

**ADVANCING OZONE AND CLIMATE PROTECTION TECHNOLOGIES AND POLICIES:
THE FOOD COLD CHAIN**

WORKSHOP REPORT

21 NOVEMBER 2015

International Civil Aviation Organization (ICAO)
World Headquarters
999 Robert-Bourassa Boulevard
Montreal, Quebec
Canada H3C 5H7



**CLIMATE &
CLEAN AIR
COALITION**
TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS



EPA
United States
Environmental Protection
Agency



**GLOBAL
FOOD
COLD
CHAIN
COUNCIL**



The Alliance
for Responsible Atmospheric Policy



UNEP



**Environment
Canada**

I. Background: From Farm to Market

This workshop provided an opportunity to share information and expertise on technologies and policy measures with a focus on the food cold chain -- how we bring food from farm to market. There are climate-friendly alternatives to ozone-depleting substances and high-global warming potential hydrofluorocarbons (HFCs) in each part of the cold food chain where refrigeration is necessary. The food cold chain represents about a fifth of all HFCs use today, and the use of HFCs is expanding. While there is no "one-size fits all" alternative, a growing range of solutions are becoming available that protect the ozone layer, are much less harmful to the climate system and enhance energy efficiency while minimizing food spoilage.

The event was open to all participants of the preceding meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, as well as any other interested industry, government, or NGO representatives.

The conference was conducted in the English language.

The event was sponsored by the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), the United States Environmental Protection Agency (USEPA), the Global Food Cold Chain Council (GFCCC) and the Alliance for Responsible Atmospheric Policy (Alliance), with support from the United Nations Environment Programme (UNEP) and Environment Canada.

II. Proceedings

Introduction

Ms. Cindy Newberg, United States Environmental Protection Agency (EPA), welcomed the participants on behalf of the sponsors of the meeting. She noted that the workshop was an excellent opportunity for an exchange of views on the technologies involved in the food cold chain, as well as the key challenges and opportunities related to expanding the food cold chain in an environmentally sustainable manner. While it was not possible to have an in-depth discussion of all the issues during a single conference, she hoped that the discussions would open a robust dialogue that would continue in the margins of the meeting and beyond. The food cold chain supports bringing food safely from farms to markets and plays an important role in avoiding serious problems associated with food waste. The equipment used vary widely, as do the refrigerants, but hydrofluorocarbons (HFCs) account for one fifth of those used; in the United States it is closer to one third. As countries transition from the use of ozone depleting substances (ODS), and many are also transitioning from high global warming potential (GWP) HFCs while others seek to avoid their increased use, there are important questions related to the available climate-friendly alternative technologies and experience with their use.

Session I: What is the Food Cold Chain

Introduction by Philippe Chemouny, Environment Canada

Session I provided an overview of the key sub-sectors within the food cold chain, the equipment used for farm-to-market refrigeration, a synopsis of climate-friendly alternatives to HFC and hydrochlorofluorocarbons (HCFC) refrigerants (in use or being considered for use), and some of the challenges and opportunities associated with transitioning to those alternatives. Individual presentations by the panellists were followed by a short question and answer session.

Ray Gluckman, Gluckman Consulting, panellist

Mr. Gluckman presented the main market sectors of the food cold chain, the types of refrigeration equipment being used in the different sectors and sub-sectors, the refrigerants and blowing agents in current use and the potential to reduce green-house gas emissions. He said that emissions were of two types: direct emissions caused by the leakage of refrigerants, and the indirect emissions that resulted from the energy used to operate the refrigeration systems, with indirect emissions making up more than two-thirds of the total emission of greenhouse gases.

Roberto Peixoto, Maua Institute of Technology, panellist

Mr. Peixoto presented the alternatives to HFC and HCFC refrigerants in commercial, industrial and transport applications, and explained the options for converting or retrofitting existing equipment. The three main criteria for converting and retrofitting are: materials compatibility, safety and performance. He summarized the different refrigerants available and explained some of the challenges with their use. He noted that the use of flammable, low-GWP refrigerants required the creation of standards of good practice. Technical training was required for the proper handling of the refrigerants, and countries operating under Article 5 of the Montreal Protocol needed support for this, as well as the transfer of technology, which could be aided by demonstration projects and fiscal incentives. He also said that high ambient temperatures affected the choice of alternative refrigerants.

Questions and Comments

It was pointed out by a participant that carbon dioxide transcritical systems and ejection systems were being used successfully in Italy and that the latitude below which such systems could efficiently be used had shifted south, in part because regulatory certainty in the European Union has encouraged companies to invest in those systems. The first transcritical system has already been established in Argentina and transcritical systems could be adapted for use in tropical countries with the appropriate engineering, although in general they did not perform as well at high ambient temperatures.

Mr. Gluckman said that the decision to convert from HCFC-22 to R-404A was likely a poor choice, but Article 5 countries no longer needed to make that choice as there were other alternatives available. Much work remained to be done to reduce the leakage from

refrigeration systems. As a start the European Union Fluorinated Greenhouse Gases regulation EU/517/2014 (replacing regulation EC/842/2006) provides for mandatory record keeping for equipment that contains a charge of more than three kilogrammes of fluorinated greenhouse gases.

Mr. Peixoto said that incidents involving ammonia might be more common in Article 5 countries as not all of them had the maintenance procedures needed for the refrigerant or the sensors to detect its accidental release. He explained that the HFC blends were considered climate-friendly alternatives because their GWP was generally half that of R-404A, but cautioned that the total climate impact, which included both direct and indirect emissions, had to be assessed in terms of the systems being used and not just the refrigerants themselves.

In response to a question about the appropriate ratio between engineers and technicians when they were working with highly flammable refrigerants, Mr. Gluckman said that in Europe, where there are some 200,000 technicians trained to handle HFCs, less than a tenth of them were qualified to service equipment using flammable refrigerants, and the majority of those engineers had not yet been asked to service such equipment. The issue is one of timing; training has to be coordinated with the introduction of the equipment and the possible ratio of technicians to engineers can be from 10:1 or 20:1.

Session IIa: Equipment Manufacturers and Refrigerant Producers Perspectives - Refrigerated Transport, Industrial Processing Refrigeration, Cold Storage

Moderated by Yaqoub Al-Matouq, National Ozone Unit, Kuwait

Session IIa was designed to improve understanding on the current state and availability of low-GWP technologies, as well as the challenges associated with producing related equipment and refrigerants in each sub-sector within the food cold chain. Individual presentations by the panellists were followed by a short question and answer session.

Nacer Achaichia, Honeywell, panellist

Mr. Achaichia noted that Honeywell was committed to the production of new hydrofluoroolefins (HFOs) and had identified three new molecules with a low atmospheric lifetime and a GWP of one or less: HFO-1234yf, HFO-1234ze and HFO-1233zd. European Regulation EU/517/2014 instituted a cap and phase-down system based on equivalent carbon dioxide emissions that would lead to a 27 per cent reduction by 2018 and a 79 per cent reduction by 2030. Honeywell expects that the United States EPA will also limit high-GWP refrigerants in some applications. Honeywell is working, along with others, towards solutions for applications in areas with high ambient temperatures and Mr. Achaichia said that the results so far had been very encouraging.

Steve Kujak, Ingersoll Rand/Thermo King, panellist

Mr Kujak stated that it was a difficult to design transportation equipment that had to function in both hot and cold regions, or on land or water, especially when the selection of refrigerants was restricted by both the size and weight of the vehicles. However, there are a number of HFC

and HFO low GWP blends available. In particular, Thermo King would be using R-452A, which is a blend that has around half the GWP of R-404A, in its European operations. The major issue in transportation is flammability and the liability it entailed, which was complicated by the lack of clarity in the chain of custody as the vehicles moved back and forth between public and private areas. While the lack of standards for the flammable refrigerants is a problem, it might not make sense to continually use ever lower GWP alternatives since beyond a certain point, their use had to be balanced against the other efficiency requirements of the supply chain.

Joseph Pillis, Johnson Controls, panellist

Mr. Pillis started by noting that ammonia was an efficient and cost effective refrigerant but is also corrosive, mildly flammable, toxic and has a pungent smell that makes leaks self-alarmed. It is sometimes banned from use in highly populated areas and has been effectively discouraged because of the regulatory need for a compliance officer, or a full-time operator, in some locations. He noted that carbon dioxide was being used, especially in cascade systems, but is less efficient than ammonia. Leaks are a concern: if water mixed with carbon dioxide it could form acid and if carbon dioxide mixed with ammonia the gases could form solid contaminants. In his view hydrocarbons, while efficient refrigerants, were not a viable option in most of the cold chain, as the operational staff do not have sufficient training to use them safely. The key issues of concern with alternatives are: safety, reliability, risk, efficiency, environmental impact, availability and affordability. When using ammonia as a refrigerant, it is important that industry-recognized good engineering practices are followed, as promoted by the international Institute of Ammonia Refrigeration, or similar organizations.

Jianyi Zhang, Fujian Snowman, panellist

Mr. Zhang explained that China currently used HCFCs, in small and medium sized applications, in facilities such as supermarkets. Fujian Snowman is developing a new condenser that would increase the efficiency of the use of ammonia in those facilities. Compared with developed countries, the food cold chain is underdeveloped in China. It had great potential for further development, and the new condenser unit would aid both that and the global phase out of HCFCs

Marc-André Lesmerises, Carnot, panellist

Mr. Lesmerises described the activities of his company, which had designed a number of industrial and commercial cooling systems. Carnot has expanded into the field of eco-efficient refrigeration, especially in the area carbon dioxide cooling systems. Mr. Lesmerises explained that carbon dioxide is a natural refrigerant that its use was good for the environment. His company used carbon dioxide to reduce, or emulate, the ammonia used in supermarkets, warehouses, liquid chiller, and ice rinks.

Questions and Comments

The moderator said that there was a need to look at alternatives; while there was no single solution for all problems the core elements were there. With respect to the increased costs of using carbon dioxide, Mr. Achaichia said that carbon dioxide was a good refrigerant for removing heat in low-temperature applications but had a problem when rejecting it to

ambient; the higher the temperature, the more difficult that became. At higher ambient temperatures, where carbon dioxide became transcritical, the costs increased as parallel compressors and ejectors are added, or a cascade system is used. To reduce these costs in one supermarket, carbon dioxide is cascading with HFO-1234ze. This system produced hot water for both heating and sanitary needs, and the air-conditioning is provided by the cooling system.

Mr. Kujak said that solutions were available for high-ambient transportation. R-404A worked in high ambient temperatures, but so did R-452A, R-448A, and R-449A. The GWP of the new blends is in the range of 1400 to 2150 and the new molecules performed even better than the old ones, including at high ambient temperatures.

Mr. Pisano said that the cost of carbon dioxide was about three euros per kilogramme, while Mr. Lesmerises explained that carbon dioxide was being used in automotive air-conditioning and could be used for both heating and cooling a vehicle, when used with a heat pump system. This would allow for the battery to be reduced in size. Therefore, it is important to look at systems in new ways and not just repeat what has been done earlier. A particular characteristic of carbon dioxide and its biggest advantage is that it could bring a lot of heat and energy to a remote area. He said that a better view of the costs of any system could be found by considering its entire life-cycle.

Mr. Achaichia said that while carbon dioxide was an inexpensive fluid, the cost of the fluid was only a very small part of the cost of a system. HFO-1234ze has a GWP 20 per cent less than that of carbon dioxide and can be used in combination with it to take advantage of the characteristics of each fluid. The three new HFOs (HFO-1234yf, HFO-1234ze, and HFO-1233zd) are available worldwide and all 3 molecules worked at medium to low pressures. At higher pressure production blends were required. They were now commercially available with a much lower GWP than that of R-404A. R-452A, which is used in transportation, is one of them, but R-448A and R-449A are two blends with a GWP of 1,400. Honeywell is working on new refrigerants with a GWP of 150, and has registered a new refrigerant R-455A with a GWP of less than 150, because the European Regulation is based on that level of GWP. All the alternatives have better performance than R-404A and the only issue with the blends is that they are mildly flammable. The flammability of new the blends is less than the flammability of hydrocarbons as the blends are difficult to ignite and require a high energy source for that to happen.

In response to a question about the breakdown in the atmosphere of HFO-1234yf into trifluoroacetic acid (TFA) Mr. Achaichia said that TFA existed well before industrial era, and was a natural substance. He added that it had been studied many times and a recent report prepared by ICF International for the United States EPA had concluded that it should not result in a significant risk of toxicity, and should not be a major concern for local air quality in most locations. Mr. Achaichia also said, in response to a question about the availability of the new HFOs in South America, that the three new molecules he mentioned were available worldwide.

In response to a question about the level of use of ammonia in the Chinese market, Mr. Zhang said that while ammonia was used in China in larger systems, several accidents had occurred so that its use was now forbidden in some areas of the country.

Session IIb: Equipment Manufacturers and Refrigerant Producers Perspectives - Commercial Refrigeration

Moderated by Agustin Sanchez Guevara, National Coordinator, Ozone Protection Unit, Mexico

Giancomo Pisano, Dorin Compressors, Italy, panellist

Mr. Pisano noted that Dorin produced compressors that used both natural and chemical refrigerants. There had been a rapid development of new refrigerants recently and it has been impossible for the industry to keep up with all of them. Therefore, although it did not suit all applications, carbon dioxide is one of the best solutions for manufactures as it drives investment in right the direction. It is proof against future legislative changes, as it does not fall under the European Regulation EU/517/2014, and there are means for improving its efficiency in any climate. Although cost can be an issue, technical solutions existed. His company is willing to make that investment but there had to be a policy, laws and standards, to drive that investment. Training is also a barrier to the use of carbon dioxide, but that training is not difficult.

Tatsuro Kobayashi, Daikin, panellist

Mr. Kobayashi said that Daikin produced refrigerants in addition to heating and air-conditioning systems. He said that for refrigerant producers there were two possible approaches to addressing the issue of GWP: the overall phase-down target for the GWP or the GWP cut-off limits for the different applications. In either case the refrigerants have to be safe to use throughout their entire life cycle. A generally known trade-off to low GWP is flammability, and while some sectors have started to use refrigerants with a lower flammability such as HFO-1234yf, a thorough risk assessment was still needed for each application. Flammable hydrocarbons, for example, could be used in small stand-alone systems which are hermetically sealed with a small charge. When considering the options, the energy efficiency and cost effectiveness of the refrigerants has to be considered, which included, *inter alia*, the ease of installing the system, and the expense of doing that, whether changes can be made to the system at a minimal cost, whether the refrigerant is readily available and affordable, and whether the applicable codes and standards existed.

Torben Funder-Kristensen, Danfoss, panellist

Mr. Funder-Kristensen explained that Danfoss had been producing components for systems using low GWP refrigerants for a number of years. The challenge with carbon dioxide has been high, but for hydrocarbons, HFCs and HFOs it had been relatively simple to adopt components for controls, aside from compressors which require testing for each application. However, there is still a need for regulatory certainty to drive further investment in the alternatives, especially for carbon dioxide.

Juergen Goeller, Carrier, panellist

Mr. Goller said that the expansion of the food cold chain was important. One third of the food produced is lost or wasted; of that amount two-thirds is lost between the farm and the markets, and a further third lost between the markets and the consumers. The majority is lost in developing countries: in developed countries it is mainly food waste that is the concern. An expansion of a reliable food cold chain could significantly reduce food losses and aid in better feeding the world. He also said that there had been a substantial increase in transcritical carbon dioxide applications across Europe. Carrier is adding parallel compressors and ejectors to adapt this technology to warm and hot ambient climates in southern Europe and later for other regions. Carrier has also developed transport container systems using carbon dioxide as a refrigerant, and had concluded that in terms of energy efficiency, cost, safety and regulatory compliance carbon dioxide is a better choice than hydrocarbons or the currently used HFCs and HFOs.

Questions and Comments

It was observed by a participant that there were many environmentally friendly solutions available and that some of them had reached parity costs with the previous solutions. The way to achieve that, from an industrial point of view, is a specific driver such as legislation. Transcritical carbon dioxide systems are now well established in Europe and compressor demand is doubling every year. That was driven by the regulatory environment in Europe, once legislation had been enacted that prohibited any new system with a charge of more than 10 kilogrammes of HFC, as for example in Denmark. While the first solutions had been more expensive and less efficient, after five or six years parity was achieved in both efficiency and cost. Legislation helped drive industry in the right direction with rules, fiscal incentives and taxation, and that would help to make carbon dioxide as cost-effective as HFCs. Parity between them already existed for some applications but for split systems with condenser units the difference in cost is still large, although the gap can be reduced with the appropriate policy measures to encourage industry to invest in technology. Industry needed to know which refrigerants it could use; a market based solution is not feasible because the rapidly increasing number of new blends made it impossible to follow up on, and invest in, all of them without losing money.

Mr. Gluckman said that there are two types of regulatory certainty and that regulators had a poor history when imposing a particular technology on industry; any regulations developed should not be prescriptive of a technology. The attraction of the HFC phase-down approach under the Montreal Protocol is that it allowed choice in the technologies being adopted.

Another participant pointed out, however, that Article 5 countries have to achieve their HCFC phase-out and therefore had to adopt currently available technologies. Article 5 countries wanted reassurance that they will not experience the same problem that has occurred when they transitioned from CFCs to HCFCs. They had made that transition in good faith but are now being told that they have to make yet another transition. Assurance was sought that the solutions being proposed now would not require another transition in the future. Article 5 countries did not generally have the large centralized or stand-alone systems of non-Article 5

countries; the majority of their systems are small condensing units and small split systems. They are currently transitioning to R-404A because they did not see other solutions in the market.

Mr. Torben said there were substitutes for R-404A, including HFC blends with a GWP level of around 1,500 on the market. Mr. Pisano agreed and said there were condensing units that worked with chemical refrigerants and had a GWP of around 500 that would work in these applications. There are also 'plug and play' carbon dioxide condensing units that are easy to work with and which are available for low and medium ambient temperatures, although cost is an issue with them.

With respect to the food loss in developing countries and the importance of adequate regulations, another participant pointed out that part of the reason for that loss was the lack of a sufficient food cold chain in those countries. Legislation is required to force all the stakeholders along the food cold chain to guarantee that the temperatures are adequate to reduce food losses.

In response to a query on whether countries should move to the next generation of refrigerants or wait for a better solution to develop, Mr. Kobayashi said that countries should not wait for an ultimate solution to be developed. It would be good if there was one refrigerant for all the applications but unfortunately that remained unidentified. However, attempts at standardization are ongoing and hopefully the number of refrigerant solutions can be narrowed down to several candidates.

Session III: Global and Regional Challenges and Opportunities for End-Users, in Adopting Low-GWP Alternatives

Moderated by Tom Land, United States Environmental Protection Agency

Session III was designed to provide insight into the current state of technologies in the food cold chain, with a particular focus on end-users, and the challenges and opportunities in adopting low-GWP alternatives, taking into account regional dimensions. Individual presentations by the panellists were followed by a short question and answer session.

Paul Anderson, Senior Group Manager of Engineering at Target Corporation, panellist
Mr. Anderson reported on the operations of Target. Target is a grocery and general merchandise retailer with stores located in the United States. Since opening its first distribution centre in 2008, Target has used ammonia to cool its cold storage areas but has moved from HCFCs to HFCs to ammonia/glycol to cool the associated office space, thus eliminating HFCs and increasing energy savings. That said, it also increased installation costs by nearly \$75,000. Target devoted substantial time and resources to addressing the safety concerns associated with ammonia. In the United States, growing demand for fresh, local foods pointed to an increase in small distribution centres in and around urban locations, for which viable options were ammonia/carbon dioxide cascade systems and packaged ammonia systems.

Randel Walthers, Manager of Energy / Utilities of Raley's Family of Fine Stores, panellist

Mr. Walthers reported on the operation of Raley's Family of Fine Stores. Raley's is a privately held, family-owned supermarket chain in the United States that operates stores in northern California and Nevada. Regional considerations in California include temperatures of up to 47° C and the strong impact of the 2008 financial crisis. Mr. Walthers reviewed Raley's progress in eliminating ozone-depleting refrigerants over time and the company's plans for its refrigeration systems in the short and longer term, including the results of a comparative analysis of various cascade systems using carbon dioxide as the secondary fluid.

Ray Gluckman, Gluckman Consulting, panellist

Gluckman Consulting is a specialist technical consultancy providing expertise related to climate change mitigation and refrigeration. Mr. Gluckman made a presentation on the European Regulation EU/517/2014 that came into force in Europe on January 1, 2015, which legislated a challenging HFC phase-down over the next few years. He described how that would be achieved, including alternatives for various types of refrigeration systems.

Riccardo Savigliano, Industrial Development Officer at UNIDO, panellist

Noting that refrigeration is closely linked to food safety and food security, which were important concepts for the United Nations, Mr. Savigliano presented two industrial projects: one in which the use of methyl bromide was replaced with HFC refrigeration, and another involving the upgrading of an old, leaky refrigeration system. He stressed that in developing countries, consideration of a company's business model was key when introducing and optimizing refrigeration systems, and capital investments should ideally be small.

Zhong Zhifeng, Deputy Director of Division III, Foreign Economic Cooperation Office, China, panellist

According to Mr. Zhong, one of the main obstacles to the adoption of low GWP alternatives in China was lack of availability of technologies, and technology suppliers should be encouraged to promote alternatives to a greater extent in Article 5 countries. Another major challenge is system operation, including installation, maintenance and service, particularly on systems using carbon dioxide, or flammable refrigerants like ammonia and hydrocarbons. There are a greater number of accidents with ammonia systems in the Article 5 countries because, although standards and codes are in place, they are often only for fire, or are not applied properly. The potential for the adoption of low-GWP alternatives is good, especially if energy savings could be shown to offset the higher capital investment.

Mr. Mohamed Yassine El Aroussi, Department Head, Ministry of Agriculture and Fisheries, Morocco, panellist

Mr. El Aroussi said that while the fish processing industry in Morocco, which exports to the European Union and the United States, operates in compliance with general hygiene and food safety guidelines, industry awareness of the need to reduce environmental impact and improve energy efficiency was new. The government is more aware of such considerations and has recently subsidized a program to replace old freezing equipment on vessels with environmentally friendly alternatives. Two relevant international cooperation projects were underway: one with UNIDO that includes technical conversions to ozone- and climate friendly,

energy efficient refrigeration technologies, and another with Japan involving a demonstration project for the introduction of advanced refrigeration technologies to enhance value of sea products.

Questions and Comments

In response to questions on the commercial availability of low-GWP systems, Mr. Walthers indicated that HFO-1234ze (GWP under 50) was already commercially available. According to Mr. Gluckman, R-448A (GWP 1400) and R-449A were alternatives for small industrial systems, but a GWP under 300 required a mildly-flammable HFO/HFC blend that was not yet commercially available. However, anyone using ammonia in a factory is already using a mildly-flammable refrigerant and would be able to use those HFO blends when they became commercially available, which he suggested would be in a year or two. Mr. Savigliano indicated that for the fishing industry, UNIDO was considering the feasibility of a cascade system with carbon dioxide as the secondary refrigerant and possibly ammonia or HFOs as the primary refrigerant, but the concept is still at the project design stage; more information should be available within twelve months. It was noted that retrofitting existing refrigeration equipment on a vessel was very complicated due to space constraints.

Addressing a question about whether safety or economics was the main consideration for the production of hydrocarbon equipment, Mr. Gluckman acknowledged there were major hurdles involved with having large quantities of hydrocarbons at a manufacturing facility. In Europe, hydrocarbons are used for foam blowing when the volumes are large enough to make the associated safety precautions cost effective. Furthermore, large suppliers of refrigerated products often supplied hydrocarbons and carbon dioxide equipment for use by the food retailers to sell their products.

Mr. Janos Maté from Greenpeace drew participants' attention to a website called cooltechnologies.org, which hosted an interactive database of companies that produced and used HFC-free cooling technologies.

Session IV: Public Sector Policies and Initiatives

Moderated by Leslie Smith, National Ozone Officer for Grenada

Session IV was on the role of domestic and international policies, standards and practices influencing refrigerant choices across the food cold chain, and opportunities for promoting a more climate-friendly transition. Individual presentations by the panellists were followed by a short question and answer session.

Introducing the session, Mr. Smith said that policies and standards were critical to industry's role in the adoption of new technologies, with a lack of standards sometimes cited as the cause of incidents related to ammonia and other flammable refrigerants as well as the challenges facing Article 5 countries in the adoption of low-GWP alternatives.

Mark Wagner, Senior Vice President, ICF International, panellist

ICF International is a management, technology, and policy consulting firm. Mr. Wagner presented an overview of policy approaches in the United States, the European Union, and Japan, looked at bilateral and multilateral initiatives in the international community and developing country efforts. Mr. Wagner also presented the global picture and existing support for HFC policy making and implementation.

Vasile Minea, Member, Commission E2 of the International Institute of Refrigeration (IIR), panellist

Mr. Minea gave a presentation on the activities of the IIR, an intergovernmental organization that promotes many different sustainable refrigeration technologies.

Mohamed Alaa Olama, Consultant and member of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC) of the United Nations, panellist

Stressing the importance of the food cold chain in providing the world's growing population with the fresh food essential for good health, Mr. Olama reviewed the five stages of food cold chain and the existing standards. He concluded that considerable efforts should be invested in establishing standards, particularly in commercial refrigeration and in Article 5 countries, in order to achieve the global goal for food security.

Madi Sakande, General Manager and co-partner, New Cold System s.r.l., panellist

Mr. Sakande said that New Cold System s.r.l. was an Italian company that produced systems and manufactured components for standard and special applications in refrigeration and air conditioning. In his presentation, Mr. Sakande spoke about the severity of food losses in Article 5 countries and the pressing need for the introduction of standards in those countries, and more specifically about the need for and process of certification.

Arumugam Duraisamy, Director of Ozone Cell, Ministry of Environment, Forest and Climate Change, India, panellist

Mr. Duraisamy spoke about the development of the food cold chain in India and the associated challenges. He reviewed the use of refrigerants and emerging low-GWP alternatives, as well as current government incentives to support development of the food cold chain and what still remained to be done.

Questions and Comments

During the question and answer portion of the session, panel members were asked which of the policy options available to achieve a climate-friendly transition they considered most easily achievable, and whether changes in public procurement would be one such policy option. In response, Mr. Wagner pointed out that Climate and Clean Air Coalition (CCAC)-supported efforts and the activities undertaken by developed country governments to assist in the leadership process with federal procurement had a spill-over effect in developing countries. He also said that UNEP and CCAC activities that brought together National Ozone Unit and federal procurement personnel were also a good development. HFC decision-making was a holistic process that required a series of approaches, including standard setting and development, policy outreach initiatives, federal procurement and communications.

Responding to a question on certification standards and training in Africa, Mr. Sakande reiterated that there were currently no standards for certification in Africa. As most African technicians were self-taught, he said, the development of training centres would be a good first step. Mr. Wagner noted that multinationals working in developing countries also served as a mechanism for training of smaller local entities.

Asked whether large multinationals from developed countries applied the same standards when working in developing countries, Mr. Wagner thought they would, as it would be impractical for them to have different operations in different locations. Mr. Olama noted that hypermarket chains could not ensure an unbroken cold chain on their own, as they were not responsible for every step in the food cold chain. What was needed was creation and implementation of appropriate legislation based on a code for the food cold chain, which no Article 5 country had yet. Mr. Sakande agreed, saying that companies were interested in profit, and it was up to legislators to ensure that the appropriate standards were in place.

Session V: Private Sector Initiatives – Need, Effectiveness and Impacts

Moderated by Alessandro Peru, Italy

Session V was on ways to further encourage actions within the private sector, taking into account HFC commitments from the 2014 United Nations Climate Summit. Individual presentations by the panellists were followed by a short question and answer session.

Kevin Fay, Executive Director, Alliance for Responsible Atmospheric Policy, panellist
Mr. Fay said that the Alliance coordinated industry participation in the development of international and United States government policies regarding ozone protection and climate change. He described the industry-led Global Refrigerant Management Initiative (GRMI), which proposed to address the problem of refrigerant emissions due to leakage from the existing installed equipment base by educating the industry's global supply chain on ways to improve the management of refrigerants to reduce leaks and service emissions, and promote refrigerant re-cycling, recovery, reclaiming and end-of-life destruction. Among the specific issues that the Initiative hopes to address are the lack of a consistent approach and communication among implementing agencies working on education, training, and certification for equipment servicing, as well as the lack of associations representing the service industry in many countries.

Another goal of GRMI was to set up a reclaimed HFC credit bank aimed at creating market incentives for the recovery of HFCs. Mr. Fay made a presentation on the newly-approved methodology that the bank would use to establish greenhouse crediting for the use of certified and reclaimed HFC refrigerants. The presentation was made on behalf of EOS Climate, the company that developed the methodology.

Rajan Rajendran, Vice President, System Innovation Center and Sustainability at Emerson Climate Technologies and Co-chair of the Global Food Cold Chain Council (GFCCC), panellist
Mr. Rajendran presented the GFCCC, a technology-neutral industry initiative aimed at promoting food preservation to ensure food safety and food security. Membership in the

GFCCC is voluntary and is open to private sector entities, trade associations, national governments or regional economic integration organizations (REIOs) and government entities, all of whom are encouraged to join.

Zhong Zhifeng, Deputy Director of Division III, Foreign Economic Cooperation Office, China, panellist, on behalf of **Zhang Zhaohui**, Secretary General, China Refrigeration and Air-Conditioning Industry Association (CRAA)

Mr. Zhong said that CRAA was a non-profit industrial organization primarily representing refrigeration and air-conditioning manufacturer, and presented an overview of the food cold chain in China, including refrigerant use and the challenges related to low-GWP adoption. Ammonia/carbon dioxide cascade systems have gained good acceptance in China, even though the cost is higher.

Janos Maté, Senior Consultant, Political Business Unit, Greenpeace International
Greenpeace is a non-governmental environmental organization, and Mr. Maté described “Refrigerants, Naturally!”, an initiative by international companies to use climate-friendly natural refrigerants in point-of-sales cooling and freezing units, and SolarChill, a project aimed at delivering solar-powered vaccine coolers to regions of the world with inadequate electricity.

Questions and Comments

During the question and answer session, participants posed a number of questions on food waste. Both Mr. Fay and Mr. Rajendran responded to these by indicating that they drew their information from a 2013 FAO study on the subject.

Mr. Fay also addressed questions from participants in relation to the HFC credit bank project. He pointed out that 60 per cent of annual HFC consumption was attributable to servicing, with recovered HFCs in large part either vented or lost by service technicians. This occurred even in the United States, where venting was indeed prohibited. The goal of the bank project is to create a market mechanism that provided an incentive to capture and reuse HFCs, instead of venting them. In response to a concern expressed regarding potential “gaming” of the system, Mr. Fay explained that there was no plan for the credits issued by the bank to be marketable under the European emission trading scheme, and acknowledged the need to avoid gaming of the system. He recalled, however, that a significant component of the climate policy regime relied on market mechanisms, and felt that while not a panacea, the bank would prove to be an effective market mechanism for managing the HFCs already in use in the field.

Responding to a participant who expressed frustration that such industry interest in HFCs had been lacking in 2007 when the HCFC phase-out was negotiated, Mr. Fay underscored that industry responded to the objectives set by policy makers. While in 2007 the objective had been to eliminate ozone-depleting substances, the priority was now climate change. In his opinion, to achieve both the environmental objective and the financial objective of cost-effective transition, what was needed was a policy that sent a long-term signal, a reasonable time frame to achieve the desired objective, and appropriate financial assistance for Article 5 countries.

Mr. Janos addressed a couple of questions related to the use of solar power for refrigeration, saying that while he did not know whether solar would eventually replace refrigerants altogether, combining the two certainly made sense. He also said that an increasing number of health ministries in Article 5 countries were opting for solar vaccine coolers to replace kerosene or gas coolers, and that by 2020, 80 per cent of refrigerators would use hydrocarbons.

Closing Session

Mr. George Chaumba, Head of the National Ozone Unit of Zimbabwe made a short closing statement, highlighted a number of points raised during the day's discussions that were of particular importance for developing countries. He said food supply was critical for developing countries, and the involvement of external stakeholders in the refrigeration sector was important for improving the food cold chain and reducing food losses. Article 5 countries, particularly in Africa, often used outdated technology, and needed to benefit from technology transfer in order to upgrade their systems. Leakage was another area of concern for both developed and developing countries alike. Technicians in Article 5 countries needed training to minimize losses of refrigerant gases and cut greenhouse gas emissions, both direct and indirect. He also noted that actors in all six stages of the food cold chain needed to be made aware of technological developments like the ozone- and climate-friendly technologies mentioned during the workshop. He invited technology providers from developed countries to explore the markets in developing countries in order to help speed up the adoption of such technologies, while noting that industry and government should work together to avoid the enacting of legislation that was counterproductive to industry. Expressing his satisfaction at the level of interaction during the workshop, he hoped that the exchange of information could continue, and expressed the desire for a similar workshop to be held in Africa to provide local technology providers with a much-needed learning opportunity.