forestry, Mineral Resources, Agriculture, Trade & Industry, Economy, Sustainable Development, Energy, Science & Technology), representing 79 countries. The findings were used for an internal UNEP report and partial findings were kindly released for this GUIDE.



The survey attracted respondents from the Asia & Pacific regional network (43%), followed by Africa (27%) and Latin America & the Caribbean (15%). Response rates from North America (1%), West Asia (4%) and Europe & Central Asia (10%) were less pronounced.

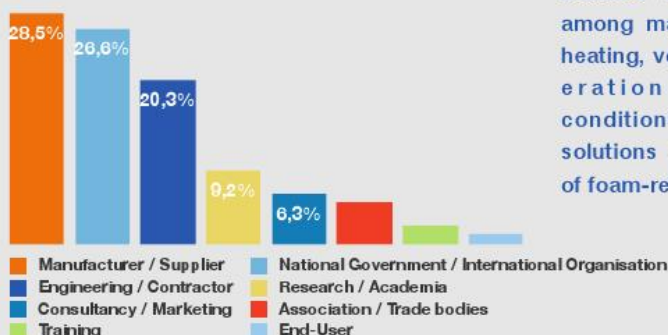
Relevant findings from the joint UNIDO-shecco survey, and the internal UNEP survey will be integrated in the report's following chapters to provide background information to specific sections.



SURVEYS: RESPONDENTS PROFILES



The **UNIDO** survey addressed influential **stakeholder groups involved in the HCFC phase-out** in developing countries and economies in transition. It attracted most interest

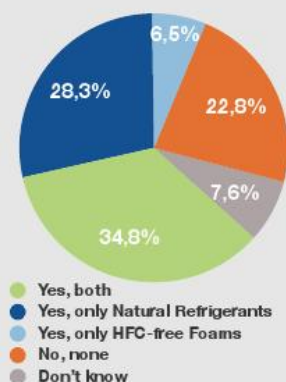


among manufacturers of heating, ventilation, refrigeration and air-conditioning (HVAC&R) solutions and suppliers of foam-related solutions.

The second-largest response group was national governments and international organisations, followed by engineering and contracting firms. The academic sector, consultancy and marketing companies, training providers, and end-users were less represented.

The academic sector, consultancy and marketing companies, training providers, and end-users were less represented.

In terms of **Present use of natural substances among respondents**, close to 70% of respondents use, regulate or otherwise are actively involved with natural refrigerants and/or foams. The following graphic depicts if respondents are active in both areas, in one of them, or are currently not active in the use of natural substances.



In terms of the Area respondents are active in for Natural refrigerants, most had experience with commercial & industrial air-conditioning, commercial refrigeration, and industrial refrigeration (58-55%). The second-strongest group was represented by organisations active in domestic refrigeration, domestic air-conditioning, and light-commercial refrigeration (44-40%). Less experience was expressed in the areas of commercial & industrial heating, mobile air-conditioning, and domestic heating (31-20%).

For the Area respondents were active in for the Foam sector, most had experience in appliance foams, followed by PU panels. Both spray foams and XPS boards were significantly less mentioned.

For questions about the survey:
Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org

SUCCESS STORIES OF NATURAL SUBSTANCES

INDUSTRIAL REFRIGERATION

NH₃ freezing systems are successfully used in the food processing and the fishery industries in Argentina, Brazil, Colombia, India, Indonesia, and the Philippines, among others. However, whilst over 90% of the industrial refrigeration and cold storage industry in developed countries rely on ammonia, and to a minor extent on CO₂ and hydrocarbon refrigerants, the market share in developing countries is still much lower, currently at 40%.

LIGHT-COMMERCIAL & COMMERCIAL REFRIGERATION

In the light-commercial industry, around 1 million ice cream freezers using hydrocarbons are now being applied in developed and developing countries. Moreover, another 1.6 million HFC-free bottle coolers and vending machines use either HCs or CO₂.

In the commercial refrigeration sector, supermarkets can save 10-35% energy by applying a CO₂-only transcritical refrigeration system compared to conventional solutions in low- and medium ambient temperatures. Regarding market penetration, first results from a September 2013 survey indicated the number of stores using CO₂-only transcritical systems in the European Union to be above 2,800, with another 1,500+ using CO₂/HFC cascade systems. By early 2013, more than 125 supermarkets in North America used secondary, cascade and transcritical CO₂ refrigeration systems combined, and another 150+ stores in Japan are expected to be using CO₂ transcritical systems by the end of 2013. There are now at least 160 cascade CO₂ systems being used in Australia, and another 40 CO₂ cascade refrigeration system installations in Brazil (both September 2013). Venezuela and Colombia are also introducing supermarkets with CO₂-based refrigeration technology, and in South Africa some large supermarket chains have begun to convert their refrigeration systems to CO₂, with 17 stores in South Africa now being equipped with CO₂-only systems. Market uptake for natural refrigerants in food retail is also expected to grow in China, from 6 supermarkets using CO₂ cascade systems today. With the support of

global consumer brands and international food retailers, hydrocarbon and CO₂ cooling equipment is being introduced to Turkey, Thailand, Indonesia, India, China, Mexico, amongst other countries.

DOMESTIC REFRIGERATION

In the domestic refrigeration sector, developing countries account for about 12% of global consumption of HFCs as refrigerants and blowing agents. Regarding the use of natural refrigerants, more than 650 million hydrocarbon refrigerators had already been sold by 2012 with the market experiencing a strong upwards trend. In Asia, HC refrigerators have been adopted in India, Indonesia, Japan, Pakistan and Russia. 75% of new domestic refrigerators/freezers produced in China use isobutane refrigerant (R600a). In South America and the Caribbean, Argentina, Brazil, Cuba and Mexico are introducing hydrocarbon refrigerators into their domestic markets. Africa has also set up its first production line for hydrocarbon-based units in South Africa. It is predicted that 75-80% of new refrigerators worldwide will use HC refrigerants by 2020.

DOMESTIC & MOBILE AIR CONDITIONING

The air-conditioning industry is one of the main consumers of high global warming HCFC refrigerant gases. Several Article 5 countries have started to seriously look into the use of hydrocarbon R290 as a viable alternative for small unitary air conditioning units. In India, more than 3,000 R290 room air conditioners had been sold by July 2012. Several leading Indian and Chinese air conditioner manufacturers have finalised R290 air conditioner production line conversions with the support of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and UNIDO. In total, China has committed to converting 35 of such plants to hydrocarbon-based technology.

Around 20 million cars use hydrocarbons as a refrigerant for mobile air conditioning systems, mostly in Australia and North America, but also in South-East Asia. MAC systems with HCs have

been reported to be up to 30% more energy-efficient than HFC-based ones.

HEATING

Around the world, there are more than 3.5 million hot water heat pumps produced that use CO₂ as a refrigerant, with a stronghold in Japan where they have a market share of 98% of all new residential hot water heaters and a production capacity of 500,000 units per year. In Europe, 16 CO₂ heat pump manufacturers currently operate in the market, while China has upgraded its production capacity of CO₂ heat pumps to 100,000 units per year, and already has 50-70 successfully running projects in the country.

FOAM SECTOR

In Southeast Asia, as in other parts of the world, there is a trend to shift from HCFCs to hydrocarbons in the domestic refrigerator/freezer manufacturing and housing sectors. Hydrocarbons now already account for about 1/3 of the total blowing agent consumption of domestic appliances in Southeast Asia. The whole production of PU-Block-Slab has shifted to hydrocarbons in the region. As an example, Thailand aims to adopt hydrocarbons in the entire rigid PU foam sector in the country. Vietnam has drafted the first phase of a project to manage the depletion of HCFCs in Vietnam in the 2012-2016 period by replacing HCFC-141b used in the production of insulated foam with cyclopentane technology. In Colombia, four manufacturing plants have been converted to HCs as of January 2013.

In South America, UNIDO has been involved in two projects in Brazil at Eletrofrio and Crios, in which CFC-11 was substituted by cyclopentane, whilst in Argentina most of the large panel manufacturers have substituted CFC-11 with N-pentane, and a flexible foam manufacturer was converted from CFC to liquefied carbon dioxide (LCD). UNIDO has implemented similar projects converting factories in the foam sector in Africa, West Asia, and Europe.

UNIDO ATMOSPHERE TECHNOLOGY SUMMIT: OVERVIEW



Vienna



From 3 to 4 June 2013, the UNIDO ATMOSPHERE Technology Summit was held at the United Nations headquarters in Vienna, Austria. Jointly organised by UNIDO and market development company shecco, the Summit brought together 150 participants from developing and developed countries. Titled "Natural Solutions for Developing Countries" the Summit focused on gases with low global warming potential, especially natural substances, for the heating, refrigeration & air-conditioning sectors, as well as for the foam sector. Substances considered included all five natural substances CO₂, ammonia, hydrocarbons, water and air.



Co-chaired by Sidi Menad Si Ahmed, Director of the Montreal Protocol Branch of UNIDO, and Marc Chasserot, Managing Director of shecco, the event's main purpose was to support developing countries in their efforts to find efficient, safe and sustainable solutions to replace hydrochlorofluorocarbons (HCFCs) in both the HVAC&R and foam sectors, and avoid substances with high Global Warming Potential.

The conference programme was designed to address topics of particular concern to developing countries, among them technology availability, cost-effectiveness over time as well as other barriers relating to safety, training, and regulatory frameworks. Case study presentations were combined with panel discussions generating lively debates between speakers and audience members, including system and component suppliers, end-users, national and international policy representatives, non-profit organisations, and the academic sector.

Over 40 invited speakers from Europe, Africa, West Asia, South-East Asia, North and South America discussed viable substances and technologies to fit specific applications, industry sectors, countries and/or climatic regions.



"As a UN agency we have to be technology neutral, but I also strongly believe that it is our duty and mandate to promote new technologies for the benefit of the developing countries."

- Sidi Menad Si Ahmed,
Director of the Montreal
Protocol Branch, UNIDO

<http://www.atmo.org/media.presentation.php?id=277>

UNIDO ATMOSPHERE TECHNOLOGY SUMMIT: OVERVIEW



Vienna



The Technology Case Study Sessions clearly demonstrated the viability of natural refrigerants in Article 5 countries, detailing carbon dioxide use in supermarket refrigeration systems in Brazil and South Africa, ammonia refrigeration plants in Eastern and Central Europe and the Russian Federation, and light commercial hydrocarbon refrigeration cabinets and bottle coolers in use in developing countries like Thailand.



Leading system and component suppliers made clear in their presentations and case studies that natural refrigerant technologies are already available in developing countries and are a sustainable solution thanks to their high efficiency and reduced energy consumption.

The Summit also made clear that HCFC Phase out Management Plans (HPMPs), together with GEF and MLF funding, are opening the door for natural substances. For example, the Summit session dedicated to discussing HPMPs highlighted the opportunity to phase-in R290 room air conditioners in Article 5 countries such as Mexico and China.

Furthering the uptake of natural solutions, however, will require concerted action in terms of raising awareness, training and certification schemes for technicians, as well as reforming some standards and regulations.



"Even a small player can have an impact in a big market. I think that when you are talking about the business case sometimes you just have to have the vision and the courage to fight for it, and the others will follow the leadership."

- Marc Chasserot, Managing Director, shecco

Nina Masson, Head of Market Research, shecco
Franziska Menten, Events Manager, shecco

nina.masson@shecco.com

franziska.menten@shecco.com

<http://www.ATMO.org/UNIDO2013>

UNIDO ATMOSPHERE: MARKET & TECHNOLOGY TRENDS



Vienna



At the UNIDO ATMOSPHERE Technology Summit, representatives from Article 5 countries and industrial experts worldwide acknowledged ammonia as a very suitable low Global Warming Potential (GWP) and zero Ozone Depletion Potential (ODP) refrigerant to be used as a main alternative to HCFCs in the industrial refrigeration sector of developing countries. In his presentation, Professor Pega Hrnjak, from the University of Illinois, considered ammonia chillers to be an especially attractive solution for developing countries. Developments such as hermetic compressors, microchannel condensers and Ni brazed plate evaporators have made the safe use of ammonia possible in low-charge applications.



Eric Delforge, from system manufacturer Mayekawa, presented various case studies using ammonia, carbon dioxide and water as refrigerants in food production and distribution centres, as well as the successful application of hydrocarbons in chemical plants in many developing countries. The supplier's ammonia industrial refrigeration packages are used in Serbia, Bosnia Herzegovina, Croatia, Macedonia, Slovenia, Russia and Egypt. According to Delforge, the growing demand for frozen food in developing countries will result in higher needs for refrigeration systems that can be met by ammonia plants worldwide.

End-users are complementing efforts by the supplying industries to introduce natural solutions to developing countries. According to Vincent Grass from Nestlé, over 90% of the company's 467 factories around the world use ammonia, hydrocarbons and CO₂ systems.

Presentations also revealed that CO₂ solutions are increasingly being introduced to the food retail sector in Article 5 countries such as South America and South Africa. Various component manufacturers, including Danfoss, Carrier and Carel, presented successful business models for CO₂ solutions.

"Each of these main alternatives that I have shown are excellent and very competitive. They need to be treated with understanding to maximise the opportunities."

- Predrag Hrnjak, University of Illinois

"With regards to our sales we can say that we are present in over 80% of Article 5 countries with natural refrigerant compressors. So, we believe that the knowledge and experience to service and to operate these units with natural refrigerants is present in the field, and that the technology based on natural refrigerants will continue to become more efficient and more cost effective. We are sure of that."

- Eric Delforge, Mayekawa

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UNIDO ATMOSPHERE: MARKET & TECHNOLOGY TRENDS



Vienna



With more than 4,000 CO₂ systems installed worldwide, systems that have helped reduce energy consumption by 20%, Torben Funder-Kristensen from Danfoss was confident about CO₂ technology becoming available worldwide, including in developing countries. Nina Masson from shecco stated that there is a minimum of 113 different food retail brands using CO₂ in their commercial refrigeration systems worldwide, concluding that the market adoption of natural refrigerants has been a success story for many applications.

Also discussed was the successful combination of CO₂ systems with ammonia in high ambient temperatures such as in South African and Southern US supermarkets, as presented by Caleb Nelson from CTA Architects and Bernd Kaltenbrunner from Eurammon.

With regards to smaller systems, hydrocarbons were shown to be making significant inroads in domestic and commercial refrigeration. In Pakistan, for example, Electrolux has sold 15,000 units of its new line of R600a fridges, whilst in Thailand, Austrian manufacturer AHT has already installed 2,750 light commercial R290 units. Globally, according to Reinhold Resch, AHT has installed around 530,000 hydrocarbon cabinets, whilst "Refrigerants Naturally!" members The Coca-Cola Company, PepsiCo, Unilever and Red Bull have collectively placed more than 2.5 million HFC-free refrigeration units in almost all countries around the world. These include over 400,000 hydrocarbon units from Red Bull, which plans to have 1 million hydrocarbons units by 2015.

When it comes to HCFC and HFC-free blowing agents, Igor Croiset from GIZ made clear the relationship between insulating foams and refrigerant use, explaining that the conversion of foams to non-HCFCs has a positive effect on direct emissions of ODS and high GWP substances, and indirect emissions, by reducing energy demand. Cyclopentane has already been successfully introduced for PU blowing foam in two Brazilian companies.

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"Nestlé has a natural refrigerant policy in place, since 1986, that is more than 27 years."

- Vincent Grass, Nestlé

"Across the world we have sold more than 500,000 R290 cabinets. [...] In 2005-2006 we switched to propane refrigerant and introduced variable speed compressors for these light commercial units and we found that for the first time we could reduce the energy consumption very dramatically."

- Reinhold Resch, AHT

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UNIDO ATMOSPHERE: UNIDO PROJECTS



Vienna



As an Implementing Agency of the Multilateral Fund for the Implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer (MLF), UNIDO currently has projects in nearly 80 countries that aim to help client countries in Africa, the Arab region, Latin America, Asia Pacific, and Europe and the Newly Independent States attain their ozone-related objectives. The agency focuses its work on six specific areas of expertise: ODS production, refrigerants, foams, halons, solvents, fumigants and aerosols, and plays a leading role in the transfer of the latest non-ODS technologies to developing countries.

During the UNIDO ATMOSPHERE Technology Summit, Ákos Kőszegváry, Industrial Development Officer at UNIDO's Montreal Protocol Branch, discussed non-ODS technology selection, emphasising the key requirements for the adoption of new technologies: (1) maximising climate benefits for MLF-funded UNIDO projects; (2) adopting standards allowing alternatives (flammability, toxicity) on the market; (3) availability of appropriate after sales services; (4) availability of equipment kits based on new technologies; and (5) appropriate pricing of alternatives, associated components & products.

Presentations made clear that UNIDO encourages the use of natural replacement alternatives in the refrigeration sector, with several of its projects focusing on the use of R290 (propane) and R717 (ammonia) as HCFC replacements. In China, UNIDO provided assistance to the Jiaxipera factory to redesign its compressor products to accommodate isobutane as the new replacement. UNIDO's assistance in fact helped Jiaxipera become one of the first companies in developing countries to produce hydrocarbon compressors.

Other demonstration projects to convert production plants to R290 in China by UNIDO, in collaboration with GIZ, were mentioned in a side event during the Summit.

UNIDO is also collaborating with UNEP on a demonstration project on "Promoting low-GWP Refrigerants for Air-Conditioning Sectors in High-Ambient Temperature Countries", funded by the MLF. The project involves the manufacture of prototypes (window, split, central) with up to 4 different low-GWP alternatives, independent testing of prototypes, and an assessment study on alternative technologies, including district cooling options (for Qatar). Participating countries include Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and the United Arab Emirates.

Outside of its work with the MLF, UNIDO has access to the Global Environment Fund (GEF) to finance projects to address the phase-out of ozone depleting substances (ODS) in countries with economies in transition that are not eligible for MLF funding. The "Phase-Out of HCFCs and Promotion of HFC-free Energy Efficient Refrigeration and Air-Conditioning Systems in the Russian Federation through Technology Transfer" is one such project.

"I do hope there are more practical examples that can make people see the future and the selection of alternative technologies. Yes, we can do it not just on the natural refrigerant side, but also on the phase out of HCFCs globally. We can leap off HCFCs and switch to Low Global Warming Potential alternatives"

- Sidi Menad Si Ahmed,
Director of the Montreal
Protocol Branch, UNIDO

<http://www.unido.org>

<http://www.ATMO.org/UNIDO2013>

UNIDO ATMOSPHERE: UNIDO PROJECTS



The UNIDO-GEF collaboration recognises the synergies that exist in generating global environmental benefits in projects that aim to phase-out ODS in industrial sectors and that simultaneously achieve climate change benefits by promoting energy efficiency measures.

Therefore, UNIDO has developed pilot projects that aim to leverage both MLF and GEF support, such as projects to convert HCFC 22 fishery and food processing installations in the Gambia and Viet Nam to low-GWP and energy efficient technologies. Riccardo Savigliano, Industrial Development Officer at UNIDO's Montreal Protocol Branch, reported that the fishing industry was identified as the most appropriate sector for the pilot projects, since most technologies used in Article 5 countries in the industrial refrigeration sector (cold stores, fish processing, handling & ice-making plants, and freezing units of fishing vessels) have high carbon emissions and work with low energy efficiency. The two project proposals explore a range of refrigerants with low GWP, including ammonia systems, CO₂ in single as well as cascade systems, and hydrocarbon units. The integrated project schemes are expected to be approved for co-financing support by the Global Environment Facility (GEF) in 2013.



Vienna

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<http://www.youtube.com/watch?v=QaLM--szdvE&feature=youtu.be>

Ákos Kőszegváry, UNIDO
Ole Reinholdt Nielsen, UNIDO
Jürgen Hierold, UNIDO
Riccardo Savigliano, UNIDO

a.koeszegvary@unido.org
o.nielsen@unido.org
j.hierold@unido.org
r.savigliano@unido.org

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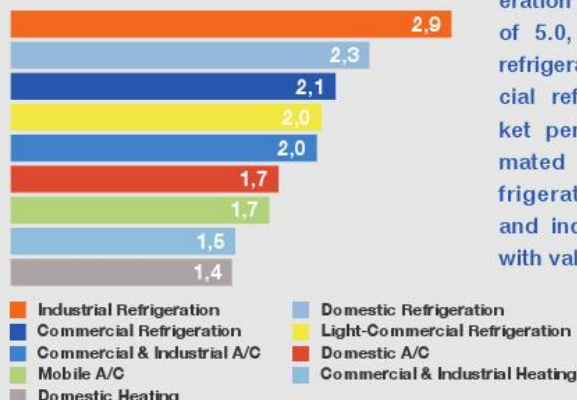
SURVEYS: MARKET SHARE & ADOPTION POTENTIAL OF NATURAL SUBSTANCES



World



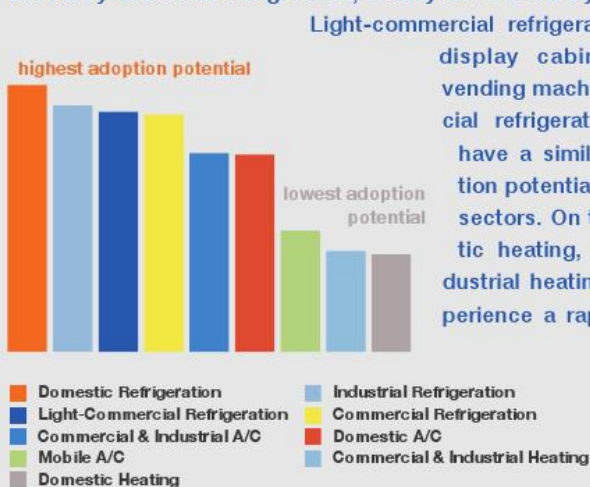
In the **UNIDO** survey 207 respondents from developing countries and emerging economies were asked to rate the **Market share of natural refrigerants per industry sector**, with options ranging from “none” (1) to “very high” (5). Their market share is, according to respondents, currently highest in industrial refrigeration with a value of 2.9 out of 5.0, followed by domestic refrigeration (2.3) and commercial refrigeration.



eration with a value of 2.9 out of 5.0, followed by domestic refrigeration (2.3) and commercial refrigeration. Similar market penetration rates are estimated for light-commercial refrigeration, and commercial and industrial air-conditioning, with values of 2.0 out of 5.0.

Participants were next tasked to rank application sectors from “lowest” (1) to “highest” (9) according to their **Adoption potential for natural refrigerants within the next 5 years**.

The application sector with the highest potential for natural refrigerants compared to other industry sectors is the domestic refrigeration sector, pointing to an already widespread and growing use of hydrocarbons in domestic refrigerators and freezers. This is followed by industrial refrigeration, mainly dominated by the use of ammonia.



Light-commercial refrigeration, such as plug-in display cabinets, bottle coolers, vending machines, etc., and commercial refrigeration are estimated to have a similarly good future adoption potential as compared to other sectors. On the other hand, domestic heating, and commercial & industrial heating are less likely to experience a rapid increase in natural refrigerant use, respondents estimate.

Sectors with a continued use of natural refrigerants in different world regions, such as the use of ammonia in industrial refrigeration or the quickly increasing application of HCs in domestic refrigerators, will continue to be responsible for growing markets in developing economies in the near future. The simultaneous introduction of HFC-free appliance foams plays an important role in this respect. Other applications, among them small-size commercial plug-in display refrigeration equipment and centralised food retail refrigeration systems also show promising prospects. Domestic, as well as commercial and industrial heating, on the other end, currently inspire less trust among respondents.

For questions about the survey:

Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org



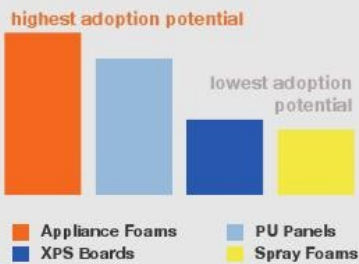
SURVEYS: MARKET SHARE & ADOPTION POTENTIAL OF NATURAL SUBSTANCES



World



The same question about the **Adoption potential of HFC-free foams in the next 5 years** - measured on a ranking scale from “lowest” (1) to “highest” (4) - indicated that the adoption in appliance foams is regarded as the most promising by respondents, followed by PU panels. The spray foam sector is, according to respondents, less likely to experience a rapid adoption of natural foams when compared to the other three applications.



BARRIERS FOR THE UPTAKE OF NATURAL SUBSTANCES & HOW TO ADDRESS THEM

Depending on the country or world region considered, different types of barriers impede or significantly slow down the introduction of safe, reliable, efficient and otherwise sustainable substances, components and systems to use other than HCFC gases. The following section provides an introduction to a range of such obstacles, by providing an overview of the theoretical impact of each barrier and its real-life manifestation in developing countries. Most importantly, however, it outlines best-practice examples in Article 5 countries and where appropriate also in developed countries to serve as a suitable example for technology and knowledge transfer. Results from the UNIDO and UNEP surveys complete the section with data from developing countries.

AWARENESS

The adoption of natural substances requires solid awareness levels among various stakeholder groups, including: national governments and local public authorities, who can drive appropriate regulation and standards; the non-profit industry and environmental organisations, who can accompany and drive market adoption; the suppliers and manufacturers, who can ensure a steady supply of technology options; and lastly those representing the demand side, commercial and industrial end-users as well as private consumers, who armed with knowledge about the economic and environmental benefits of natural substances can also help to drive the market.

BARRIERS



Overall, awareness levels of natural refrigerants among stakeholders in most Article 5 countries are still low. There is often little or no awareness of the existence of natural refrigerants, and no guidance exists as to which natural refrigerant to use for a given system and application. In some Article 5 countries, it is also felt that the lack of knowledge and understanding about natural refrigerants extends to those government departments and industrial associations working on HPMPs. In the 2013 survey conducted by UNIDO and shecco among 207 representatives from developing countries and economies in transition participated (see following SURVEY section). Access to information and stakeholder involvement were explored as barriers to the uptake of natural refriger-

ants and foams among industry and policy representatives. In the complementary UNEP survey conducted in 2012 on the most important criteria for the selection of technologies with HCFC alternatives, the familiarity with the technology and substance - mostly demonstrated through successful installations and case studies - was mentioned by National Ozone Units (NOUs) as a key selection criterion for developing countries. Both surveys confirm that the non-availability of targeted information among institutions, the industry, and to a lesser extent the wider public, constitutes a major challenge for the adoption of natural substances. Individual responses from Article 5 countries stress the importance of more motivational campaigns to encourage all stakeholders to proactively work on the implementation of the Montreal Protocol; of a stronger engagement by national and local media to distribute best practice examples in converting HCFC installations to more sustainable options; and of making sector-specific introductory and technical information available in national languages. Moreover, effective measures should encompass: the strengthening of institutions and officers to support a stronger collaboration between developing countries in the same Regional Networks or between neighbouring countries; an emphasis on using networking meetings and sharing platforms (online / offline); a shift to the regional and local level in engaging stakeholders to jointly work on projects, even across countries; the use of multidisciplinary working groups to evaluate all aspects relating to the selection of new technologies; and generally a more effective knowledge transfer from developed to developing countries.



SURVEYS: BARRIERS FOR NATURAL SUBSTANCES



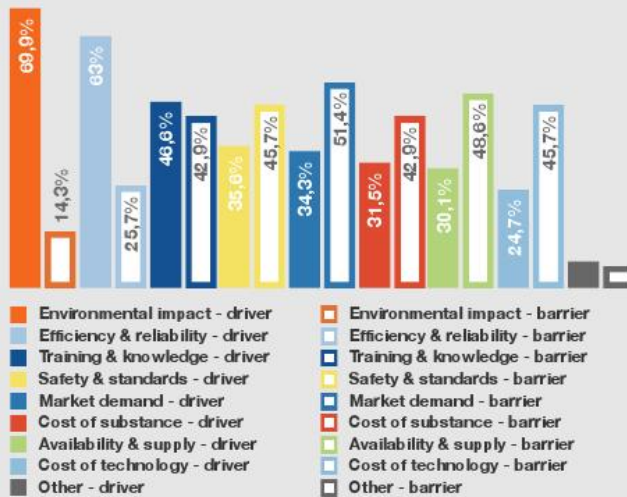
World



In the joint **UNIDO** survey participants that are currently working with natural substances (refrigerants and/or foams) were asked to select only those **Drivers that had encouraged them to work with natural substances**. Consequently respondents could select a number of factors of their choice, ranging from zero to all 9 factors. As can be seen, a positive environmental impact (70%), the technology's efficiency & reliability (63%), and training & knowledge (47%) represent the three strongest drivers for activities involving natural substances.

Alternatively for respondents indicating no prior experience the question explored **Reasons that had prevented them from activities involving natural substances**. For organisations not yet active in their use, market demand (51%), availability & supply (49%), safety & standards (46%), and the cost of technology (46%) constitute the four largest barriers.

The graphic below depicts combined results from both questions, where fully coloured bars represent the percentage of respondents from organisations experienced with natural substances that had selected a certain driver as important for their uptake. Their white bar equivalents indicate the percentage of respondents from organisations with no prior experience of using natural substances that selected an item as a barrier impeding their adoption.



substances that selected an item as a barrier impeding their adoption.

It can be concluded from the comparison of both response groups that training & specific knowledge is a field seen as a barrier and a driver at the same time. An overwhelming

agreement across both response groups, however, exists about natural substances' positive environmental impact, as well as their efficiency & reliability. Fields of concern - where the largest discrepancy between these being mentioned as a driver and as a barrier exists - are the cost of technology, followed by availability & supply, and market demand.

Survey respondents, independent of their current or future willingness to engage in activities involving natural substances, overall do not question the positive environmental contribution from a more widespread use of ammonia, carbon dioxide, hydrocarbons, water or air as refrigerants and/or foam-blowing agents. Strong drivers for their use also include the technology's efficiency & reliability. On the other hand, reasons preventing their use include a current lack of market demand, of technology options and steady supply, and unfavourable safety & technology standards.

For questions about the survey:

Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org



SURVEYS: BARRIERS FOR NATURAL SUBSTANCES

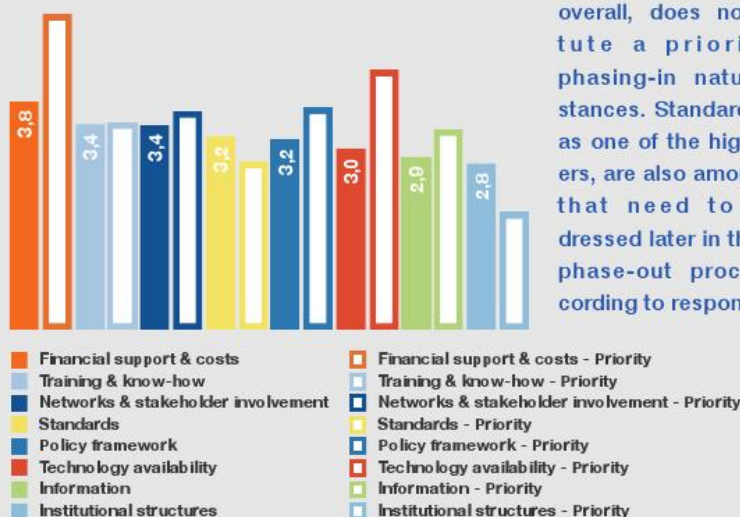


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As a confirmation of the aforementioned question, when asked about the **Most important barriers for the uptake of natural substances in the respondent's country** overall (range from 1 "no barrier" to 5 "very high barrier"), individuals indicated financial support & costs (3.8 out of 5.0) as the largest obstacle for a faster adoption of natural refrigerants and foams. Training & know-how (3.4), as well as networks & stakeholder involvement (3.4) are among the highest obstacles. However, a lack of institutional structures as the least important barrier is still felt to exert a considerable negative impact with a value of 2.8 out of 5.0, pointing to a situation where different world regions and countries face a variety of different barriers to the uptake of natural substances.

A second question enquired about the **Priority of addressing each barrier in the respondent's country**. Individuals had to rank items from the least urgent barrier (1) to the one with the highest priority on top (8). Not surprisingly, by far the most urgent obstacle to be addressed in developing countries are financial support & costs, indicating that the barrier that is considered to be the most important also needs to be addressed first. The second most urgent issue to overcome, and although only ranked as the 6th most important barrier overall, is the lacking availability of technology. Evaluated as having a lower but still rather high priority is the establishment of favourable policy frameworks, and the improvement on effective networks & stakeholder involvement, were ranked 3rd and 4th, respectively. On the other hand, the creation of institutional structures, rated as the least important barrier overall, does not constitute a priority for phasing-in natural substances. Standards, rated as one of the higher barriers, are also among those that need to be addressed later in the HCFC phase-out process, according to respondents.



Survey responses indicate that the lack of financial support and comparatively higher initial costs represent the major overall barrier for developing countries in a transition towards HFC-free solutions. This is followed by a lack of trained personnel, and unsatisfactory stakeholder involvement generally. In terms of when to address each barrier, the availability of technology in certain countries and applications, besides closing the financial gap, needs to be urgently increased, together with creating a favourable policy framework and engaging with different stakeholder groups.

Demonstration projects or installations are one of the most effective tools to build up first-hand expertise among legislators, marketing and technical personnel in corporations, and the research community, and ultimately increase the independence of Article 5 countries.

 The need for continued education and knowledge sharing in the HVAC&R sector in developing countries was frequently mentioned during the UNIDO ATMOSphere Technology Summit. Jürgen Usinger of GIZ/Proklima affirmed that a culture of continued education and knowledge sharing is necessary to accelerate the adoption of natural refrigerant technologies, together with capacity building and the introduction of certification and quality assurance schemes.

Torben Funder-Kristensen, Danfoss, and Lothar Serwas, Carrier, echoed these needs in their respective presentations. While Funder-Kristensen emphasised the importance of raising awareness of safety practices to ensure a safe use of components, Serwas stressed the importance of building local service and start-up capabilities to ensure the sustainability and independence of a natural refrigerant project.

These points were reiterated by Yaqoub Al-Matouq, refrigeration expert at the Kuwait National Ozone Unit, who drew attention to the lack of technical capacity to promote the installation, operation and service of natural refrigerant systems in West Asia, and Samba Bajie, Programme Officer at the NOU, National Environment Agency in the Gambia, who argued that the way forward for naturals in developing countries is awareness and capacity building.

In an example of positive action in this direction, according to Wang Yong, Deputy Manager at the Ministry of Environmental Protection (MEP/FECO) in Beijing, China's HCFC Phase-out Management Plan includes outreach, in addition to training, standard revisions and R&D in replacement technologies.

TRAINING & CERTIFICATION

Market adoption of new technologies in the Heating, Ventilation, Air Conditioning & Refrigeration (HVAC&R) and foam sectors hinges on the competency of involved personnel throughout the whole value chain, and more specifically on the sales, storage, handling, certification and licensing, transportation, and disposal of substances. More importantly, education, training, and certification is required for various professional groups: students, who represent the future researchers and engineers developing and designing new systems; technical personnel handling system installation, operation and end-of-life processes; in-house and external consultants optimising system performance in terms of leakage reduction and prevention of energy efficiency loss; and last but not least end-users, those carrying responsibility for the safe and efficient operation of each installation. Besides the lack

of training material and instructors, a second major barrier occurs when either no certificates for trained personnel exist or they are not accepted across the different country regions, and outside national borders.

BARRIERS



Both in most developed and developing countries there is a clear and noticeable lack of skilled engineers and HVAC&R technical staff. A global survey among HVAC&R industry experts in 2011 confirmed lack of training as the most important barrier, out of a list of seven decision factors, providing strong evidence of the urgency of addressing the problem of missing expertise (see the following SURVEY section). The problem is mostly related to a lack of general technical information about natural refrigerants like design guides, instructions for carrying out servicing and energy optimisation, and for the maintenance and disposal of equipment. Another challenge results from training facilities and hands-on equipment not being available for practical training of engineering and servicing personnel. As a result, the use of natural refrigerants with challenging properties has led to accidents and other safety issues avoidable with proper training of all involved parties. Concretely, in some newly industrialised countries like Brazil, India, Turkey and China, the increasing usage of industrial refrigeration with ammonia, particularly in the food and beverage processing industry, has led to an increase in incidents of ammonia releases. The problem is also consistently mentioned by large consumer goods brands with a global commitment to the use of natural refrigerants looking for qualified servicing staff in Article 5 countries. The adoption of hydrocarbon-based vending machines and light-commercial equipment has been slowed down in some geographic areas due to a lag in creating a skilled base of servicing technicians. The non-availability of Refrigeration and Air-Conditioning (RAC) associations and expert working groups in several countries has further aggravated the problem.



The importance of programmes in accelerating the safe adoption of natural refrigerant technologies in developing countries was reflected in the UNIDO ATMOSphere presentations. According to Professor Risto Ciconkov, from the University Ss. Cyril and Methodius, Skopje, Macedonia, there are few, if any, training centres equipped with CO₂, ammonia and hydrocarbon installations.

Iqbal Sheikh, IN Consult (Pvt.) Ltd., pointed to the need for a certification system in Pakistan, together with an overall revamp of curricula, to ensure that hydrocarbons are covered.



SURVEYS: AWARENESS & STAKEHOLDER INVOLVEMENT



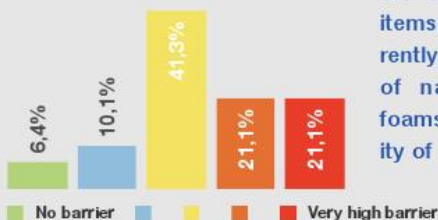
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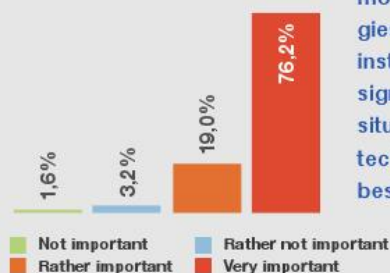
In the **UNIDO** survey among 207 representatives from developing countries and economies in transition, a more detailed analysis on the most important barriers for the uptake of natural substances in emerging economies was performed for the barrier item “**Information (no access to publications, manuals, standards etc.).**” As it can be clearly seen, the distribution in the below chart is rather balanced with slightly more respondents indicating that the lack of relevant information for different target groups constitutes a rather minor barrier as compared to, for example, financial or training issues. Overall, this item was ranked as the second least important barrier from a list of 8 barrier categories, with however still close to 30% of respondents saying it would be a rather “high” or “very high barrier” for natural refrigerants and foams.



However, when asked about the lack of **Networks & stakeholder involvement (no knowledge exchange, lack of stakeholder proactivity)**, respondents stated a less positive situation. Overall ranked as the 3rd strongest barrier from a list of 8 items, only 16% thought this is not currently a major problem for the introduction of natural refrigerants and HFC-free foams. The remaining overwhelming majority of 84% sees this as at least as a moderate if not a very high barrier.



In the **UNEP** survey among National Ozone Units from 79 countries in July 2012, the 3rd ranked criteria in selecting technologies with HCFC alternatives for developing countries was **Familiarity: high knowledge of the technology / substance, proven number of successful installations, case studies.** Although not specifically talking about natural refrigerants and foams it confirms that the availability of information among institutions, the industry and the wider public is a major driver for the selection of more sustainable substances and technologies. More importantly, the proven number of installations, publicised in case studies, can significantly help to counteract a lock-in situation where the familiarity with a known technology - although in some cases not the best available alternative - is the deciding factor for its use.



While information provision in form of direct access of stakeholders to relevant publications seems to constitute a slightly less important barrier overall, the lack of effective networks and proactive stakeholder engagement is rated as being a strong obstacle for the introduction of natural substances.



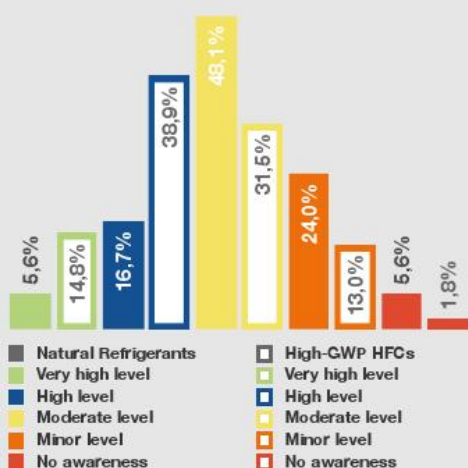
SURVEYS: HCFC ALTERNATIVES & THE ROLE OF STAKEHOLDERS



World



The survey then investigated **how well informed relevant stakeholders in the respondents' countries were about selected HCFC alternative substances and respective technologies** in July 2012, on a 5 point scale from "very high level of awareness" (5) to "no awareness" (1). Unsurprisingly, **High-GWP HFCs** reached the highest awareness levels, given their prominent role as replacements for HCFCs in a range of industry sectors in most developed economies. Consequently, 15% of respondents opted for the "very high level" awareness level; together with the "high level" option an absolute majority of 54% believed the knowledge among stakeholders was at an advanced level.



The situation for **Natural Refrigerants**, including ammonia, carbon dioxide, the group of hydrocarbons, water and air, was rated differently. With an average value of 3.00 the overall awareness level was "moderate" but with significantly lower occurrence than for high-GWP HFCs. Only 22% of respondents indicated an advanced knowledge ("very high level" and "high level" combined) about natural substances would exist among stakeholder groups – 32% less than for

high-GWP refrigerants. This situation can be interpreted as highly unsatisfactory for attempts to introduce natural substances as HCFC replacements, given that countries have to make long-term decisions about their use today.

Respondents to the joint UNIDO-shecco survey among private and public organisations involved in the HCFC phase-out were asked about the **Importance of selected stakeholder groups in adopting HFC-free foams and natural refrigerants**, on a 5 point scale from "not important" (1) to "very important" (5). National governments are considered to be the most important driver for a move away from fluorinated gases (4.2 out of 5.0), followed by the manufacturing and supplying industry (4.1), and industry associations (4.0). The non-profit sector is considered the least important to help a transition towards natural substances, with respondents still expecting an overall significant contribution from non-governmental organisations (3.1 out of 5.0).

In a subsequent question respondents had to evaluate the **Current positive or negative contribution of each stakeholder group to the adoption of natural substances**, on a scale from "very negative role" (1) to "very positive role" (5). The graphic below depicts results from both questions. Fully coloured bars represent the importance of stakeholder groups, while white bars represent the positive or negative role a selected stakeholder group currently plays.

However, familiarity with natural refrigerants, as compared to high-GWP refrigerant solutions currently widely used in developed countries, is rather low among relevant stakeholder groups involved in the HCFC phase-out.



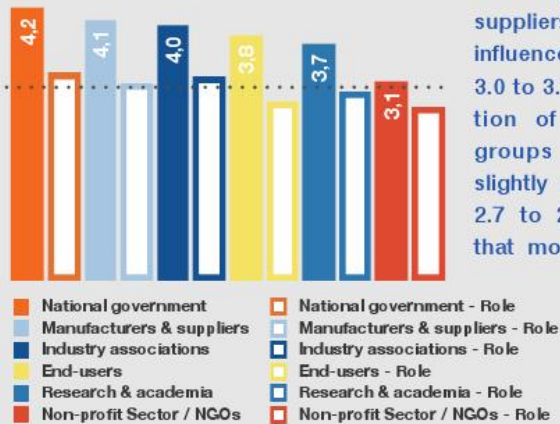
SURVEYS: FAMILIARITY WITH HCFC ALTERNATIVES



World

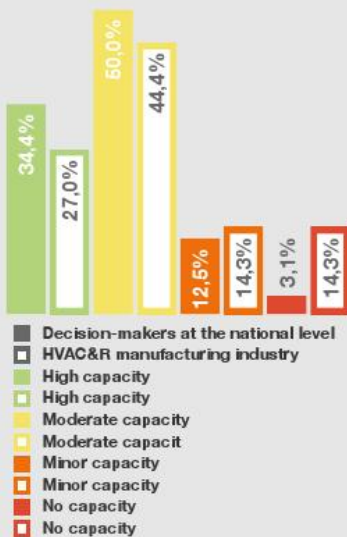


The dotted line indicates the point ("meridian") where stakeholder groups neither exert a negative nor a positive influence on the uptake of natural substances. All values above the line (above 3.0) point to a rising positive impact.



It can be concluded that only national governments, industry associations, and manufacturers & suppliers exert a weak positive influence, with values of around 3.0 to 3.2 out of 5.0. The contribution of all other stakeholder groups is currently rated as slightly negative, with values of 2.7 to 2.9. The results suggest that more needs to be done to fully use the potential of all stakeholder groups in driving the adoption of HFC-free substances.

UNEP's survey supports the findings of the UNIDO survey in a more general way. It asked respondents to evaluate the **Current overall capacity of different stakeholder groups in their countries to facilitate the HCFC phase-out process**. On a scale from "no capacity" (1) to "high capacity" (4), respondents had



to rate the contribution from decision makers at the national policy level; decision makers at the regional / local policy level; HVAC&R manufacturing industry; end-users; the non-profit sector / NGOs; research / academia; and the public.

The highest capacity is assumed for Decision makers at the national policy level, hence the survey's target group of National Ozone Units and state agencies. A mean of 3.16 - the only average value above 3 - equates to a "moderate capacity". More than a third (34%) ascribe this group a "high capacity". The HVAC&R industry has slightly less current capacity to facilitate the transition away from HCFCs, according to respondents ranking industry representatives with a lower

"moderate capacity". For the HVAC&R manufacturing industry, nearly a three quarter majority (71%) rate the capacity to be either "moderate" or "high".

National governments, the manufacturing & supplying industry, and industry associations are considered to be highly important stakeholder groups to influence the adoption of natural substances in developing countries. However, when looking at their current role in the transition process, their contribution is evaluated to be only very slightly positive. End-users, while generally being a very influential stakeholder group in a successful transition towards HFC-free solutions, are even exerting a negative current impact.

BEST PRACTICE



In Europe, Australia and North America there are a variety of training programmes available for CO₂, ammonia and hydrocarbons - regions where natural refrigerants have made inroads at least for some applications.

tions.

As laudable initiatives in Article 5 countries, in 2012, in the Caribbean region, Grenada in cooperation with the United Nations Environment Programme (UNEP) organised a regional training workshop on hydrocarbons for 35 technicians. In Africa, Ghana has been working hard to establish a culture of hydrocarbon and natural refrigerant use with the help of an Italian industry association, while in 2011 Benin started teaching workshops for instructors for air-conditioning conversion. A leading compressor manufacturer provides hands-on experience for refrigeration and air-conditioning professionals with a newly-built fully-functional, transcritical CO₂ supermarket booster system in its training centre in Brazil, while Pakistan has opened a "Natural Fluids Refrigeration Center" as a Research & Development hub for students and technicians. In India, the Association of Ammonia Refrigeration established a common platform to share knowledge, train engineers and plant operators, and advise the government on standards. In Central Asia, UNEP and a UK-based online learning platform have joined forces to promote the use of distance-learning courses eliminating barriers to introducing climate-friendly alternatives to HCFCs. In Turkmenistan, a seminar for both policy makers and HVAC&R companies working on alternative technologies using natural refrigerants was held in 2012.

NOUs responding to a 2012 survey mentioned the following elements as important to address the situation: ensure internationally acceptable industry training programmes would be made available; implement mobile training schemes where consultants would reach local technicians otherwise not able to participate in training schemes; and increase the provision of technical guides in all national languages adapted to the relevant industry sector and end-use application. New HVAC&R associations, training bodies and certification schemes that would allow technicians to use their skills across the country and even outside would lead to a more flexible workforce, driving a faster market adoption of natural substances-based equipment.



During the UNIDO ATMOSphere Technology Summit industry and NGO representatives as well as training experts with experience in Pakistan, India, the Gambia and the Republic of Macedonia, shared lessons learnt from their success stories relating to training and the introduction of hydrocarbons for foam blowing agents and in domestic refrigeration.

Torben Funder-Kristensen from Danfoss showed how an education programme in Brazil had led to concrete examples of successful natural solutions in the country. Michael Englebright,

from Carel, also discussed training in Brazil, in particular Bitzer's CO₂ Technology and Training Centre, the only one of its kind in the Americas to present new technologies and promote technical improvements in a simple and objective way. The centre has trained more than 1,000 technicians on the use of carbon dioxide in commercial and industrial refrigeration.

South Africa has seen CO₂ training conducted in a supermarket with a CO₂ cascade system. Here training covered both practical and theoretical aspects of using CO₂ as a refrigerant.

Lothar Serwas from Carrier discussed the manufacturer's multiple level service training approach (Basic level, Qualified level, Expert level, Central Support, and R&D Team) aimed at providing support for local service and engineering teams. Successfully applied for an effective market roll-out of CO₂ food retail refrigeration technology across Europe, the model constitutes a valid model for similar activities in emerging economies.

Moreover, such initiatives are not confined to systems and component suppliers, with end-users such as Nestlé also taking the lead in implementing in-house training and working with external training institutes to ensure the safe use of refrigerants.

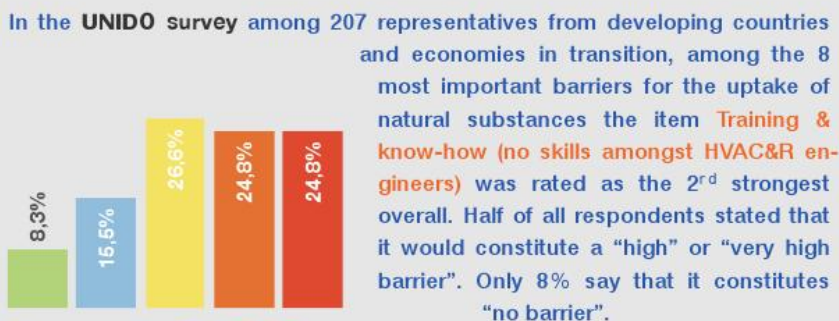
Anshu Kumar, Anadi Enviro Training, noted that based on his many years of practical experience working with hydrocarbons in India and South East Asia, when it comes to training "there are barriers and gaps – but there are also solutions". These include harmonising of training and streamlining certification systems; updating existing curricula; raising public awareness and changing the mindset of technical personnel; establishing a reliable evaluation tool to ensure the success of any refrigeration and air-conditioning training and integrating it in national and international policies; publishing a handbook on good servicing practices; rewarding technicians for adopting good practices; and emphasising country to country (South-South) co-operation.

SAFETY & TECHNOLOGY STANDARDS

The uptake of best-available technology and techniques is - besides economic and social factors - largely dependent on their proven, efficient, and safe use. Standards that directly affect the uptake of new alternatives in the HVAC&R and foam sectors include safety rules and technical norms regarding the flammability, toxicity, the release of the fluids themselves (refrigerants, heat transfer fluids, oils, foams), the components (pipes, valves, vessels, heat exchangers, pumps, compressors), the associated equipment (gauges, hoses, detectors, pumps etc.), as well as instrumentation and controls (alarms, switching, pressure reliefs etc.). Overall, system design is affected by technical standards in the fields of strength, tightness, the safety of moving parts, electrical safety, chemical compatibility, and noise levels, to name a few.



SURVEYS: TRAINING & KNOWLEDGE



In the **UNEP** survey among National Ozone Units from 79 countries, from a list of 8 Barriers in the HCFC phase-out process, **Training & know-how (no skills amongst HVAC&R industry & engineers)** ranked 3rd. Given the prominent role of the HVAC&R industry sector in all responding countries, the result confirms the lack of appropriate industry knowledge as a major stumbling block for the adoption of more sustainable refrigerant solutions in other studies also from a policy perspective.

Training & know-how among the HVAC&R industry were rated among the top three barriers in both the UNIDO and UNEP survey. Lack of expertise on substances, components and technologies therefore constitute a high obstacle for a more rapid uptake of natural substances.

For questions about the survey:
Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org

BARRIERS



Overall, one of the largest barriers to natural substances in both developing and developed countries is the limited understanding of the technical and safety aspects specific to the use of natural refrigerants and foams, that require either new design considerations for the systems and/or new practices in their installation, maintenance and operation. This stumbling block is often related to misconceptions and public resistance resulting from the non-availability of authoritative guidelines on best-practice use of such substances. The standardisation of containers, connections and piping are just a few examples where norms are missing. Exaggerated safety concerns are rarely properly addressed, as expert working groups qualified to update safety standards following the latest technology advances are lacking.

Safety standards and regulations that completely prohibit the use of flammable or toxic alternatives in Article 5 countries need to be updated to reflect increasing interest in natural refrigerants. While the successful use of natural substances in various applications has demonstrated their technical viability and safe operation, national safety standards lag behind the rapid introduction of market-ready solutions in some applications.



Many speakers underlined the need for continuous efforts in updating safety standards during the UNIDO ATMosphere Technology Summit. For example, in Professor Risto Ciconkov's presentation (University Ss. Cyril & Methodius in the Republic of Macedonia), the need to review old safety standards and the lack of a certification system in the Republic of Macedonia was highlighted.

In Pakistan, regulatory barriers to the adoption of hydrocarbon technologies in the RAC (Room Air Conditioning) were identified as ASHREA 34, ISO 817, and EN 378, which classifies R290 as A3 i.e. toxic and highly flammable. Also problematic are IEC standard 60335-2-24 and 60335-2-89, which restrict the charge size to 150 grams of flammable refrigerant. In addition there are no standards that establish safety guidelines for units with a charge size in excess of 150 grams.

In China, safety considerations and charge restrictions remain important barriers for a wide market acceptance of hydrocarbon applications according to Li Tingxun, Midea.

Alongside the lack of safety standards, Danfoss stressed the importance of raising awareness of safety practices to ensure proper use of components. A single mishap, whether due to a reduction in safety or due to a failure to provide the promised decrease in operating costs, can have far-reaching consequences.

BEST PRACTICE



In some Article 5 countries, a revision of safety standards has led to a lifting of bans on the use of hydrocarbons. For example, China has launched a national safety standard for flammable refrigerants which has permitted the adoption of flammable refrigerants like R290 in the production of air conditioners since May 2013; and a safety standard for cold stores reflecting the development needs of the cold storage industry, which now relies mostly on ammonia. India has established a strategic partnership with Germany to introduce hydrocarbons into the manufacturing of air conditioners and to strengthen India's capacities in adopting other natural refrigerant technologies. China has teamed up with Europe and the USA to develop common CO₂ compressor performance standards. The Chilean Chamber of Refrigeration and Air Conditioning has developed a "Good Practices Manual for Ammonia Refrigeration Systems" to set out minimum criteria for the safe operation of new and existing installations.

In the USA, the Environmental Protection Agency (EPA) has given the green light to the use of hydrocarbon refrigerants in certain refrigeration applications and officially gave Significant New Alternatives Policy (SNAP) approval to R290 (propane) and R600a (isobutane) - removing a major barrier to the market entry of HCs in the last big world market where their use had been prohibited. The EPA also published a proposed rule in April 2013 to lift the venting prohibition of three hydrocarbon refrigerants in domestic and stand-alone retail refrigeration, after an analysis concluded that R290, R600a and HC blend R441A "are not expected to pose a significant threat to the environment" and that "after release they break down into naturally occurring compounds."



Tackling safety considerations head-on, Li Tingxun from Midea provided an overview of barriers for the uptake of R290 AC in China. Safety considerations and charge restrictions remain important barriers for a wide market acceptance. However, Dr. Li stressed that these barriers can be solved. Midea has successfully received certification from the China National Product Quality Supervision and Test Centre (CQST), which demonstrates their R290 RAC can even work in a flammable atmosphere.

Speaking from the end-user perspective, Vincent Grass from Nestlé spoke of the company's stringent internal standards that go above and beyond many codes and regulations to assure safety. In order to overcome the hurdle of lack of competences in developing countries, Nestlé introduced a series of solutions including developing standards, "safe by design" service, training, and education, on natural refrigeration. Raising awareness of safety practices and delivering training of a high standard are identified by Nestlé as crucial for their successful proliferation of natural solutions in developing countries.



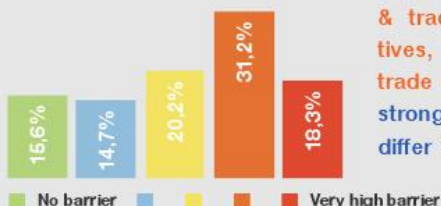
SURVEYS: SAFETY & STANDARDS



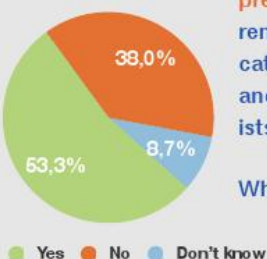
World



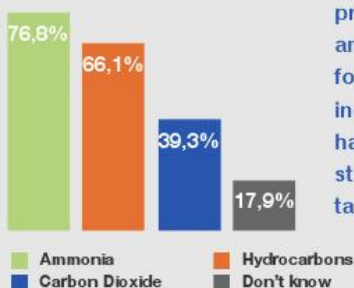
In the **UNIDO** survey among various stakeholder groups from developing countries and economies in transition, among the 8 most important barriers for the uptake of natural substances the item “Standards (no or unfavourable safety & trade standards for HFC-free alternatives, no quota systems / control of HCFC trade etc.)” was overall rated to be the 4th strongest barrier. However, respondents differ in their evaluation. While nearly half of all respondents (49%) think this is a “high” to “very high barrier”, on the other hand a combined 30% says it is “no barrier” to a minor barrier only.



More than half of all respondents (53%), when asked about the **Availability of safety standards on refrigerants with flammability, toxicity and/or high-pressure properties**, indicate that such standards currently exist in their country. However, a high 38% indicates that no such standards exist in their country, with another 9% not being informed if such a standard exists.



When asked about **which refrigerants would currently be covered by national safety standards** (only in countries where such standards for flammable, toxic and/or high-pressure refrigerants exist), 77% of respondents indicate that ammonia is already covered by such standards. Two-thirds indicate this to be the case for hydrocarbons, whereas only 39% say carbon dioxide is already covered. Another 18% are not informed about which refrigerants are covered. The situation can be interpreted as being unfavourable for hydrocarbons and especially unsatisfactory for CO₂, whereas for NH₃ as a refrigerant widely used in 40% of industrial refrigeration appliances worldwide has a better coverage in safety and technology standards. Results are in line with the importance of safety standards as a barrier currently



impeding a wide-spread use of natural refrigerants in emerging economies.

A lack of suitable safety and trade standards are among the most important challenges developing countries face in the adoption of natural substances. While a slight absolute majority of respondents have safety standards in place in their country, another large percentage of respondents indicate a lack of such standards.

In terms of substances covered in most respondents' countries ammonia is the dominant refrigerant, followed by flammable hydrocarbons.

For questions about the survey:
Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org

Torben Funder-Kristensen from Danfoss introduced the company's safety training programme in Brazil and how these practices have led to concrete examples of successful natural solutions in Brazil. By building safety into the components and by taking measures to ensure their safe and responsible use, Danfoss now allows its control systems and components for natural refrigerants to be sold globally.

REGULATION & POLICY FRAMEWORKS

The restriction on the use of ozone-depleting substances and those with high global warming potential by international environmental agreements and national authorities is one of the most effective ways to increase the attractiveness of natural substances. A set of tools exists for national authorities to drive the adoption of economically, socially and environmentally sustainable options, ranging from direct subsidies for those industry players that choose a certain technology, to marketable permits to limit the use of undesired substances, and voluntary partnerships with industry to achieve sector-specific emission reduction targets. One of the most popular measures taken by governments is imposing taxes on obsolete technologies and practices with a view to phasing out their use. As an evident example of this approach, the availability of HFCs is increasingly controlled by legislation in Europe, Australia and North America due to their environmental impact. Another, and indeed complementary way to financially regulate the market, is to define global, national or sector-specific standards. The limitation of ODS and high-GWP substances is mostly affected by trade standards.

BARRIERS



The deficiency in trade standard enforcement and lacking capacity of customs officials to control the trade of HCFCs has further slowed down a move away from ODS towards solutions with a lower environmental impact, including natural refrigerants. National Ozone Units also lament the absence of clear guidelines on the HCFC phase-out process, and unclear policy frameworks for facilitating the leapfrogging to low-GWP or no-GWP alternatives. As a priority, the harmonisation of global HCFC frameworks with local rules is suggested.



The UNIDO ATMOSphere Technology Summit heard global consumer goods brands on the main policy barriers preventing them from adopting natural solutions in developing countries. Representing Red Bull and global initiative "Refrigerants, Naturally!" Jürgen Brenneis talked about the challenges the company faced in introducing even more HFC-free equipment in their branches in developing countries. These include after sales capabilities and component availability, a lack of approvals and certificates as well as legal and trade barriers.

Brenneis called on the governments to work together with globally active end-users to find viable solutions so as to facilitate the introduction of more equipment using natural substances.

Nestlé shared these views, arguing that end-users cannot do it alone when introducing natural solutions to developing countries. According to Vincent Grass, governments and industrial stakeholders need to do more.

BEST PRACTICE



In November 2012, the European Commission proposed a revision of the EU Fluorinated Gas (F-Gas) Regulation, which would introduce a phase-down of HFCs in the EU as well as HFC bans in some new equipment where viable climate-friendly alternatives are readily available. In addition, the so-called "Mobile Air-Conditioning (MAC) Directive" prohibits the use of F-gases with a global warming potential 150 times greater than that of carbon dioxide (CO₂) in all new passenger cars and light commercial vehicles produced from 2017. After introducing taxes on HFC refrigerants in 2003, a total ban on the use of HFC refrigerants in Denmark in new systems with charges exceeding 10 kg has been enforced since 2007.

At the global level, Parties to the Montreal Protocol recognise the climate impacts of high-global warming substances and are increasing their calls to give priority to "substitutes and alternatives that minimise other impacts" to the environment besides having a zero ODP. The Multilateral Fund provides additional funding for the implementation of the Montreal Protocol (MLF) for additional climate benefits including a low GWP.



At the UNIDO ATMOSphere Technology Summit, efforts by developing countries to involve more natural refrigerant technologies in their HCFCs Phase-out Management Plans were in evidence. Wang Yong from the Ministry of Environmental Protection (MEP/FECO) of China introduced the country's national plan to adopt natural substances in the HVAC&R sectors prior to 2015. In Room Air Conditioning (RAC) R290 will eventually be used in 70% of RAC production (annual capacity of 5 million HC AC units), with two demonstration projects on-going by UNIDO and GIZ, and a total of 35 plant conversions underway. In industrial and commercial refrigeration, CO₂/NH₃ cascade technology will be one of the main options.

A growing movement of companies towards natural refrigerants despite a lack of government incentives was also highlighted by several speakers. According to Caleb Nelson from CTA Refrigeration, the occurrence of 100+ CO₂ cascade and secondary commercial refrigeration systems and a most recent trend to introduce CO₂-only systems has happened in the absence of HFC legislation, taxation and production quotas. A similar situation is developing in Mexico, where domestic companies are voluntarily converting production lines to HCs for commercial and domestic



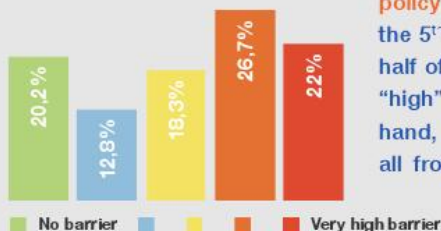
SURVEYS: POLICY FRAMEWORKS



World



In the **UNIDO** survey, among various stakeholder groups from developing countries and economies in transition, among the 8 most important barriers for the uptake of natural substances the item **Policy framework (no guidelines on HCFC/HFC phase-out process, unclear policy schemes etc.)** was rated to be only the 5th strongest barrier overall. Still, nearly half of all respondents (49%) believe it is a “high” to “very high barrier”. On the other hand, every fifth encounters no barrier at all from current legislative frameworks or the lack of appropriate guidelines (20%).



on HCFC/HFC phase-out process, unclear policy schemes etc.) was rated to be only the 5th strongest barrier overall. Still, nearly half of all respondents (49%) believe it is a “high” to “very high barrier”. On the other hand, every fifth encounters no barrier at all from current legislative frameworks or the lack of appropriate guidelines (20%).

Respondents to the **UNEP** survey conducted in July 2012 were asked about the **availability of a detailed strategy and performance-based plan for the phasing out of HCFCs in different sectors**.

Refrigeration, heating & cooling (HVAC&R) is the only sector that is available in all countries responding, with no “sector not available in my country” response recorded. 79% of valid responses had already developed a strategy for the HCFC phase-out in mid-2012, while a significant 21% had not yet done so. Given the importance of this sector, this result can be interpreted as a sign that progress was not being made at the same speed in all countries, shortly before the HCFC freeze deadline.



For the **Foam sector** the situation in July 2012 was comparable, with 21% of valid respondents not having implemented a detailed strategy for this sector – the same rate as for the HVAC&R sectors. As a marked difference, 40% of respondents do not have this sector available in their country.



Although policy frameworks, including unclear schemes and guidelines on the HCFC/HFC phase-out process, are not among the highest barriers overall, still nearly half of all respondents believe this to be a significant barrier for the uptake of natural substances in their country.

For questions about the survey:
Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org

refrigeration, and in Brazil, where several supermarket chains, such as Verdemar, have voluntarily started investing in CO₂.

Agustín Sánchez Guevara, National Coordinator of México's Ozone Protection Unit, concluded that "there are some companies that are doing this by themselves because of the cost. Because they have to reduce the cost of energy and they can do this with R290".

FINANCIAL INCENTIVES & COSTS

Direct financial incentives and subsidies on one side, and penalty and tax schemes for undesired technologies on the other, usually constitute one of the strongest basis for a more rapid implementation of pilot projects, awareness raising campaigns, the organisation of dedicated stakeholder events, and other tools necessary for achieving a broad introduction of best-available technologies and techniques.

BARRIERS



In a 2011 global HVAC&R industry survey "Funding & Costs" was ranked as the 3rd most important barrier to a faster market uptake of natural refrigerants. In later surveys both industry and policy makers singled out a lack of funding and financial support as the most difficult challenge in developing countries to select HCFC alternatives and more specifically natural substance-based options (see for more details the following SURVEY section). While HVAC&R suppliers confirm that capital costs for natural refrigerant-based technology are on par with conventional (HCFC, HFC) systems in a steadily rising number of applications, still the initial system acquisition cost remains one of the strongest arguments against the viability of natural refrigerant solutions. Compared to other more mature solutions like HFCs, introducing natural refrigerant technology generally requires an even higher investment cost in Article 5 countries, considering the additional costs associated with prior technology transfer, import tariffs, personnel training and etc. However, once introduced on a larger scale, the growth of natural refrigerant equipment use and a wider variety of available components, associated with more competitors entering the market, will naturally result in lower acquisition costs.

BEST PRACTICE



In countries like Denmark and Australia, HFC taxes that internalise the external cost of HFCs and create a level playing field for natural refrigerants have already been introduced. Denmark in particular has in place a combination of measures enabling a transition to natural refrigerants, including: bans on all HFC uses except for applications with a refrigerant charge between 150g and 10kg, taxation of F-gases at €20/tco₂eq, as well as support for the de-

velopment of alternative technologies. Domestic F-Gas policy in Denmark has been the main driver explaining the fast growth in the market uptake of CO₂ refrigerant in commercial refrigeration systems (now 600+ stores), the use of hydrocarbons for commercial refrigeration plug-in cabinets and domestic refrigerators/freezers, of ammonia for industrial refrigeration systems, as well as of ammonia and hydrocarbons but also water refrigerant for chillers. Now more and more countries like Sweden and France are considering the introduction of taxes on HFCs. Regarding general messages to be extracted from the Danish example it can be noted that in a country where stricter than supranational standards regarding the use of F-gases apply, not only a steady decline in imports of HFCs could be seen but also a drastic reduction in overall F-gas emissions. In November 2012, Switzerland announced its strengthened national F-Gas policy. The new regulation will be introducing HFC bans as of 1 December 2013 in a series of air-conditioning and refrigeration applications, with a particular focus on larger capacities. Switzerland has sent a message of confidence in the availability of HFC-free solutions in a number of sectors where the industry can optimally cover the cooling and heating needs with technologies using natural refrigerants. As one result of clear government action the number of CO₂-only commercial refrigeration equipment more than doubled from around 150 stores to 365 stores in just 2 years.

In Japan, because the Japanese government subsidises the purchase of CO₂ heat pumps, around 3.5 million units had been sold throughout the country by 2012. This number is estimated to reach 10 million by 2020.

Although most Article 5 countries still have not created favourable economic conditions in the form of clear subsidy schemes for natural refrigerant technology, in some sectors like domestic air conditioning, the PU foam sector and the industrial refrigeration sectors, projects with natural substances have received funding by the German development agency GIZ, the Global Environment Facility (GEF), and Multilateral Fund for the Implementation of the Montreal Protocol. Decision 60/44 (2010) of the Executive Committee of the Multilateral Fund has allowed for up to a 25% funding increment, above cost-effectiveness thresholds, when projects provide additional climate benefits. This support was mainly created to facilitate the uptake of low-GWP alternatives and has, to some extent, increased the attractiveness of projects with natural substances.

One commendable initiative in Africa resulting from the MLF funding is the first refrigeration manufacturer in the sub-Saharan region to have successfully converted production lines to the use of natural refrigerants with financial and technical assistance provided by a German development agency. Qualifying the engineering and technical staff in new refrigeration technologies helped to secure and maintain around 500 jobs at the company.

In China, India and Indonesia production lines of major air conditioning manufacturers for R290 room air conditioners and refriger-



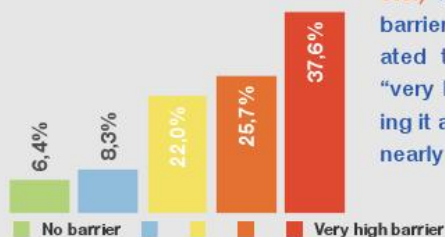
SURVEYS: FINANCIAL INCENTIVES & COSTS



World

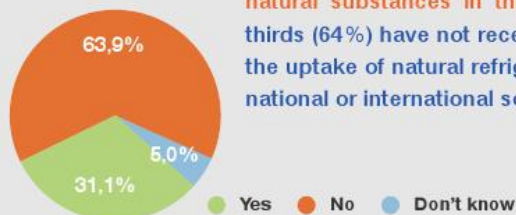


In the **UNIDO** survey among stakeholders from developing countries and economies in transition, among the 8 most important barriers for the uptake of natural substances the item **Financial support & costs (investment, no national and international finance schemes, etc.)** was rated to be the most significant barrier overall. Not surprisingly, 38% evaluated the cost and finance aspect as a “very high barrier”; together with those rating it as a high barrier, the rate increased to nearly two-thirds combined (63%). Only 6% said it would not constitute any obstacle for a faster introduction of natural substances.

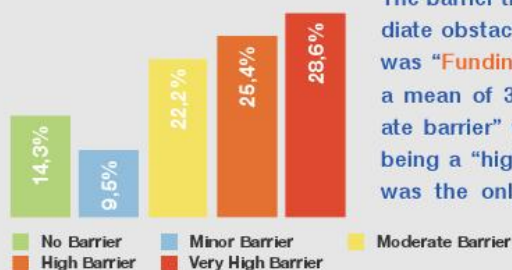


Only 6% said it would not constitute any obstacle for a faster introduction of natural substances.

Respondents were then asked about the **availability of financial support for natural substances in their organisation**. Nearly two-thirds (64%) have not received any financial support for the uptake of natural refrigerants and foams from either national or international sources.



As a confirmation to the findings from the 2013 UNIDO survey among various stakeholder groups, the **UNEP** survey conducted in July 2012 among National Ozone Units shows similar results, but on a more general level. Participants were asked which would be the **main barriers their country would be facing in the HCFC Phase-out process**. The list of suggested barriers contained 8 items, that had to be evaluated on a 5 point scale ranging from “no barrier” (1) to “very high barrier” (5).



The barrier that emerged as the most immediate obstacle to a faster HCFC phase-out was “**Funding and financial support**”. With a mean of 3.4 it translated into a “moderate barrier” with strong tendency towards being a “high barrier”. This response item was the only one out of the 8 surveyed items where the “very high barrier” option was selected as the single

most frequent one (mode = 5 “very high barrier”).

The strongest obstacles for developing countries in adopting HFC-free refrigerants and foam-blowing agents are the lack of financial support and real or perceived costs associated to the adoption of such technology.

This was confirmed in both the UNIDO (2013) and UNEP (2012) surveys.

For questions about the survey:

Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org



SURVEYS: COST BARRIERS



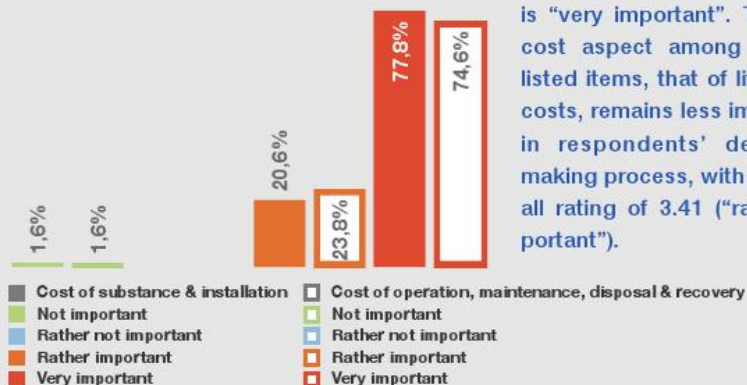
World



The UNEP results about general obstacles confirm the findings of the more recent UNIDO survey about the major barriers specifically for the uptake of natural substances which again demonstrates that financial incentives regularly constitute the basis for a more rapid implementation of pilot projects, awareness-raising campaigns, the conduct of dedicated stakeholder events, and other tools necessary for achieving a broad effect.

The survey further investigated **which cost barrier would constitute the highest obstacle**. The cost of substance & installation is the most important single decision factor for respondents, with a mean of 3.75 on a scale of 1 ("not important") to 4 ("very important"). An overwhelming 78% say it is "very important". The response confirms that the capital cost remains a more decisive factor in opting for a specific solution as compared to life cycle costs calculated over the whole lifetime of a substance/technology. Similarly, the cost of operation, maintenance, disposal & recovery is an important decision factor for or against an HCFC alternative, with nearly the same average value of 3.73

("very important"). 75% say it is "very important". The last cost aspect among the 11 listed items, that of life cycle costs, remains less important in respondents' decision-making process, with an overall rating of 3.41 ("rather important").



In regards the specific cost categories which pose the largest challenge to developing countries, the cost of substances and installation is the most important single decision factor for respondents.

The capital cost of a system, therefore, remains a more decisive factor in opting for a specific solution compared to its overall life cycle costs.

eration systems were set up with the support of UN development agencies and the German development agency, GIZ. A grant from the Global Environment Facility (GEF) for the promotion of HFC-free equipment has enabled Azerbaijan to investigate in the viability of natural refrigerants technology.

 Riccardo Savigliano, UNIDO, presented two pilot projects to convert HCFC-22 facilities to ozone- and climate-friendly alternatives in the fishing & food processing (servicing) sectors in Viet Nam and the Gambia. UNIDO will use the synergies between the MLF and the GEF to promote the conversion of existing HCFC-22 installations to low-GWP and high energy efficiency technologies.

MLF funding will also be used to fund a project entitled "Phase Out HCFCs and Promotion of HFC-free Energy Efficient Refrigeration and Air-Conditioning Systems in the Russian Federation Through Technology Transfer." The rationale for this project is to take advantage of the redesign and conversions required to phase out HCFCs to provide the technical assistance and technology transfer for enhancing the energy efficiency of the equipment being manufactured. By combining these two activities, the programme can achieve the climate benefits of both an ODS phase out and an energy efficiency programme without the full cost of two initiatives. The primary target of this project is the direct phase-out of 600 ODP tonnes of HCFCs in the foam and refrigeration manufacturing sectors in the Russian Federation to meet the 2015 Montreal Protocol target. The project also aims to achieve indirect GHG emissions reduction through reduced electricity consumption in the commercial and industrial refrigeration sectors, of approximately 10 MMT CO₂ in 5 years, contributing to the Russian Federation's CO₂ reduction targets.

As another effective way to globally spread technology to increase energy independence, the GEF has approved USD 2.7 million for the further development of "SolarChill", combining the use of solar energy with "Greenfreeze" hydrocarbon refrigeration in Kenya, Swaziland and Colombia.

Successful business models for CO₂, ammonia and hydrocarbon refrigeration projects that have not received MLF and GEF funding also exist. Those discussed at the UNIDO ATMOSphere Technology Summit include CO₂ supermarket systems in South Africa and Brazil. In South Africa, supermarket Pick n Pay has successfully introduced a subcritical cascade CO₂ system (R134a MT/CO₂ Dx LT) to its store in Johannesburg. A CO₂/R404a cascade system helped to achieve total energy savings of 22,26% when it was installed in a local supermarket. Also, in Brazil, a CO₂/R134a system has helped a supermarket reduce its operating costs by 4% compared to state-of-art HFC solutions in Brazil.

TECHNOLOGY & MARKET AVAILABILITY

As the most basic requirement for replacing obsolete substances and technologies, the availability of viable alternatives has to be ensured. New technologies usually face a "chicken-and-egg problem," in which the non-availability of technology prevents a market from growing and seizing benefits from emerging economies of scale, and where the non-existence of market demand does not entice suppliers to invest in a technology with currently unattractive profit margins and unknown future prospects. To ensure rapid technology adoption in a national market and/or industry sector strong signals are required - financial, legislative, voluntary industry-led, etc. - to strengthen the manufacturing base and build a business case around the adoption of previously underused substances and technologies.

BARRIERS



While world regions like the European Union or North America have emerging or already mature markets for natural refrigerants and foams, in most Article 5 countries there is an actual or at least perceived non-availability of natural refrigerant solutions due to a lack of information, a shortage of knowledge exchange, and uncoordinated initiatives. Technology non-availability has many facets, from the mere sourcing and distribution of the substance (refrigerant, foam), to the access to components and systems optimised for toxic, flammable or high-pressure substances. Especially countries with a less-developed local HVAC&R manufacturing base and workforce might encounter difficulties in influencing the speed and direction taken by the HVAC&R market. Some international companies that would like to apply natural refrigerant equipment often find it hard to identify local partners to deal with the maintenance and repair of the equipment and to source components matching the selected systems locally.

BEST PRACTICE



Nevertheless, there are pioneering companies in various emerging economies driving the market acceptance of natural substances. International suppliers have made technology available across different continents, drawing on their experiences in mature markets in developed countries to develop well-defined launch strategies to ensure natural refrigerant products succeed in new markets. These strategies include the provision of training and support for local service and start-up capabilities to ensure the sustainability and independence of a natural refrigerant project.

With various multinational supermarket chains and consumer goods brands expanding their natural refrigerant commitment to developing countries, leading to the adoption of subcritical CO₂

and ammonia refrigeration systems in countries in South America and Asia, it is clear that more and more transnational and local enterprises have realised the market value of natural refrigerant technology and are actively exploring the market potential for these in developing countries.

Action will not only be required in the HVAC&R but also in the foam sector, where pentane or water-blown foams are excellent alternatives to the commonly used high GWP HCFC 141b, as demonstrated by successful cases in South America. In Brazil two domestic companies have converted production lines to cyclopentane as a blowing agent for PU foam, whilst in the Philippines supercritical CO₂ is being tested as a blowing agent.

 Since the early 1990s, environmental NGO Greenpeace set out to reduce the use of F-gases. Under its GreenFreeze global campaign it promotes the use of hydrocarbons for both the blowing of the insulation foam and the refrigerant in domestic refrigerators. The GreenFreeze revolution is one of the main success stories of technology and market availability for natural refrigerants. It has resulted in more than 650 million HC refrigerators worldwide. Janos Maté and Wolfgang Lohbeck drew attention to the rapid adoption of GreenFreeze providing strong evidence that despite initial fierce opposition the transition to natural refrigerants can be achieved safely.

Another global market player, AHT, has made light commercial hydrocarbon refrigeration technology available in many developing countries. In Thailand, the company has already installed a total of 2,750 (64 units per store on average) R290 cabinets.

Other examples include two Chinese heat pump manufacturers who have introduced 50-70 projects using CO₂ refrigerant-based commercial and industrial heat pumps that can operate in extreme climatic conditions.

Wang Yong, Ministry of Environmental Protection (MEP/FECO) in Beijing, explained that China's HPMP requires an annual production capacity of 5 million R290 ACs by 2015, whilst Li Tingxun from Midea, one of China's largest manufacturers of air conditioners and compressors, said "Environmentally friendly technology should be the right direction for the RAC industry... Midea has not decided in which part of China to sell the product first, [but] we are quite sure we need to build the production line and be ready for the market."

REFRIGERANT SELECTION METHODOLOGY

When selecting alternative refrigerant technologies for HVAC&R systems, it is crucial to consider not only the direct environmental impact in terms of ozone-depletion and global warming potential of refrigerants, but also to calculate the energy consumption of the system under consideration. A holistic methodol-

ogy, such as the Life Cycle Climate Performance (LCCP), the Life Cycle Assessment (LCA) or the Total Equivalent Warming Impact (TEWI) approach evaluating the total environmental impact guarantees an informed choice for industry selecting the best-available refrigerants and technologies per end-use application and sector.

BARRIERS



In UNEP's 2012 survey a clear majority indicated that a common methodology for evaluating HCFC alternatives among industry is missing in their country and is highly appreciated as a way to standardise the evaluation of alternatives on environmental, technical and economic grounds. Currently, a simple evaluation on the basis of the Global Warming Impact (GWI) is commonly used in Article 5 countries, together with an evaluation of energy efficiency. However, neither a consensus on the atmospheric lifetime to be used as a baseline (20 vs. 100 years GWP) nor a uniform energy efficiency evaluation exists.

BEST PRACTICE



A notable effort at the global level to overcome this barrier has been the development of the Multilateral Fund Climate Impact Indicator (MCII) that is aimed at providing a reliable numerical indication of the climate impact associated with ODS phase-out projects and programmes funded by the Multilateral Fund. However, most recently there have been discussions on validating this tool, either by the Intergovernmental Panel on Climate Change (IPCC) or other climate change scientific body, and on how to further improve the tool.

At the national level, "Pack Calculation" is an application developed together with both Danish and international companies for comparing the yearly energy consumption of refrigeration plants. Among other features, transcritical CO₂ systems can be compared with traditional systems. The application makes this comparison based on geographical location. In the current version, the application contains models of 11 commonly used refrigeration cycles and more than 4000 commercially available compressors. Another tool is the "Quickcheck" used to compare the annual energy consumption of supermarkets with statistical data from other stores. However, for the latter no simulation is carried out.



It was evident from discussions at the UNIDO ATMosphere Summit that projects should maximise the climate benefit, i.e. replacement technologies should utilise alternatives with low global-warming potential (GWP) wherever available/ applicable. This has clearly been the case in many of UNIDO's projects across the world - from China and the Gulf countries to the Gambia and Viet Nam.



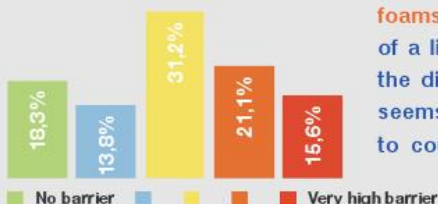
SURVEYS: AVAILABILITY



World

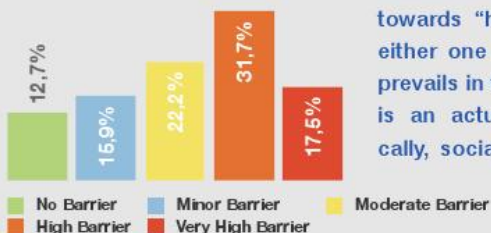


In the **UNIDO** survey of stakeholders from developing countries and economies in transition, among the most important barriers for the uptake of natural substances the item **Technology availability** (systems, components, refrigerants, foams not available) was only rated 6th out of a list of 8 barriers. However, looking at the distribution of responses the situation seems to differ significantly from country to country, with 18% saying “no barrier” would exist, while 15% state that lack of alternatives in their country would indeed be a “very high barrier”.



It can be concluded that a more focused approach for world regions where only few alternatives have been trialed and are now commercially available needs to be pursued.

Results are significantly different in **UNEP's** survey conducted in July 2012 among National Ozone Units. In this survey, the second strongest barrier from a list of 8 items was “**Technology Availability**”, following “Funding & Costs” as the most important obstacle for a faster HCFC phase-out process. The availability of systems & components, refrigerants / foams etc. reached an average value of 3.25 out of maximum 5.0, meaning a “moderate barrier” with slight tendency towards “high barrier”.



The result is that either one of the following two situations prevails in the surveyed countries: 1) There is an actual non-availability of economically, socially and environmentally sustainable refrigerant and system options in the respective country. 2) There is a perceived non-availability of such solutions, due to lack of information, lack of knowledge exchange, uncoordinated initiatives and approaches taken by the policy and the industry sphere, etc.

Results about the importance of technology availability as a barrier to the faster introduction of HCFC alternatives generally and natural substances more specifically differ widely, depending on the type of stakeholder group asked and the country concerned. While for some countries the lack of market-ready technology and substances remains a large obstacle, others are progressing well in overcoming this barrier.

For questions about the survey:

Nina Masson, shecco
Raquel Aledo, UNIDO

nina.masson@shecco.com
r.aledo@unido.org

CASE STUDIES

Real-life applications are the most convincing evidence of technology and market change happening around the world. An ever increasing number of groups and associations, dedicated stakeholder meetings, system and component solutions, training courses or viable business cases, are proof of developing countries' initiative to drive forward the adoption of natural substances. The following section provides a collection of 50 case studies of high relevance to developing countries and economies in transition. Case studies are sorted by the barrier type they predominantly address:



Each case study specifies the following information:

CASE STUDY (INCL. BARRIER ADDRESSED)		COUNTRY / REGION
SUBSTANCE USED & APPLICATION SECTOR		
CASE STUDY DESCRIPTION Global consumer goods brands require effective solutions for their operations involving light-commercial, commercial and industrial refrigeration and air-conditioning processes in developing countries. During the 2013 UNIDO ATMOSPHERE Technology Summit, Nestlé introduced the company's experiences dealing with natural refrigerants in developing countries. Nestlé introduced a series of solutions including standards-making, "safe by design" service, training and education on natural refrigeration. 	CO₂ NH₃	KEY MESSAGES Energy consumption decreased by 51% as compared to an R404a system.
CONTACT PERSON	MORE INFORMATION LINK EMAIL PHONE NUMBERS ORGANISATION LINK	



CAREL: CO₂/R134A FLAGSHIP STORE IN JOHANNESBURG



South Africa

System Design Objective



The installation is located at The Falls, Pick n Pay's flagship 4,800 m²/50,000 ft² store in Johannesburg, South Africa. The system design objective for (1) Lower GWP (2) Efficient Plant Performance and (3) Ease of Service was realised with the development of a R134a/CO₂ Subcritical Cascade System.

R134a Dx with Sub Cooling MT System

The medium temperature system operates on R134a refrigerant with a suction temperature of -10°C/14°F and condensing at the design condition of 43°C/109°F. The refrigeration requirement for the R134a system is 648.77kW/ split over the two multiplex racks. The unique design allows for cooler liquid refrigerant to be supplied to the evaporators, maximizing their efficiency and contributing to the already energy-efficient plant.

R744 (CO₂) Dx LT System

The CO₂ low temperature system operates at a design condition of -32°C/-25°F suction temperature, condensing at -5°C/23°F. The condensing of the low temperature system is done via a plate heat exchanger on one of the medium temperature systems. The low temperature system has one rack and the system capacity requirement is 70.9kW.

Training and Education

Training on both practical and theoretical aspects of using CO₂ refrigerant was conducted onsite. Additionally, training onsite was provided to service CAREL system components, including Case Controllers (MPXPro), Pack Controllers (pRack), EEV (E2V Stepper Valves) and the Front End Supervisory System (PVPPro).

Energy efficiency

The Carel pRack Controller and EVD Cascade Controller collectively optimised smarter compressor management, as well as improved plate heater exchanger efficiency.

System Design	Total Energy (kWh)	Total Capacity (kW)
CO ₂ /134A	106,399	736.92
404A	217,256	705.74

The total energy consumption decreased using the CO₂/134a design

vs. 404a design by 51% as the total capacity increased 4.4%.

Pick 'n Pay Supermarket is the second largest supermarket chain store in South Africa, established in 1967. In partnership with CAREL and Matador Refrigeration, the first CO₂ system design was implemented focusing on energy efficiency and utilizing state-of-the-art refrigeration technology.

Energy consumption decreased by 51% as compared to an R404a system.

According to Grant Ford, engineering director at Matador Refrigeration, "The unique design of the cascade system allows for cooler liquid refrigerant to be supplied to the evaporators, maximizing their efficiency and contributing to the already energy efficient plant."



Michael Englebright
Key Accounts Manager
Retail & Refrigeration

michael.englebright@carel.com
Mobile: +61 448694159
UK Mobile: +44 7452271853
<http://www.carel.com>



<http://www.atmo.org/media.presentation.php?id=223>



DANFOSS: COMPACT VALVE STATIONS FOR AN NH₃ SYSTEM IN AN ICE CREAM PLANT



Russia



During a recent refitting of an ammonia refrigeration system in an ice cream manufacturing plant in Vladivostok, Russia, the application of ICF Flexline™ valve stations from Danfoss led to a significant reduction in production down-time.

Approximately 80% improvement was realized when compared to traditional valve assemblies. Also, due to the small footprint of ICF Flexline™ valve stations and their ready-built feature, installation was made much easier and faster. This led to substantial savings in installation costs and component costs. It also reduced loss of valuable production time.

The main goals of the re-equipment were to reduce energy consumption, to install modern and efficient equipment, to optimize temperature levels and to add the possibility of producing more varieties of deep-frozen products.

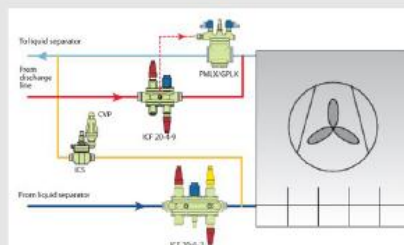
The new refrigeration unit had to be installed within the existing rooms in the plant. However, since the ICF Flexline™ valve stations are very compact in size, this could easily be accommodated. This was one of the benefits the system engineer cited as a reason for developing a solution based on the Danfoss ICF Flexline™ valve stations.

Due to the lack of space and the limited time available for installation work, the combined ICF Flexline™ valve station was applied on the distribution lines of the storage chambers. The ICF Flexline™ valve stations were installed on the liquid ammonia lines for the evaporators and the hot ammonia gas lines used for defrosting the evaporators.

A similar solution is used in the deep freeze packing shop in the ice cream factory. ICF Flexline™ valve stations are installed in the distribution sections of fast-freezers. The compact design of the valve stations meant that the installation took up six times less space than traditional valve assemblies. Also, ICF Flexline™ valve stations require up to 80 % less time in installation, which meant that interruption of the production process for the installation was significantly reduced.



During a recent refitting of an ammonia refrigeration system in an ice cream manufacturing plant in Vladivostok, Russia, the application of compact valve stations from Danfoss led to a significant reduction in production down-time. 80% less installation time was needed.



Carsten Dahlgaard
Industrial Refrigeration
Global Marketing Director

carstendahlgaard@danfoss.dk
Phone: +45 89 48 91 11
Mobile: +45 40 60 91 21
<http://www.danfoss.com/IR>



<http://www.atmo.org/media.presentation.php?id=225>



DANFOSS: VALVES FOR LANDMARK CO₂ SYSTEM IN ZHANGZI COLD STORAGE



China



Danfoss's award winning valve station for industrial refrigeration, called ICF Flexline™, recently achieved a major milestone in China. The whole Flexline™ family of valves were extensively applied in a landmark CO₂ refrigeration project at the scallop & sea cucumber processing centre of the Dalian Zhangzi Island Fishery Group.

After comprehensively considering safety, the environment, and efficiency, the Zhangzi Island group decided to use CO₂ as the refrigerant for this project. Danfoss was subsequently selected as the valve supplier due to its industry leading CO₂ technology, vast experience with CO₂ and high-quality products.

In the newly developed seafood processing centre, the freezing plant utilises a NH₃/CO₂ cascade system for refrigeration, which lowers the NH₃ charge amount by over 90% and limits the NH₃ refrigerant inside of the refrigeration control room, fully satisfying the safety requirements of Zhangzi Island group.

The cold storage plant utilises a CO₂ brine system and uses the abundant sea water as the cooling medium for the high level ammonia refrigeration. The setting up of the condenser heat recovery appliance prior to the cooling process, realized a good balance between safety and environment protection.



Seafood processing depends heavily on reliable refrigeration systems. This is the main reason why Danfoss CO₂ solutions and components were used for the Zhangzi Island project. With leading TDR technology, Danfoss AKS 4100U series radar liquid level sensor was adopted for liquid level controlling of the NH₃/CO₂ cascade system, working together with the ICM series motor control valve for precise control of the refrigeration liquid level control. The feeding line of the freezing room uses the Danfoss premier product ICF series valve station, which compressed the installation area by 2/3 and reduced the welding time by 80%. The newly launched SVL Flexline™ series of refrigeration line components were also widely used.

In a landmark project in China, the new Zhangzi sea food processing centre uses a NH₃/CO₂ cascade system for refrigeration. This has lowered the NH₃ charge amount by over 90% and limits the NH₃ refrigerant inside of the refrigeration control room. The cold storage plant utilizes a CO₂ brine system and uses the abundant sea water as the cooling medium for the high level ammonia refrigeration.

Danfoss supplied its Flexline™ valve station for CO₂ solutions extensively throughout the entire system, raising safety and reliability while reducing welding time by 80%.



Carsten Dahlgaard
Industrial Refrigeration
Global Marketing Director

carstendahlgaard@danfoss.dk
Phone: +45 89 48 91 11
Mobile: +45 40 60 91 21
<http://www.danfoss.com/IR>



<http://www.atmo.org/media.presentation.php?id=225>



DSI: AMMONIA PLATE FREEZER PFP AT SOLTUNA, SOLOMON ISLANDS



Solomon Islands



DSI has over the years sold many freezers for the seafood industry in Asia. In a recent project, a freezer was installed in a fish processing plant in the Solomon Island, freezing tuna loins. The self-contained plate freezer DSI PFP 2810 operates on ammonia. It is equipped with a refrigeration system and needs only the connection of power and cooling water to operate. The end-users are mainly fish factories that are exporting some of their products to the USA and Europe.



By choosing DSI freezers the fish processors received a very reliable solution made for operation in a tough environment. A focus was put on high quality, a robust construction, cleaning friendliness, hygiene and minimal maintenance.



DSI attaches great value to the readiness of its worldwide operating technology for natural refrigerants. As a result, freezers are made to operate on natural refrigerants like NH_3 and CO_2 .



The DSI 2000 series is a self-contained unit with an efficient compressor and a flooded refrigerant system which ensures a high freezing rate and low power consumption. The complete unit has been designed to meet the new strict hygienic standards and therefore only carefully selected materials have been used. Long trouble-free operation and low maintenance costs are assured. The DSI 2000 series is available with a variety of optional equipment which ensures versatile use of the freezer. It has a CFC-free insulation and is suitable for marine and land installation. The DSI PFP 2000 series is primarily used for freezing of: seafood such as fish, fish fillets, shrimps, roe, squid, etc.; vegetables such as chopped spinach, broccoli, carrots, etc.; pulp and concentrates; and ready-made meals.

The ammonia plate freezer installed in a tuna processing plant in the Solomon Islands only needs the connection of power and cooling water to operate.

It features high quality, a robust construction, cleaning friendliness, hygiene and minimal maintenance.

DSI offers its freezers for CO_2 and NH_3 worldwide.



Mads Sigsgaard
Regional Sales Manager

ms@dsi-as.com
Phone: +45 98 86 42 99
Mobile: +45 20 10 37 66
<http://www.dsi-as.com>



DSI: AMMONIA PLATE FREEZERS FOR FISH AND SHRIMP IN VIET NAM AND MALAYSIA



Viet Nam & Malaysia



DSI has over the years sold many freezers for the seafood industry in Asia. In a more recent project it supplied Horizontal Plate Freezers operating on ammonia for freezing fish and shrimp in Viet Nam and Malaysia. The freezers are connected to a central refrigeration system with pump circulation for efficient freezing.



End-users of ammonia plate freezers are mainly fish factories that are exporting some of their products to the USA, Europe and other markets. By choosing the NH₃ freezers the fish processors get a very reliable solution made for operation in a tough environment. A focus was put on a high quality and high efficiency of the system. Moreover, a short freezing time, a robust construction, cleaning friendliness, hygiene and minimal maintenance were important.



All DSI freezers are made to operate on natural refrigerants like NH₃ and CO₂.

DSI Horizontal Plate Freezers feature a low power consumption and are easy to maintain and clean. The element surface structure prevents dents and marks in the packaging. The most common block dimensions can be produced in this type of freezer. The freezer is made with a heavy-duty hotdip galvanised steel frame and is mounted with hydraulic twin rams ensuring a stable and even plate pressure which guarantees homogenous blocks. The fast low temperature freezing maintains the natural quality of the product.

Horizontal ammonia plate freezers are suitable for the freezing of shrimps, filets in blocks, vegetables, H & G fish, and chopped products.

The ammonia horizontal plate freezers for freezing fish and shrimp in Viet Nam and Malaysia have led to an increase in quality, cleaning friendliness, hygiene and maintenance of the system.

Moreover, it has improved system efficiency and lowered freezing time.



Mads Sigsgaard
Regional Sales Manager

ms@dsi-as.com
Phone: +45 98 86 42 99
Mobile: +45 20 10 37 66
<http://www.dsi-as.com>



JOHNSON CONTROLS: FIRST LARGE-SCALE NH₃/CO₂ CASCADE SYSTEM IN JORDAN



Jordan



In 2007 “Jordan Poultry” placed an order with the Sabroe Factory in Denmark. The cascade system was installed in August 2012 outside Amman in Jordan. The plant is for freezing poultry products for the Jordanian and Middle Eastern markets. The climate in this region is quite challenging because of the very big temperature differences seen over the year. The summer is warm and hot and the winters can be very cold and even snow is seen but it tends to melt away very quickly.

The plant is a cascade system with three ammonia (NH₃) screws on the high temperature side of the system and carbon dioxide (CO₂) on the low stage. The new system was built in a new machine house with space for additional compressors on both the ammonia side and the CO₂ side.



The products are frozen at a temperature of around -40°C in two air-cooled batch freezers. Also a chilling tunnel for cooling the freshly killed chicken uses CO₂ circulated at -10°C and a tunnel temperature about +1°C. A falling film ice water cooler is cooled with CO₂ at -10°C.

The NH₃ system uses an evaporative condenser, which ensures the lowest possible condensing temperature in the dry summer. The freezing of the product lasts about 3 hours to reach the required temperature. The product is wrapped in to the final packing. It can differ and the products are not totally uniformly packed. This not a problem but increases the process time a little.

The food quality and food safety of the product has a very high priority for the producer. Therefore there is a focus on hygiene and temperature control. It is here that the cascade system plays a role keeping the temperature within the required limits quickly after the process in the cooling tunnel. In addition, a quick freezing process helps maintain a high product quality.

The reason for investing in CO₂ technology in an environment where R22 is still allowed was the intention to future-proof the investment. Industrial refrigeration systems have an expected lifetime of 25 years. The installed system therefore provides investment security for the operator to face any potential restriction on the use of high-GWP refrigerants in the future.

Jordan's first large-scale NH₃/CO₂ system was installed by Sabroe in a poultry processing plant outside Amman. The system was designed to ensure highest food quality and safety.

The project was engineered and project-managed by the factory's employees to ensure highest familiarity with the operation and maintenance of the installed system.

The natural refrigerant solution ensures investment security for the plant operator who has invested in a long-term solution not affected by any potential change in legislation on high-GWP substances.



Alexander Cohr Pachai
Technology Manager
Industrial Refrigeration

alexander.c.pachai@jci.com
Phone: +45 8736 7159
Mobile: +45 2922 7159
<http://www.johnsoncontrols.com>



LINDE: SAFE SUPPLY OF R290 REFRIGERANT IN ARGENTINA



Argentina



A multinational Argentinean petrochemical company wanted to reduce the environmental impact of its refrigeration systems and to prepare to meet future legislation. The company needed to replace old equipment utilising CFC R-12 with a system using the natural refrigerant R290. The switch required significant logistical and technical support.

Using its global network, Linde secured a reliable supply of high quality R290 natural refrigerant from North America and supported the customer throughout the delivery process. Linde sourced the ISO tanks and cylinders required to safely transport the gas and managed the onsite storage and filling operations. Linde's technical and Safety, Health, Environmental and Quality (SHEQ) teams played a major role in overseeing product stewardship and regulatory compliance throughout the supply chain.

The new eco-friendly refrigeration system is operating efficiently and safely and delivering measurable business benefits. As well as driving performance improvement in the oil refining and liquid gas recovery process, the use of R290 is helping to make the customer's operations far 'greener'.

In a move away from CFC12 an Argentinean petrochemical company increased performance and environmental impact at high safety levels by opting for a reliable supply of hydrocarbon R290 from North America.



LINDE: REFRIGERANT SUPPLY & TRAINING FOR R1270 IN TURKEY



Turkey

A major Turkish manufacturer of refrigeration and cooling equipment for supermarkets needed to develop a refrigeration system using natural refrigerants to meet its customer's environmental goals. The manufacturer had no experience with natural refrigerants and was unable to determine which refrigerant gas offered the best solution. The company recognised the need for expert advice and, if it was to make the switch, a reliable source of supply. Technical support was also high on the agenda as the company needed to understand how to handle and store the refrigerant gas safely.

Linde Turkey worked to understand the business requirements. This groundwork narrowed the choice of suitable natural refrigerants to R290 or R1270. Trials were set up providing both the gas and the technical expertise, and it was decided to use R1270. Training on natural refrigerants handling and satisfying regulatory compliance was provided. Linde used its global network to identify a suitable supply source from within the EU and managed the supply chain to ensure a reliable and uninterrupted cross-border supply chain.

Expert advice on refrigerant selection, storage and handling, as well as training on hydrocarbon R1270 (propylene) supported a Turkish food retailer to fulfill its environmental goals.



Linde AG
Gases Division, Seitnerstrasse 70,
82049 Pullach, Germany

refrigerants@linde-gas.com
Phone: +49 89 7446 2399
Fax: +49 89 7446 2071

<http://www.linde-gas.com>



MAYEKAWA: LARGEST REFRIGERATION PLANT IN UKRAINE



Mayekawa has branches in more than 40 countries and is active with products covering all five natural refrigerants: carbon dioxide, ammonia, hydrocarbons, water and air. It can build on more than 90 years of experience with ammonia technology and 40 years of using CO₂ and hydrocarbons in industrial-size applications.

In a recent case Mayekawa's regional partner installed the largest refrigeration plant for PJSC "Myronivsky Hliboproduct" (MHP) in Ladyzhin Vinnitsa region, Ukraine. The "Vinnitsky Broiler" plant has a slaughter capacity of 24.000 birds per hour and the installed refrigeration capacity is about 20 MW supplying cold to several consumers. In addition, heat was used to heat water at 45 degrees Celsius approximately to 4 MW.

In a 100 metres compressor hall 16 Mayekawa compressors were installed. The ammonia screw compressors were used to obtain evaporation temperatures for freezing, cooling



and processing purposes from -41°C up to -5°C. Excellent efficiency and performance results for single stage screw compressors reaching temperatures of -30°C or higher, and two-stage or compound screw compressors generating temperatures of -41°C, were obtained.

During the UNIDO ATMOSphere Technology Summit, Eric Delforge and Jan Boone presented Mayekawa's wide range of activities in over 80% of Article 5 countries with natural refrigerant compressors. Mayekawa believes that the knowledge and experience to service and to operate these units with natural refrigerants is present in the field, and that the technology based on natural refrigerants will continue to become more efficient and more cost effective. Boone presented examples from Serbia, Croatia, Bosnia and Herzegovina, Russia and Egypt to demonstrate the variety of different solutions for different applications and climatic regions.

Eric Delforge presented various cases using ammonia, carbon dioxide and water installed in food production and distribution centres, as well as the successful application of hydrocarbons in chemical plants. According to Delforge, the growing demand for frozen food in developing countries will result in a growing demand for refrigeration systems. Ammonia plants have the potential to meet this growing demand.



Eric Delforge
Corporate Business & Policy Officer
Mayekawa Europe

eric.delforge@mayekawa.eu
Phone: +32 2711 0421
Mobile: +32 479 808 399
<http://www.mayekawa.eu>



Ukraine

In Ukraine's largest poultry slaughtering and processing plant 16 Mayekawa ammonia screw compressors were used to enable an efficient processing, freezing, cooling and heating process.

Mayekawa is present with natural refrigerant solutions for industrial applications in over 80% of developing countries. The company uses all five natural refrigerants carbon dioxide, ammonia, hydrocarbons, water, and air.



<http://www.atmo.org/media.presentation.php?id=236>



GLOBAL CONSUMER GOODS BRAND EXPANDS NATURAL REFRIGERANT USE



Global consumer goods brands require effective solutions for their operations involving light-commercial, commercial and industrial refrigeration and air-conditioning processes in developing countries. During the 2013 UNIDO ATMosphere Technology Summit, Nestlé introduced the company's experiences in dealing with natural refrigerants in developing countries. Nestlé introduced a series of solutions including standards-making, "safe by design" service, training, and education, on natural refrigeration.

Based on a clear corporate strategy to increase the use of HFC-free solutions in industrial facilities, Nestlé is currently seeking natural solutions for air conditioning systems. The company has now installed a 100kw NH₃ enclosed packaged ammonia chiller in a factory and a centralised chilled water system with ammonia for its new regional head office in Africa. In China, CO₂ systems for small low temperature cold stores are installed in the northern part of the country. A centralised chilled water system with ammonia for a new R&D centre in India has also been established.

<http://www.ammonia21.com/news/view/4298>



World

Nestlé now has 468 factories in 86 countries, of which over 90% use ammonia, hydrocarbons and CO₂ systems.



<http://www.atmo.org/media.presentation.php?id=232>



BRAZIL INSTALLS THE FIRST R600A WATER FOUNTAIN



February 2013 saw the launch of Continental's latest R600a product on the Brazilian market: a hydrocarbon refrigerated water fountain. The new Continental R600a water fountain has both hot water and cold water taps and features automatic temperature control that maintains the water either at 5°C or 95°C. The water fountain has a safety lock that prevents the accidental opening of the hot water tap by small children.

<http://www.hydrocarbons21.com/news/view/3883>



Brazil

The Brazilian market for hydrocarbon refrigerants is expanding. Its application in commercial refrigeration and cooling presents good business opportunities for the local HVAC&R industry.



SUCCESSFUL WAYS TO DEVELOP R290 RAC IN CHINA



Midea, one of the largest Chinese manufacturers of air conditioners and compressors, develops R290 room air conditioners (RAC) in China. With the financial support of Multilateral Fund for the Implementation of the Montreal Protocol (MLF), since 2010, Midea has allocated substantial resources to develop R290 in air-conditioning and refrigeration systems. After more than 3 years of R&D, Midea has developed 3 generations of R290 RAC and tested 60 demonstration models in several different regions of China. This year, Midea will finalise its production line for R290 RAC, of 2HP, equipped with an inverter.

The development of HC air-conditioners in China was accelerated by the adoption of national safety standards in May 2013.



<http://www.atmo.org/media.presentation.php?id=222>

<http://www.atmo.org/media.presentation.php?id=219>



China

The R&D of R290 air conditioners in China makes the mass production of HC air-conditioners possible in the near future.

<http://www.hydrocarbons21.com/news/view/4280>



CO₂ HEAT PUMPS ARE GROWING IN POPULARITY IN CHINA



The CO₂ heat pump market is developing fast in China, with the technology being applied in hospitals, train stations, schools and public buildings.

Heating Bumade Station on the Qinghai-Tibet railway line at 4,800m above sea level: Three 50kW CO₂ heat pumps were installed in a 3000 m² maintenance area of the Bumade railway station to provide space and water heating. According to supplier Melinda, the heat pumps work well even during winter when the outside temperature is as low as -30°C. The heat pump project is the highest in elevation and lowest in operating temperature in China.

50% energy saving for hot drinking water production in Wuhan University: A CO₂ heat pump water heater was installed in October 2011 in the Wuhan University of China to provide hot drinking water. The combined CO₂ heat pump and electric boiler save 50% in energy for the university compared with a 100% electric boiler. The system is able to provide 5 tons hot drinking water per day to students.

<http://www.r744.com/news/view/3424>



China

Increasingly more CO₂ heat pumps are used in space and water heating in China. A group of domestic manufacturers have emerged. Today there are more than 30 CO₂ heat pump installations across the country.



MAJOR FOOD RETAILERS INVEST IN ALL-NATURAL STORES



Food retail chain Tesco equipped four stores with R744 refrigeration in China, in Beijing, Shanghai, Xiamen and Ningbo. In a workshop organised by the Chinese Association of Refrigeration and shecco this April, Mr. Wei Qian from Tesco China said: "in the near future, let's say 3-5 years, all new Tesco stores will adopt natural refrigerants."

The latest store in Ningbo, occupying an area of 15,895 square meters, is the largest supermarket in the region. A series of energy saving technologies are used, including an advanced Environmental Management System (EMS), LED lights and a heat reclaim system. The store captures waste heat to produce hot water to reduce fossil fuel use. Using the CO₂ cascade system can contribute to an annual reduction of 9.7 million kilowatt hours in power and savings of 1560,9 tons in carbon emissions.

Tesco also built a large distribution centre with a CO₂ refrigeration system in Jiashan of Zhejiang Province. Competitor Carrefour is also introducing CO₂ refrigeration to its stores in China.

<http://www.r744.com/news/view/4422>



China

Using CO₂ refrigeration in supermarkets has led to 25% savings in annual electricity costs. More and more food retailers in China are attracted by the benefits of R744 and are introducing CO₂ refrigeration into their business in China.



CO₂ COOLERS & VENDING MACHINES AT THE BEIJING OLYMPICS AND AFTER



Coca-Cola is committed to expanding its worldwide number of coolers and vending machines running on CO₂ refrigerant. To fulfill its pledge, its use of carbon dioxide coolers and vending machines in the Chinese market is also growing year by year. From 2008 to 2009, Coca-Cola introduced 13,300 units of the HFC-free coolers to China. In 2010, another 5,000 units were placed in the market. In 2011, another 13,566 CO₂ cold drink equipment units were purchased. Coca-Cola has involved CO₂ refrigeration technology in its business strategy in China since 2008.

As one of the global sponsors of the 2008 Beijing Olympics, the consumer goods brand used natural refrigerants to power more than 5,600 coolers and vending machines in Olympic venues. The eKOfresh units placed in all official venues of the Beijing 2008 Olympic Games used the innovative EMS technology to deliver energy savings of up to 35%. After the Beijing 2008 Olympic Games, these eKOfresh units were redeployed in China by the local Coca-Cola bottling system.

<http://www.r744.com/news/view/3607>



China

The Coca-Cola Company introduced more than 30,000 CO₂-based coolers and vending machines to the Chinese market between 2008-11.

The units are up to 35% more energy-efficient.



TRAINING & SUCCESSFUL PRODUCTION OF HYDROCARBON BLEND LB-12 IN CUBA



In Cuba the hydrocarbon mixture LB-12 was developed. Over 700,000 domestic refrigerators and 10,000 small commercial systems were converted to the blend. In 1996, a plant with Cuban-made technology, was built in the Petroleum Refinery "Hermanos Diaz" located at Santiago de Cuba to produce the refrigerant LB-12. In two years one thousand technicians were trained on the safe use of LB-12.

About 15% of the population has benefited from the use of LB-12 in domestic and small commercial refrigeration in Cuba. LB-12 has also been used in small commercial units such as water coolers and freezers. Around 10,000 units of water coolers and freezers have been converted to LB12. In addition, some R134a refrigerators and freezers were converted to LB-12 with good results.

<http://www.hydrocarbons21.com/news/view/3565>



Cuba

1,000 trained technicians in two years made sure the introduction of the hydrocarbon mixture LB-12 was a success in Cuba.

The blend has been used in 10,000+ domestic and small commercial units.



TECHNICIANS IN THE CARIBBEAN INVEST IN HYDROCARBON TECHNOLOGY



Two refrigeration and air-conditioning technicians on the island country of Grenada have invested in hydrocarbon refrigerants and compressors, enhancing the availability of hydrocarbon technology in the local market and other neighbouring islands in the Caribbean.

Following the training sessions, demand for hydrocarbon servicing components for the retrofit of mobile air-conditioning and unitary split air-conditioning systems with hydrocarbons has been on the rise in Grenada. For several years now, hydrocarbon technology has also been introduced into the domestic refrigeration sector in Grenada.

<http://www.hydrocarbons21.com/news/view/2707>



Grenada

The availability of hydrocarbon technology in Grenada was enhanced by an initiative of two technicians investing in HC refrigerant and compressors.



3,000+ ROOM AIR-CONDITIONERS WITH R290 SOLD IN INDIA



India



About 3,000 R290 room air conditioners (ACs) have been sold to date by Indian manufacturer Godrej, which began commercial production in April 2012. Out of these, about 2,000 units have already been installed by trained technicians. The EER 3.7 of the R290 units compare to values of 3.4 that are achieved by comparable R22 products on the market. It is also higher than the efficiency achieved by best-in-class inverter technology AC model provided on the Indian market by competitors. The market price is 33,000 Indian Rupee (about €480) including free installation from certified technicians, which typically costs 1,500 (€22), compared to market price of 31,000 (about €450) Indian Rupee for a comparable R22 unit. Godrej recently conducted a study to evaluate the performance of hydrocarbon air-conditioners vis-à-vis R22 units in high ambient temperatures with the following results: Variations in COP at high ambient temperature for R290 are the same as with R22 and variation in the capacity of R290 also remains the same as for R22. The testing concluded that R290 is well suited to high ambient regions and further studies will be conducted to analyse results using various components under different conditions.

<http://www.hydrocarbons21.com/news/view/3395>

The sales figure of R290 AC in India indicates that the interest in HC-based AC is increasing rapidly.

Tests have shown that R290 is well suited to high ambient temperature regions.



<http://www.atmo.org/media.presentation.php?id=222>



PROPANE AIR-CONDITIONING IN INDONESIA INCREASES ENERGY EFFICIENCY BY 15%



Indonesia



Different types of air-conditioning and refrigeration systems using propane (R290) are being introduced to Indonesia. A cooling system based on optimised design and tailor-made equipment was installed at a hotel in Bali. Due to its special physical properties, the hydrocarbon refrigerant is best suited for hot climates and allows for a substantial reduction of raw materials to be used for production.

A propane air-conditioning system installed in a hotel in Bali has significantly improved energy efficiency by 15%.

<http://www.hydrocarbons21.com/news/view/2732>



NAMIBIAN SUMMER HEAT PUTS NH₃ COLD STORE TO THE TEST



A refrigeration system for a fruit and vegetable storage facility in Namibia, which employs ammonia compressors, has proved its effectiveness after operating in the African summer (November through March), meeting expectations with respect to energy efficiency. Using the natural refrigerant ammonia allowed for significant efficiency gains in the central refrigeration complex.

Storage of dates, which are harvested from February to April, required a special solution to enable them to be frozen in one of the halls until export. The refrigeration system operates in two stages (-28°C/0°C and 0°C/+35°C) to achieve the required temperature of -20°C in the hall. Special valve units enable switch-over between the two-stage mode for freezing and the single-stage cooling mode.

<http://www.ammonia21.com/news/view/3226>



Namibia

An ammonia system for fruit and vegetable storage facility in Namibia has proved its effectiveness operating reliably during the African Summer.



SUCCESS STORIES IN PAKISTAN WITH NATURAL SUBSTANCES



Although several barriers still need to be overcome in relation to training, certification and standards, the following success stories in Pakistan are solid proof that natural refrigerants can be safely introduced:

- 100% of production in PU block slab shifted to hydrocarbons. 51% of R141b was replaced with cyclopentane in manufacturing of insulating PU rigid foam in the refrigeration sector. The remaining 49% is planned to be phased out using either cyclopentane or water-based technologies.
- Almost all industrial refrigeration, cold storage, cargo ships and food industries use ammonia.
- One new R290 line has been added to replace R134a in PEL by Agramkow - 5,000 units of bottle coolers have been sold. One new R600a line for domestic refrigerators has been added by Electrolux - 15,000 units have been sold.

<http://www.hydrocarbons21.com/news/view/4331>



Pakistan

A 100% production of PU block slab with hydrocarbons, a majority of industrial refrigeration running on ammonia, and new production lines for HC bottle coolers and refrigerators are solid proof for Pakistan's increasing use of natural refrigerants.



<http://www.atmo.org/media.presentation.php?id=230>



17 TRANSCRITICAL CO₂ STORES IN SOUTH AFRICA SAVE UP TO 45% ENERGY USE



In South Africa, 8 Woolworths stores and 9 Makro stores are currently running with trans-critical CO₂ systems using a common liquid line to the chillers and freezers with individual suction lines back to each section on the multiplex system i.e. freezer rack and chiller rack.

All controls are provided by Danfoss and come with electronic expansion valves, pack controllers, heat exchangers and plate heat exchangers. A reduction in power consumption of up to 45% was recorded. At this stage, because of the size of some of the plants, the CO₂, as apposed to an R404 system, costs about 12% more for installation costs. Each Makro store has two equal systems of 300KW each, a 200kw chiller and a 100kw freezer with a total refrigeration capacity per store of approximately 600kw. Woolworths has an average of 300kw of refrigeration capacity per store.

<http://www.r744.com/news/view/1049>



South Africa

17 stores in South Africa now use a CO₂ transcritical system, with the result of up to 45% reduction in power consumption as compared to an R404 system.



SUPERMARKET CHAIN INTRODUCES CO₂ CASCADE SYSTEMS TO SOUTH AFRICA



In South Africa, some large supermarket chains locally have begun to convert some of their refrigeration systems to CO₂. Pick n Pay has installed secondary CO₂-cascade systems in its stores in Johannesburg and Cape Town. The use of natural refrigerants and improved energy efficiency of the new equipment permanently and sustainably avoids greenhouse gas emissions associated with traditional HFC-only technology.

Direct emissions of 2,000 tonnes CO₂e per year are eliminated through the replacement of HCFC-22 with natural refrigerants. Decreased energy consumption significantly reduces the company's electricity expenses and, thereby, contributes to an overall improvement in profitability. After start-up, energy consumption data from both stores was collected and compared to conventional stores. After more than one year of monitoring, energy savings of 19-26% were demonstrated.

<https://www.giz.de/Themen/en/dokumente/giz2011-en-proklima-projectsheet-southafrica.pdf>



South Africa

After more than a year of operation, CO₂ cascade refrigeration systems installed in two South African stores showed 19-26% energy savings.



<http://www.atmo.org/media.presentation.php?id=238>



2,750 HYDROCARBON CABINETS INSTALLED IN THAILAND



In Thailand, AHT has already installed a total of 2,750 (64 units per store on average) R290 cabinets across the country. In one of its installations in the SIAM MAKRO store in Thailand, an R290 freezer helps the supermarket reduce its electricity consumption by 50% compared to an R404A system and cuts carbon emission by 404 tons per year.

On average, the hydrocarbon freezer can achieve a 60% reduction in running costs compared to conventional open top freezers.

<http://www.hydrocarbons21.com/news/view/4280>



Thailand

In Thailand 2,750 R290 cabinets have led to a reduction of up to 50% of electricity consumption compared to R404a and reduced running costs by up to 60%.



<http://www.atmo.org/media.presentation.php?id=220>



NH₃/CO₂ CASCADE SYSTEM INSTALLATION IN THAILAND



A 6MW refrigeration NH₃ / CO₂ industrial refrigeration cascade system was installed in Bangkok, Thailand, in 2012.

The NH₃/CO₂ cascade plant is fitted with the latest energy efficient technologies, resulting in total energy savings compared to standard NH₃/CO₂ design of about 13% or 2,780,000 kWh/year, translating to €243,000 and 5.42 tonnes CO₂eq. Regarding direct emissions, the benefit for the planet is 1,905 tonnes/year eq CO₂ or the equivalent of 366 cars driving around the world when compared to an R404A solution (assuming 5000kg, leakage rate 10%).

The design with lower delta T on heat exchangers has increased the temperature level. For example for air conditioning, the water temperature is 9°C instead of 6°C, resulting in about 40 kW less absorbed power. Fans with high efficiency for equipment with air heat exchangers lead to 70kW less absorbed power. Heat recovery for processes has saved heating costs and improved refrigeration plant efficiency.

<http://www.ammonia21.com/news/view/3394>



Thailand

An optimised ammonia/carbon dioxide industrial refrigeration cascade system has reduced energy consumption by 13% compared to a standard NH₃/CO₂ system and saved 1,905 tonnes/year eq CO₂.



HC CONVERSION IN INDUSTRIAL A/C HAVE LEAD TO 20% ENERGY SAVINGS



Hydrocarbons in industrial air conditioning systems have gained momentum thanks to end-users in Thailand taking advantage of energy savings in the conversion from R22 and R12 to hydrocarbon 22a and 12a.

APL Asia is a private company determined to introduce hydrocarbons in Thailand by converting and servicing industrial air conditioning systems from HCFC 22 to hydrocarbons. The company's growth was due to the energy gains that users were able to achieve. APL Asia states that conversions are also taking place because customers are motivated by protecting the environment. Hydrocarbons do not deplete the ozone layer and have a negligible effect on global warming.

On average, companies that retrofit industrial air conditioning systems from HCFC 22 to hydrocarbons gain up to 20% in energy efficiency.

<http://www.hydrocarbons21.com/news/view/2598>



Thailand

In Thailand, conversions from R22 and R12 industrial air-conditioning systems to hydrocarbon refrigerants 22a and 12a have improved energy efficiency by up to 20% as compared to R22.



TURKEY'S FIRST CO₂ TRANSCRITICAL SUPERMARKET SAVES ENERGY & MONEY



French retailer Carrefour installed its first CO₂ transcritical refrigeration system in Turkey (Istanbul), at the Kurtköy-Millennium Carrefour Express. The technology has significantly reduced the environmental impact of the store.

The CO₂ used in the refrigeration system pollutes 3,400 times less than the refrigerants previously used at Kurtkoy. Moreover, the quantity of CO₂ needed for the refrigeration units is approximately one third less than the refrigerant charge required by a conventional system. The quality of the pipe fittings has been improved and refrigerant leaks should accordingly be reduced by 75%. The CO₂ solution improves the energy efficiency of the refrigeration units by around 15%, which equally limits CO₂ emissions resulting from electricity consumption. The transcritical installation offers very significant economic benefits. The Kurtköy supermarket not only reduced its overall energy bills by 7%, but it also reduced the amount spent on refrigerants, which is crucially important given that the price of synthetic gas is skyrocketing. For example, the most common of these R404a, is five times more expensive than CO₂.

<http://www.r744.com/news/view/3765>



Turkey

Turkey's first CO₂ transcritical refrigeration system has increased energy efficiency by 15%, reduced leakage by 75%, lowered refrigerant charge by one third and reduced energy bills by 7%.



SMALL CAPACITY AMMONIA 'PLUG AND PLAY' CHILLERS INSTALLED IN AFRICA



Zimbabwe, Angola, Tunisia



In the refrigeration equipment of Nestlé in Africa, several small capacity ammonia 'plug and play' chillers for AC have been installed: In Zimbabwe there are 4 installations of 70kW, Angola has 2 installations of 90kW, and Tunisia has 2 installations of 115kW.

The carbon footprint reduction achieved by the ammonia chillers compared to an R134a chiller amounts to 12 tonnes CO₂/year, equivalent to driving 2 times the Earth's circumference with a 4HP diesel vehicle.

Eight "plug and play" ammonia chillers for air-conditioning in three African countries have each led to a reduced carbon footprint of 12 tonnes CO₂/year.

<http://www.ammonia21.com/news/view/3394>



<http://www.atmo.org/media.presentation.php?id=232>



INDIAN CAMPAIGN PROMOTING HYDROCARBON AC ACHIEVES SUCCESS



India



The (F)air Conditioning Campaign was created by two organisations from Europe and India to promote hydrocarbon (HC) domestic air-conditioning in India. The campaign has achieved an initial success by involving local organisations like the Indian Institution of Management Ahmedabad (IIM-A) and CGH Earth, both early adopters of hydrocarbon ACs. The campaign aims to highlight the benefits of HC ACs such as reduced energy consumption and reduced electricity bills.

The campaign adopted a very innovative method to involve related industry stakeholders in the promotion of hydrocarbon ACs. It allows stakeholders to join the campaign in multiple ways, as Voluntary adopters, Consumer Ambassadors, Academic Ambassadors and Technical Ambassadors.

A partnership campaign between a European NGO and an Indian partner company has involved various stakeholder groups as ambassadors for hydrocarbon domestic air-conditioning in India.

<http://www.hydrocarbons21.com/news/view/4361>



SEMINAR & TRAINING ON ALTERNATIVE TECHNOLOGIES IN TURKMENISTAN



Turkmenistan



With the aim of informing national stakeholders involved in the preparation and implementation of the hydrochlorofluorocarbon (HCFC) Phase-out Management Plan in Turkmenistan about alternative technologies using natural refrigerants, a seminar was held on 17-19 April 2012 in Ashgabat. Supported by the United Nations Environment Programme (UNEP) and organised by the National Ozone Unit (NOU), the seminar targeted policy-makers as well as companies working in the refrigeration and air-conditioning sector.

In Turkmenistan's HCFC Phase-out Management Plan, with the support of UNIDO, the Ministry of Environment of Turkmenistan aims to provide assistance to train up to 300 refrigeration technicians from government and private institutions across the country. The training will build on the successes of the previous training courses in Good Refrigeration Practices and will focus on the adoption of technologies with zero ODP, high energy efficiency and low GWP. Parallel public awareness campaigns will be conducted to encourage owners of refrigeration equipment to shift to low GWP alternatives for HCFCs.

<http://www.ammonia21.com/news/view/3169>

Dedicated seminars and training schemes initiated by UN agencies have increased interest and capacity for the adoption of natural substances in Turkmenistan.



CYCLOPENTANE FOAM INSULATED PANELS HELP ACHIEVE HCFC TARGETS



Bosnia and Herzegovina



For the conversion from HCFC-141b in the manufacture of polyurethane foam insulated sandwich panels in Bosnia and Herzegovina (BiH), cyclopentane based systems are chosen as the alternative technology.

Alternativa is the major HCFC-141b consumer in BiH and its conversion is essential for the country to fulfill its environmental goals. The company is the only one currently operating manufacturing company producing polyurethane rigid foam and sandwich insulation panels and pre-blended Polyol System in Bosnia and Herzegovina. The main advantage of selecting pentane technology is that pentane is a natural substance with far lower GWP than HCFC-141b and any other HFC-based alternatives. Selection of pentane technology will result in additional investment costs. However, the company owner decided to convert to pentane technology in order to avoid any transitional substances. This Project will phase out 40.7 ton of HCFC-141b, which will help BiH to achieve its 2013 HCFC freeze and 2015 10% reduction targets.

The conversion from HCFC-141b for polyurethane foam insulated sandwich panels to cyclopentane will help Bosnia and Herzegovina achieve its HCFC 2015 reduction targets.

HCFC Phase-Out Management Plan of Bosnia and Herzegovina



HC REFRIGERATION USES 19.8% LESS ENERGY IN MUSHROOM PRODUCTION



The high running costs of the year-round cultivation of mushrooms have become a burden for many mushroom factories. Conventional HCF- or HCFC-based refrigeration equipment usually requires large amounts of energy. A hydrocarbon refrigeration system was installed in an edible mushroom research institute in Fujian Province of China in 2012. The system is manufactured by a local refrigeration engineering firm.

According to results from experiments involving two growing cycles of mushroom, the hydrocarbon refrigeration system consumes 19.8% less energy compared to the old HFC-based refrigeration equipment in the institute.

<http://www.hydrocarbons21.com/news/view/3480>



China

The high running costs of year-round mushroom cultivation have been significantly reduced by a hydrocarbons refrigeration system achieving nearly 20% energy savings as compared to an old HFC-based system.



CHINESE DEMO PROJECTS FOR PLANT CONVERSION TO NH₃/CO₂ REFRIGERATION



With the support of UNDP, a Chinese local manufacturer carried out technical research on CO₂ in May 2011. To date, the company has worked on two prototype projects for the conversion from R22 to NH₃/CO₂ technology in the manufacture of two-stage refrigeration systems for cold storage and freezing applications. One system was installed for Yantai Fengrun, a local fruit pudding supplier to McDonald's, and the other for Weihai Jiuye, a Chinese export-seafood supplier. The demonstration projects indicate that the COP of the NH₃/CO₂ screw cascade refrigeration system was over 8% higher than the HCFC-22 two-stage refrigeration system. The company is already at the stage of promoting market sales of the CO₂/NH₃ cascade system in the commercial refrigeration sector in China.

Although the initial investment for the NH₃/CO₂ cascade refrigeration system is a bit higher than for a two-stage automatic screw refrigeration system, the electricity consumed at Fengrun is 11.1% lower than an ammonia two-stage refrigeration system, offering an attractive payback period.

<http://www.ammonia21.com/news/view/3394>



China

Two demonstration projects for NH₃/CO₂ industrial refrigeration systems have led to more than 10% energy savings compared to an ammonia-only system. This has quickly offset initial higher investment costs.



ELIMINATING HCFC USE IN FOUR COLOMBIAN REFRIGERATION PRODUCERS



As of 1 January 2013, the initiative – done in partnership between the Government of Colombia and the United Nations Development Programme (UNDP) – has resulted in the complete elimination of hydrochlorofluorocarbons (HCFC) use in the manufacturing of refrigerators domestically. HCFCs contribute to the depletion of the ozone layer and cause global warming.

The conversion of Colombia's four refrigeration manufacturing plants has led to the elimination of 56 tonnes of HCFCs and reduced annual CO₂ emissions by 600,000 tonnes, a number equivalent to the emissions caused by 120,000 cars. A widely used technology employing cyclopentane was chosen to replace HCFC because of their low global warming potential and long term cost effectiveness.



Colombia

The conversion of Colombia's four refrigeration manufacturing plants has eliminated 56 tonnes of HCFCs and reduced annual CO₂ emissions by 600,000 tonnes.

<http://www.colombiaemb.org/node/2573>



CYCLOPENTANE PREFERRED OPTION FOR GUATEMALAN REFRIGERATOR PRODUCER



In a conversion project implemented by UNIDO in Guatemala, a cyclopentane based system is the chosen technology for phasing out the consumption of HCFC-141b in the manufacture of commercial refrigerators by Fogel de Centroamerica, the only producer of this kind of equipment in Guatemala.

For the manufacturing of their products in Guatemala, Fogel has five assembly lines. In July 2005, the company converted four assembly lines from HCFC-141b to cyclopentane in its foaming operations; however, the fifth assembly line continues to use HCFC-141b. UNIDO together with Fogel have decided that cyclopentane is the best option for the conversion.



Guatemala

To reduce HCFC-141b consumption, four assembly lines by a major Guatemalan commercial refrigerator manufacturer were converted to cyclopentane for foaming operations.

Guatemala HCFC Phase-out Management Plan



SOLARCHILL LARGE-SCALE TECHNOLOGY TRANSFER PROJECTS GET FUNDING



The Global Environment Facility has approved \$2.7m in funding for the “SolarChill Development, Testing and Technology Transfer Outreach” project in Kenya, Swaziland and Colombia. The project is expected to address some of the challenges to the wider deployment of SolarChill technology, which integrates the use of solar energy with “Greenfreeze” hydrocarbon refrigeration.

SolarChill has significant market potential in vaccine and food refrigeration in areas without electricity. It eliminates the need for lead storage batteries by using solar direct drive compressors to create an ice bank, thus storing the energy of the sun in ice.

The intent of the GEF funding is a large-scale demonstration of SolarChill technology, to give it higher global recognition, especially in developing countries. A second aim is to encourage companies, especially in Southern African and Latin American regions, to take up production of the technology.

<http://www.hydrocarbons21.com/news/view/2745>



Kenya, Swaziland

USD 2.7 million were provided by the GEF to the SolarChill project for increasing its market potential in vaccine and food refrigeration in areas without electricity.



INNOVATIVE PAKISTAN SOLAR WATER HEATING PROJECT WITH CO₂ REFRIGERANT



A project to provide an alternate energy system in Gilgit-Baltistan, Pakistan, shows the development of an ecologically friendly hybrid solar water heating system that uses CO₂ as the working fluid. The project is a joint collaboration between the Pakistan-US Science and Technology Programme (USAID) and the Higher Education Commission (HEC) of Pakistan.

CO₂ was selected as the working fluid as it has a low-freezing point compared to water. CO₂ only forms dry ice at -78°C and when heated to its critical point of 31.1°C, demonstrates dramatic thermo-physical changes in the presence of small thermal variations, which can lead to strong convection flow. In addition to this CO₂ it is low cost and non-toxic.

<http://www.r744.com/news/view/1432>



Pakistan

In a project to provide alternative energy to Pakistan a hybrid solar water heating CO₂ system was developed.



<http://www.atmo.org/media.presentation.php?id=230>



SECTOR PLAN TO PHASE-OUT HCFC 141B IN THE FOAM SECTOR IN THE PHILIPPINES



Philippines



The Sector Plan to Phase-out HCFC-141b in the foam sector in the Philippines, which is funded by the Multilateral Fund (MLF) and the Government of Japan, is being implemented by the United Nations Industrial Development Organization (UNIDO). The main objective of the project is to assist the Philippines in meeting its stage 1 HCFC phase out strategy in compliance with its commitment to the Montreal Protocol. The project covers two main recipients, namely: (1) those companies using spray foaming machines for foam insulations and (2) those companies using fixed foaming machines for production of rigid foams, thermowares, refrigeration and flexible moulded line. Other recipients are companies that use locally fabricated spray foaming machines for foam insulations. The companies using spray foaming machines were recommended to adopt the supercritical CO₂ technology from Japan while those companies using fixed foaming machines have been advised to adopt the cyclopentane technology for rigid foam producing both continuous and discontinuous panels, water blown technology for thermoware and refrigeration, and Liquid CO₂ (LCD) technology for flexible moulded line.

The sector plan to phase out HCFC-141b in the foam sector has assisted the Philippines to adopt supercritical CO₂ technology from Japan, cyclopentane technology for rigid foams, and water-blown technology for refrigeration.

<http://www.emb.gov.ph/portal/pod/NewsandUpdates/tabid/844/aid/2/Default.aspx>



HYDROCARBONS COME OUT ON TOP IN BRAZILIAN DOMESTIC REFRIGERATION



Brazil



In the domestic market of Brazil, R600a is rapidly becoming the preferred refrigerant. 2013 saw the start of the first phase of the Brazilian HCFC Phase Out Management Plan (HPMP), with R600a widely supported as a viable alternative refrigerant in the domestic refrigeration sector. Brazil also launched a hydrocarbon refrigerated water fountain.

Bosch was one of the first companies to enter the Brazilian market with an R600a fridge. The switch to the eco-friendly refrigerant is seen as relatively easy, the fridge being overall very similar to R134a or even R12 models. The main difference is the compressor. R600a compressors work with much lower pressures, 7.5 bar for isobutane in comparison to 15 bar for R134a, which means the mechanical resistance of the components can be lower. In contrast, the diameter of the compressor pistons must be larger to displace a larger volume of refrigerant. This in turn increases efficiency by 3%.

In Brazil, whilst the market for hydrocarbons remains "complex" for the commercial and industrial refrigeration sectors, in the domestic market, R600a is rapidly becoming the preferred refrigerant.

<http://www.hydrocarbons21.com/news/view/3883>



DENMARK'S LEADERSHIP IN THE TRANSITION TO HFC-FREE TECHNOLOGIES



Denmark



Denmark's initiative is an excellent example of how the transition to HFC-free technology can be influenced by strong regulation in combination with incentives.

Bans on all HFC uses except for applications with refrigerant charge between 150g and 10kg (Statutory Order no. 552 of 2 July 2002 governing fluorinated greenhouse gases) are combined with a taxation of f-gases at €20/tCO₂eq (Consolidated Act No. 208 of 22 March 2001 on tax on certain ozone layer depleting substances and certain greenhouse gases) administered by the Danish tax authorities (SKAT). The tax act levies a green tax on the import of fluorinated greenhouse gases, to be paid to the Danish Government. The tax on industrial greenhouse gases is differentiated: the gases with the greatest impact on climate are subject to the highest tax level, with a tax level in 2011 set at about €17.5/kg for R134a and €50.7/kg for R404A. The HFC tax is repaid when products containing HFCs are exported.

Denmark's early HFC taxes, HFC charge limits and support to the HVAC&R industry have helped move the country towards HFC-free technologies in many areas. It is a strong example of what is achieved by active government support.

<http://guide.shceco.com/GUIDE-Natural-Refrigerants-Europe-2012.php>



REMOVAL OF REGULATIVE BARRIERS FOR NATURAL REFRIGERANTS IN RUSSIA



Russia



In Russia, the government is working hard to introduce natural refrigerants by removing excessive regulatory and administrative barriers. In October 2013, the conference "Natural refrigerant ammonia. Chemical and technical security of the Russian Federation" organized by UNIDO, GEF and MNRE, took place. The conference was dedicated to investigating the need for initiating changes to legislation that favour ammonia and other natural refrigerants with respect of the chemical and technical security rules of the Russian Federation.

The current situation for natural refrigerants in Russia is changing already. The Government Edict No. 1413-p to the Russian Ministry of Industry and Trade instructs that measures on the production of ozone-safe refrigerating equipment, which includes small ammonia charges, be included. The second phase of UNIDO/GEF project "Phase Out of HCFCs and Promotion of HFC-Free Energy Efficient Refrigeration and Air-Conditioning Systems in the Russian Federation Through Technology Transfer" also provides for active support to the Russian Federation.

Russia has increased its efforts to introduce changes to national legislation and increased investment in technology transfer projects for a proliferation of ammonia and other natural refrigerants.

http://www.ozoneprogram.ru/eng/events/16102013_en/



CHILE DEVELOPS GOOD PRACTICES MANUAL FOR AMMONIA REFRIGERATION



Chile



A new Manual was launched in Chile by the Chilean Chamber of Refrigeration and Air-Conditioning. It is intended to set out minimum criteria for the safe operation of new and existing installations. Another aim of the guidelines is that they be both easy for managers and operators to understand and simple in terms of implementation. The first version of the Good Practices Manual was completed by April 2013 and includes chapters covering: Definitions, Management Tools for Ammonia Refrigeration Systems, Training Plant Personnel, Safe Operation and Maintenance, Refrigeration System Design, and Emergency Plans.

A total of 55 professionals from different sectors related to ammonia refrigeration volunteered on the different working groups developing the manual. The sectors involved end users (both local and multinational), government, firefighters, engineers, insurers, manufacturers and others.

A new Safety Manual launched in Chile sets out guidelines for the safe use of ammonia refrigeration systems, in the fields of training personnel, safe operation & maintenance, system design and emergency plans.

<https://www.iar.org/condenser/11-2012.PDF>



CHINA ISSUES NATIONAL SAFETY STANDARD FOR FLAMMABLE HCS



China



China has launched a new safety standard for flammable refrigerants, including hydrocarbons.

Compared with the old version (GB 4706.32-2004) released in 2005, the 2012 version of the safety standard sets out detailed rules for safe operation relating to safety warning, transportation, installation, storage and charging of flammable refrigerants. For refrigerant R290, the standard provides a formula for calculating the refrigerant charge quantity and security values for installation height, housing area, refrigerant concentration, etc.

The safety standard formally allows the use of flammable refrigerants in China. In particular, it formalises the use of R290 in air conditioners for the first time.

A new national safety standard formalises the use of R290 in air-conditioners in China for the first time. It specifies rules for safety warning, transportation, installation, storage and charging of hydrocarbons.

<http://www.hydrocarbons21.com/news/view/3347>



<http://www.atmo.org/media.presentation.php?id=213>



SAFETY STANDARD FOR AMMONIA IN COLD STORES IN CHINA



China



New safety standards for the use of ammonia in cold storage have been launched in China. The standard sets out detailed safety rules and principles for cold storage design, construction, operation and maintenance management. It applies to both direct and indirect refrigeration systems using ammonia refrigerant. In particular, the codes provide a series of requirements that apply to cold store personnel. For ammonia cold stores, the codes stress that staff cannot bring or store, any explosive or flammable items in the machinery room. When emitting non-condensable gases, ammonia cold stores must employ a special air separator and ensure non-condensable gases are emitted to water tanks. The ammonia charging station should be located outside the machinery room and employ security devices. Any type of heating is forbidden when adding ammonia to the refrigerant cylinder.

The standard helps remove the policy and market barriers for ammonia refrigeration systems and accelerate ammonia's market uptake in large cold storage projects.

New ammonia safety standards for cold storage design, construction, operation and maintenance will help remove policy and market barriers for NH₃ use in China's cold storage industry.

<http://www.ammonia21.com/news/view/3299>



<http://www.atmo.org/media.presentation.php?id=213>



HC COMPRESSORS INSTALLED IN A KUWAITI PETROCHEMICAL PLANT



Kuwait



27 units of hydrocarbon chillers are installed in the climate control centre of a petrochemical plant in Kuwait. In the Summer, the temperature in Kuwait can be as high as 50°C in Kuwait. The chillers are required to maintain constant water temperatures in the range of 25°C and 30°C.

At the same time, the chiller must also be certified by the ATEX directive of the European Union for use in such hazardous areas. Due to the extreme climate conditions and the risk of explosion in the control-center area, some safety modifications were made. In the end, the hydrocarbon compressors passed the test held by the contract companies under extreme temperatures (between - 40 °C and +60 °C) without difficulty and the chiller units also achieved full ATEX requirements.

Hydrocarbon compressor have demonstrated their reliability and stability under the extreme climate conditions encountered in Kuwait. They were certified under the EU's ATEX Directive.

<http://www.hydrocarbons21.com/news/view/3572>



BENIN'S HYDROCARBON TRAINING WORKSHOPS



On 15 June 2011, teaching workshops for instructors of air conditioning conversion technician training were inaugurated in the African country of Benin. The aim of the teaching workshops was to reduce the use of HCFCs by 10% in 2015, 30% in 2020, and 67,7% in 2025 and 100% in 2030.

Workshop participants came from Burkina Faso, Burundi, Cape Verde, Comoros, the Democratic Republic of Congo, Gabon, Ivory Coast, Malawi, Senegal, Uganda and Zambia. These workshops enable participants to gain essential tools and information for the safe handling of hydrocarbon refrigerants. The workshops provide training on the safe storage and transportation of hydrocarbons, the necessary changes to be made before air conditioning systems are switched to hydrocarbons, refrigerant recovery and air conditioning charge procedures for hydrocarbons.

With African countries embarking on ambitious plans to phase out HCFCs, hydrocarbons are gradually gaining favour as a viable alternative refrigerant.

<http://www.hydrocarbons21.com/news/view/2684>



Hydrocarbon refrigerants are gradually gaining popularity as dedicated teaching workshops have involved participants from Benin, Burkina Faso, Burundi, Malawi, Uganda and Zambia, among others.



CO₂ TRAINING CENTER IN BRAZIL HAS OPENED THE WAY FOR A WIDE MARKET



Bitzer Brazil is one of the biggest developers of CO₂ technology in South America. In 2008, the compressor manufacturer decided to open a CO₂ training centre in Sao Paulo. Since then, more than 1,200 technicians have already been trained with CO₂ technology. Training courses are open to technical teams, including to end customers, involved in the installation, operation and maintenance of the CO₂ refrigeration equipment. Courses are also open to students, technicians, engineers, designers and installers. The five-module training courses elaborate on the following topics: CO₂ Fundamentals, Systems Safety with CO₂ Applications, CO₂ Refrigeration Systems, CO₂ Refrigeration System Components, as well as Commissioning, Servicing and Maintenance Procedures.

During the training courses both trans-critical and subcritical systems can be seen operating in real time, making the courses an effective way to combine theoretical classes and hands-on experience.

<http://www.r744.com/news/view/3447>



A dedicated CO₂ training centre in Brazil provides hands-on and theoretical knowledge about the operation and maintenance of refrigeration systems. It has opened the Brazilian market for a wider adoption of CO₂ in supermarkets.



<http://www.atmo.org/media.presentation.php?id=218>



OVER 600 TECHNICIANS TRAINED IN HYDROCARBON USE IN GHANA



More than 600 technicians and engineers in Ghana have received training on hydrocarbon technology. A delegation of technicians from Ghana received theoretical and practical training on the safe handling and design of equipment with hydrocarbon refrigerants with the support of an Italian organisation.

Training of technicians on hydrocarbons is part of Ghana's efforts to encourage and spread good refrigeration practices and support the retrofit of domestic refrigerators to hydrocarbons.

<http://www.hydrocarbons21.com/news/view/2734>



Ghana

More than 600 technicians and engineers in Ghana have received training on HC technology to ensure safe handling and design of equipment.



ASSOCIATION OF AMMONIA REFRIGERATION FOUNDED IN INDIA



As the new growth of the cold chain and food processing industry in India has increased the use of ammonia as refrigerant, the Association of Ammonia Refrigeration, India (AARI) has been formed to provide information and education to people and government for the safe use of the refrigerant. AARI also provides guidelines, operating procedures, industrial standards and training material.

Since its establishment, AARI has conducted training programmes for various segments of industry such as dairies, cold storages, and seafood processing plants.

The national organisation is registered in Pune with members from all over India. The members profile comprises consultants, contractors, manufacturers, senior executives of various organisations engaged in the field of ammonia refrigeration industry etc.

<http://www.ammonia21.com/news/view/3118>



India

The new Indian Association of Ammonia Refrigeration (AARI) provides information and education for the safe and efficient use of ammonia as a refrigerant. This will open up the way to a larger market use of NH₃.

<http://ammoniaindia.org/>



E-LEARNING PROGRAM IN EUROPE AND CENTRAL ASIA



UNEP and online learning platform provider elearning-training.com have joined forces to encourage online training for refrigeration engineers in the regions of Europe and Central Asia (ECA). The project aims to promote online courses supported by information and communication technologies that train engineers in the refrigeration, air-conditioning and heat pump sectors as part of national hydrochlorofluorocarbon (HCFC) phase-out management plans across all different countries, with the aim of eliminating barriers to introducing ozone and climate friendly technologies. The courses allow students to complete the web-based training in their own time and in a variety of locations.

More than 12,000 students have joined this online learning website which has now awarded 20,000 Continuing Professional Development diplomas. Overall, elearning-training.com has awarded more than 2,000 Continuing Professional Development (CPD) Certificates in Refrigeration & Air Conditioning basics since last March and more than 10,000 in the last 5 years.

<http://www.r744.com/news/view/3192>



Kyrgyzstan

In a joint effort, UNEP and an online learning provider have encouraged training for refrigeration engineers in the regions of Europe and Central Asia.



PAKISTAN INAUGURATES NATURAL FLUIDS REFRIGERATION CENTER



The Natural Fluids Refrigeration Center (NFRC) was established in Topi, Pakistan by GIK Institute of Engineering Sciences and Technology in collaboration with Isotherm, Inc. USA.

NFRC provides researchers, graduate students and engineers from the HVAC&R industry with education and training on natural refrigerants. Trainees can use high quality experimental facilities to get hands-on training and become acquainted with natural refrigerant-based technology. Moreover, the NFRC offers short technical courses for professional engineers working in today's multi faceted industry.

<http://www.ammonia21.com/news/view/3114>



Pakistan

Pakistan has seen the inauguration of a Natural Fluids Refrigeration Center providing researchers, graduate students and engineers with education and training on natural refrigerants.

<http://www.atmo.org/media.presentation.php?id=230>

SUMMARY & CONCLUSIONS

This GUIDE highlighted the main findings of the UNIDO ATMosphere Technology Summit and the survey realized by UNIDO and shecco. It aimed to share useful experiences with interested parties that are involved in the refrigeration, air-conditioning and foam sectors and that have an interest in low-GWP, cost-efficient and safe technologies.

The UNIDO ATMosphere Technology Summit showcased, through various presentations of business models, case studies and experiences from national governments, that natural substances are a viable and competitive solution for the replacement of HCFC-based technologies. Lively discussions generated between participants demonstrated the large interest and the general need for more information and discussions on this topic. Moreover, participants from all parts of the world, mainly developing countries, were present in the Summit, which represented a remarkable opportunity to share and discuss challenges and prospects which are similar for developing countries. The Summit was also a place for participants to interact with stakeholders from different backgrounds, such as government representatives, end-users, academia representatives, technology providers, etc.

The online survey conducted by UNIDO and shecco complemented the UNIDO ATMosphere Technology Summit in the sense that opinions and trends surrounding the topic of natural substances were captured and quantified. This has facilitated the identification of the main barriers and opportunities in the refrigeration, air-conditioning and foam sectors in developing countries and contributed to a tailored analysis.

In line with these findings, this GUIDE strove to put the main barriers into perspective and to provide examples of best practices and a wide variety of case studies. In recognizing the special needs of the industry in developing countries, both the UNIDO ATMosphere Technology Summit and this GUIDE can be considered very unique. Both have analysed the issue of the adoption of natural substances from the perspectives of developing countries, which will prove to be essential in the future stages of phasing out ozone-depleting substances.

As case studies show, natural foam-blowing agents have already established themselves as viable, safe and cost-effective solutions in the market. Likewise, the uptake of natural refrigerants has been growing at a fast pace. Natural refrigerants have a great potential to become a mainstream option for businesses in

developing countries. This is seen from the case studies highlighted in this GUIDE, where safety, cost, availability, training and awareness in regards to natural refrigerants are no longer challenges but opportunities for a greener planet.

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AUTHORS & CONTACT INFORMATION

The following authors were involved in the preparation of the report:

United Nations Industrial Development Organization:

Sidi Menad Si Ahmed, Director of the Montreal Protocol Branch, UNIDO,
s.si-ahmed@unido.org

Raquel Aledo, Project Coordination
Montreal Protocol Branch UNIDO,
r.aledo@unido.org

Katinka Vigh, Project Coordination
Montreal Protocol Branch UNIDO,
k.vigh@unido.org

shecco SPRL:

Marc Chasserot, Managing Director, shecco
marc.chasserot@shecco.com

Nina Masson, Project Coordination / Lead Author,
nina.masson@shecco.com

Alexandra Maratou, Author,
alexandra.maratou@shecco.com

Huiting Jia, Author,
huiting.jia@shecco.com

Janaina Topley Lira, Author,
jana.topleylira@shecco.com

Franziska Menten, UNIDO ATMOSphere
Technology Summit,
franziska.menten@shecco.com



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