Project report for CCAC focal area initiative (HFCs)

Workshop on Promoting Low-GWP alternatives to HFCs in Supermarkets

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and

UNITED NATIONS DEVELOPMENT PROGRAMME

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Contents

List of abbreviations and initials

CCAC	Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants
GHG	Greenhouse gases
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HFO	Hydrofluoroolefins
LAC	Latin America and the Caribbean
NOU	National Ozone Unit
SLCP	Short-lived climate pollutants
UN Environment	United Nations Environment Programme
UNDP	United Nations Development Programme

BACKGROUND

The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) is an initiative of the United Nations Environment Program (Latin America and the Caribbean) and a group of countries launched in 2012 for a collective action to reduce short-lived climate pollutants (SLCPs) such as black carbon (soot), methane and some hydrofluorocarbons (HFCs).

One of initiatives of the CCAC works on "Promoting HFC Alterative Technology and Standards" or "HFC Initiative," which aims to significantly reduce the projected growth in the use and emissions of high-global warming potential (GWP) HFCs in coming decades. The workshops on Promoting Low-Global Warming Potential alternatives to HFCs in Supermarkets was planned and funded in the context of this initiative.

The United Nations Development Programme (UNDP) is a partner of the CCAC and has worked in the development of several activities to promote the adoption of alternatives to HFCs in developing countries.

For the development of the workshop, UNDP combined efforts with the Ministry of Environment of Chile, through the National Ozone Unit; UNDP has worked as implementing agency of the Montreal Protocol projects in the country and other countries in Latin America and the Caribbean (LAC).

The overall budget for this activity was US$ 35,000, which included agency fees.

OBJECTIVE

To build capacity amongst industry stakeholders and policy-makers on HFC alternative technologies, policies and standards; specifically, in the supermarket sector where HFCs are used.

The project aims to organize one workshop in Latin America to present the results of the demonstration project on the adoption of a transcritical CO_2 refrigeration system in a supermarket and enhance awareness on other technology options for the supermarket sector.

WORKSHOP'S DESIGN

Governing principles

As part of the objective of the project was to enhance awareness on the available technology options for the supermarket sector, the main criteria in the design of the workshops was to do it as open and participatory as possible, considering the limit funding and time available for its organization.

Also, it was considered to have an open approach that looked to include all Low-GWP technologies, based on either natural or synthetic refrigerants, treating them all with balance and equilibrium, giving an honest and clear presentation of each technology or technology solution.

Finally, the workshop aimed to have a broad participation of public and private stakeholders from LAC countries where participation and exchange of information would be encouraged.

Location

Considering that the demonstration project for the adoption of transcritical CO_2 project was developed in Chile and that one of the objectives of the project was to present its results, the first option was to conduct the seminar in Chile.

The proposal was discussed with the NOU and the country office of UNDP, which were both delighted to support this initiative. Their commitment and support were on full display during the preparation and implementation of the workshop.

Structure

The workshops were structured, based on the concept of showcase, the available options and regional examples in the global context of the Montreal Protocol and its Kigali Amendment. A duration of 1.5 days was considered; where during the first day all available technologies were presented and in the second day (half day) regional experiences on the adoption of Low-GWP alternatives were presented.

All technical presentations had 45 minutes to present the technology and answer questions from the assistants. It was considered that discussion and exchange of information was important, so discussion panels were conducted at the end of each session.

With this structure in mind, UNDP and the NOU started to identify the available technologies for the supermarket sector and adoption examples in the region, discussions were conducted with experts and technology suppliers and a preliminary list, of both technologies and examples, were

identified, which included CO_2 (subcritical and transcritical), HC, HFOs and water loop system, and examples in Chile, Brazil and Panama.

With the results of the initial research and discussions with possible lecturers the workshop's agenda was prepared, which is presented in the Annex 1.

Invitations

One of the challenges of the activity was to organize the participation of experts for the different alternative technologies and examples identified while inviting as many representatives from countries around the region. Several discussions and alternatives date were considered to accommodate as many stakeholders, NOUs and experts as possible.

Some of the criteria used for the invitation of experts and NOU´s representative were:

For presenters:

- It was required that the presented had the technical knowledge in the technology, with ample field experience in the adoption of the alternative;
- Commercial speech were not welcome;

For countries:

- Priority was given to CCAC's members. All CCAC members in LAC were invited to the event. The invitation covered air tickets and accommodation.
- It was requested, when possible, that the refrigeration technical advisors of the NOU were assigned to attend the workshop.

For end-users:

- It was suggested that personal from the engineering and procurement departments from the supermarkets were designated to attend the workshop.
- End-users had to cover their expenses.

Example of the invitation used is presented in the Annex 2.

WORKSHOP'S NOTES

The workshop was conducted in the Hotel Neruda (Av. Pedro de Valdivia 164, Providencia, Región Metropolitana, Chile), at the Avenida Providencia, located close to the financial center of Santiago, which secured easy access to all the attendees.

47 persons attended the event, 29 local and 18 international, including representatives of 7 NOUs of the region; 6[1] out 9 CCAC's state members in LAC participated in the workshop. A distribution of the affiliation of the participants is presented in the table 1.

In annex 3 the List of participants can be found.

Table 1. Affiliation of participants.

Sector	Count
Academy	3
End-user	3
Government	11
Implementing Agency	5
Installer	11
Supplier	14
Total	47

Presentations' notes and remarks

The proposed agenda was developed without changes, some note and remarks from each of the presentations are presented below, the presentation were shared between the participants.

Inauguration and welcoming words.

Presenters: Fernando Farias, Director of the Climate Change Division, Ministry of Environment (Chile)

Kasper Koefoed, Regional Coordinator for LAC, Montreal Protocol Unit, UNDP (Panama)

Key remarks:

- This kind of event are quite useful, as they bring together the technology providers and the companies that will used those technologies in the field.
- As Chile was the first country in LAC to ratify the Kigali Amendment, this workshops is a good opportunity to increase the national capabilities for the adoption of low-GWP technologies that will help Chile in fulfill its newly acquired commitments.
- The commitment of Chile with the Montreal Protocol is strong, the new links with climate change that the Kigali Amendment brings only ratified the strategy implemented by the country of close cooperation and search of synergies to deal with these environmental challenges; within the Ministry of Environment, the Ozone Unit is part of the Climate Change Directorate.

Kigali Amendment: Challenges and opportunities.

Presenter: Carlos Andrés Hernández, UNDP (Panama)

Key remarks:

[1] CCAC´ state members that attended the workshop included: Colombia, Costa Rica, Chile, Dominican Republic, Paraguay and Peru.
Mexico, Panama and Uruguay were invited but did not participated due to different reasons.

- The Kigali Amendment is a unique opportunity to reduce the global warming, the reduction in the use of HFC is considered an impactful initiative in the short term ("low hanging fruit").
- There are some challenges in the introduction of new alternatives, as some are flammable or toxic, which will implicate changes in the legal framework, training of technicians and end-users to cope with the new reality of the refrigerants.
- The entry into force of the Kigali Amendment is "around-the-corner", as (at the time of the workshop, Nov – 2018) 11 parties had ratified the agreement, so countries have to be starting the preparation of their strategies and plans.
- As energy efficiency considerations have to be taken into account when introducing alternatives to HFC, new opportunities arise for increase the efficiency of equipment and system.

Global perspective of low global warming potential options in refrigeration.

Presenter: Roberto Peixoto (Brazil)

Key remarks:

- The key challenge is the substitution of HCFC-22 and HFC of high GWP (HFC-134a, R-404A, R-410A) by low GWP refrigerants.
- The perspective to find new and different refrigerant fluids are minimal.
- A great number of new refrigerant blends have been launch, but the market will select only a few.
- For the supermarket sector, there are multiple solutions that could generate lower emissions of greenhouse gases (GHG) which include systems with reduce charge of HFC refrigerants (in cascade configuration) or based on low-GWP refrigerants (as CO_2, HC, HFO, NH_3, H_2O).
- Technical training is key for the adoption and sound management of alternative refrigerants.
- The selection of new alternatives will be based on a balance between energy efficiency, cost and environmental performance.

Subcritical CO2 for supermarkets: waterfall, pumped.

Presenter: Rogeiro Marson Rodrigues (Brazil)

Key remarks:

- It is possible to design refrigeration systems using reduced charges of the main refrigerant which could be HFC, HC, NH_3) only in the machinery room and other, minimizing its environmental impact, flammability or toxicity risks, while using glycol or CO_2 in the public areas.
- In Brazil, most of the refrigeration system using subcritical CO_2 are working in cascade configuration, only a small fraction are using pumped subcritical CO_2.
- Designers could analyze different combination of refrigerants in the machinery room and the public areas in search of the most efficient system.

Transcritical CO2: State of the art and application in the supermarket chain.

Presenter: Pier Zechetto (Chile)

Key remarks:

- CO_2 is an excellent refrigerant, it has high volumetric refrigeration capacity, 6 times higher than R-404A, which results in smaller compressors, tubes and components.
- Use of transcritical CO_2 is growing globally, energy efficiency is improving in warmer weathers and prices are falling thanks to increased availability of components and know-how.

- It is possible to use different configurations and technologies when designing and installing a transcritical CO_2 systems, such as booster, booster with parallel compression, booster with adiabatic cooling, liquid ejectors.
- Thanks to the technology advances and improvements on energy efficiency, it is possible to use transcritical CO_2 systems in warmer weathers (above 25°C).
- A transcritical CO_2 system installed in Santiago de Chile was designed to work between -35°C and 35°C in the low temperature cycle and -8°C and 35°C in the mid temperature cycle.

Recovery and recycling of refrigerants, the supermarket impact.

Presenter: José Luis Rojas (Chile)

Key remarks:

- Regener is the first refrigerant reclaim center in Chile, it was installed with support of the Multilateral Fund of the Montreal Protocol and the Ministry of Environment of Chile.
- The center has the capability to reclaim most of the refrigerants used by the supermarket sector.
- Supermarkets have large quantities of refrigerant installed, which make them key players in the cycle of recovery, recycle and reclaim of refrigerants.
- Supermarkets should avoid emissions to the atmosphere and implement recovery and reuse plans for their banks of refrigerants.
- Prices of HCFC refrigerants in Chile has increased 300% in the last 5 years.

Water loop applications for supermarkets.

Presenter: Marcelo Cataldo (Chile)

Key remarks:

- Water loops systems is a distributed system, where each unit has a small water-cooled condensing unit.
- A simple water circuit is used to carry away the heat, with little heat transfer to the sale area.
- With the application of water loops arrangements, reduction up to 75% in the charge of refrigerants can be achieved.
- Each unit can operate at is optimum set up which translate to reductions in the energy consumption.
- Easy maintenance to the equipment, as they are independent, no need to turn off the entire system.

Chemours: Experiences in the use of Opteon in Supermarkets.

Presenter: Miguel Angel Escamilla (Mexico)

Key remarks:

- HFOs have a weak double link which allows a faster decomposition in the atmosphere.
- HFOs have a lower GWP of most HFC and HCFC. Some are no flammable (i.e. R-449A, R-452A) and some others are low flammable (R-454A, R-1234yf).
- There are several HFO blends available for each refrigeration need. They are commercialized under the brand Opteon.
- R-449A (Opteon XP40) is an available alternative for R-22 and R-404A existing systems. It is a blend of R-1234yf/134a/125/32 (25.3%/25.7%/24.7%/24.3%).

- Systems retrofitted with R-449A reduced their energy consumption by 12% in medium temperature racks and 3% in low temperature racks.

Honeywell: Solstice, a Low-GWP option for refrigeration systems.

Presenter: Fernando Tanaka (Brazil)

Key remarks:

- HFOs are part of a forth generation of refrigerants, they have zero ODP and low GWP.
- The company commercialized its HFO under the brand Solstice, which has two series of blends, the "N" series for Non-flammable blends and the "L" series for low-flammable blends.
- R-448A (Solstice N40) is an available alternative for supermarkets using R-22 and R-404A. It is a blend of R-1234yf/1234ze/134a/125/32 (20%/7%/21%/26%/26%).
- HFOs can be used with CO2 in cascade configuration, achieving reduction in the energy consumption and CO_{2eq} emissions.
- It is important to achieve synergies between the refrigerant and the architecture of the system to reach its highest energy efficiency.

Energy efficiency in Supermarkets.

Presenter: Tiago Pietrobon (Brazil)

Key remarks:

- There are huge opportunities to improve the energy efficiency in supermarkets. 3 spheres: i) Operation and use (25%), ii) Adjustments and maintenance (25%), and iii) More efficient equipment (50%).
- Simple measures can generate impact in the energy consumption: clean heat exchangers, adequate temperature setting, fine-tuned defrost time, reduce leaks.
- The use of doors in the sale points can generate important savings, not only in energy but also in the quality of the merchandise.
- Changes in existing equipment is possible to generate energy efficiency gains, the refrigerant used is one component but there are other parts of the system that can be upgraded (i.e. motors, valves, controls).

Solutions to improve energy efficiency in supermarkets.

Presenter: Jorge Callejs (Chile)

Key remarks:

- Solutions has been developed to allow the use of transcritical CO_2 in all weathers. Multi-ejector technology has been one key advance on this area.
- Transcritical CO2 system with multi-ejector can be considered the third generation of this technology (being booster and parallel compressor the previous two).
- Multi-ejector solution allows more efficient transcritical CO_2 systems compare with R-404A, in all conditions.
- It is possible now to monitor in real time the performance of the complete system, so it can run in its optimal conditions, which translate in more efficiency.

Chile: Result of the transcritical CO_2 pilot project.

Presenter: Pier Zechetto (Chile)

Key remarks:

- The project was implemented with support of the CCAC, UNDP and the Ministry of Environment of Chile, through the NOU.
- The project was fundamental for the adoption of transcritical CO_2 in Chile, it helped to create confidence in the technology, remove barriers and accelerated its adoption.
- The supermarket was built in Valdivia, by Cencosud, one of the main supermarket chains in Chile. It was the first supermarket using this technology in the country.
- Cost of the first transcritical CO_2 system was 30% higher than a standard HFC system, CCAC funding helped to reduce the gap to less than 20%.
- The installed system is between 10 and 15% more energy efficient.
- Thanks to the success of the project, Cencosud adopted transcritical CO2 as its default technology for its new supermarkets.

Panama: Experience in the use of low GWP refrigerants.

Presenter: Roberto Rodríguez (Panama)

Key remarks:

- Riba Smith is one of the main supermarkets chains in Panama.
- It is the first supermarket chain to use subcritical CO_2 in the country. The decision to adopt the technology came from the direction, which empowered the engineering department for conduct the transition.
- Nor the technology neither the equipment needed was available in the country, but the company requested it to its regular supplier who imported from other countries where it was already used.
- The company showed that when there is commitment from the decision makers on the adoption of low-GWP alternatives, it can be done and there will be suppliers willing to give technical assistance and share the know-how of their technology.
- It is important to have a trained maintenance department, so the newly adopted technology can be appropriately operated.

Brazil: Evolution of low GWP systems in supermarkets.

Presenter: Rogeiro Marson Rodrigues (Brazil)

Key remarks:

- The transition from HCFC-22 in refrigeration system for supermarkets started in Brazil since 2002 with the introduction of refrigeration system with glycol as intermediary fluid.
- It is important to have a trailblazer to foster the adoption of new technologies, to show that it is possible to change paradigms or adopt alternatives.
- In Brazil, new supermarkets are using mainly cascade systems with Glycol and R-134a/404A, with growing demands for Subcritical CO_2 and Transcritical CO_2. On existing supermarkets several paths have been followed: individual units (with HC), HFO instead R-404A and improving the maintenance (avoid leaks).

- In the near future, RAC systems using only natural refrigerants will be a reality. Limited quantities of flammable or toxic refrigerant will be use in the machine room while glycol and CO2 will be used for the sales area.

CHALLENGES AND LESSONS LEARNT

The preparation and implementation of the workshop on Promoting Low-GWP alternatives to HFCs in Supermarkets was an enriching experience for all parties involved, it was an opportunity to exchange firsthand information between suppliers and end-user. Some challenges were faced, and several lessons learnt, some of them can be found below.

Challenges

The preparation and implementation of the workshop faced some challenges, which were overcome thanks to the collaboration of the National Ozone Unit of the Ministry of Environment and UNDP's country office in Chile and the understanding and flexibility shown by the experts and companies' representatives.

Some of the challenges faced were:

- To coordinate the agendas of experts, technical representatives, suppliers, officers from the Ozone units.
- To arrange flight schedules and hotel accommodations for several international participants.
- To have a balance between the different options as all participants wanted to highlight the benefits of their own technology.

Lesson learnt

The project left several lessons learnt, which include:

- There are several alternative options for HFCs. To replace HFCs in a supermarket the companies can follow different paths, such as using natural (CO_2, HC or NH_3) or synthetic (HFO) refrigerants, using direct or indirect (Cascade) cycles, using an assembly of individual units (water loop) or complete systems. It was expressed by the companies that they required more technical assistance to learn about the application and technical requirements of the different technologies.
- There are still some barriers to overcome before moving away from HFCs. It was stated by different participants that the main barriers observed are: i) cost, as some technologies have higher initial capital cost due to more expensive components and controls, ii) lack of knowledge, as local providers and end-user are not skilled in the criteria of use, evaluation and application of some technologies, iii) lack of availability, some technologies are not available in the countries.
- Technology providers are willing to show their technology options and to give technical assistance to local stakeholders. All suppliers were glad to participate and appreciated the opportunity to discuss with authorities and experts of several countries the state-of-the-art of available technologies in refrigeration for the supermarket sector.
- Information exchange opportunities are welcome and needed by all parts. The workshop was a great networking opportunity for technology suppliers but also for end-users, experts and environmental authorities, it opened the way for the introduction of alternatives in end-users, as they received information of new approaches and technologies to eliminate the use of HFC in their RAC systems.

RECOMMENDATIONS

Based on the presentation given by the experts and discussions with participants, some recommendations and next steps from the workshop are:

- Replicate this kind of workshop in other countries and sectors, as it is important to generate information exchange opportunities between the suppliers and the end-users, where there is a level ground between all (or most) of the technologies available.
- Share the lessons learnt, presentation and other information generated by the workshop within participants, National Ozone Units and CCAC' members.
- It is important to work with learning centers and technicians' training institutions, so countries can have technicians aware and with up-to-date knowledge in low-GWP alternative technologies, so supermarkets can have confidence in the adoption of new technologies, as they will find technicians with the knowledge to implement theses technologies.

CONCLUSIONS

There are multiple low-GWP options to phase out the use of HFCs and HCFCs in the supermarket sector. Natural refrigerants, such as subcritical and transcritical CO_2, NH_3, HC and water, and synthetic refrigerants, such as HFOs (i.e. Opteon XP40 and Solstice N40) are readily available, each with its own technical and energy efficiency advantage.

The selection of any alternative will be based in the combination of an economic assessment (i.e. resources available for its introduction, the particular acceptable financial indicators of each company, capital costs and operational costs), a technical assessment (i.e. energy efficiency, availability), an environmental assessment (i.e. GWP, direct and indirect emissions) and a safety assessment (i.e. high pressure, flammability, toxicity). Each end-user can differently weight the results of the assessments, so different technologies will co-exist in the near future.

The workshop was a good opportunity to increase the knowledge of the several low-GWP alternatives existing in the market; engineers from several supermarket's technical department, experts from Ozone Units from the region and suppliers were benefited by the workshop. It allowed a frank and open exchange of information, facilitating the creation of direct information channels between the participants.

The experiences exchange between countries as different as Brazil, Chile and Panama, showed that it is possible to adopt low-GWP alternatives in refrigeration systems when there are willingness and commitment from the supermarkets to find solutions and take some risks.

ANNEX

Annex 1. Workshop's agenda.

Adobe Acrobat Document

Annex 2. Example of invitation letter.

Adobe Acrobat Document

Annex 3. List of participants.

Adobe Acrobat Document

Annex 2. Presentations.