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COMITE EXECUTIF
DU FONDS MULTILATERAL AUX FINS
D'APPLICATION DU PROTOCOLE DE MONTREAL
Soixante-seizième réunion
Montréal, 9 – 13 mai 2016

PROPOSITION DE PROJET: COLOMBIE

Le présent document contient les observations et les recommandations du Secrétariat du Fonds concernant la proposition de projet ci-après:

Mousses

- Projet de démonstration sur la validation de l'utilisation d'hydrofluoro-oléfines pour des panneaux en discontinu dans les pays Parties visées à l'article 5, en ayant recours à des formules présentant un bon rapport coût-efficacité — PNUD

COLOMBIE

TITRE DU PROJET		AGENCE BILATERALE/D'EXÉCUTION
(a)	Projet de démonstration sur la validation de l'utilisation d'hydrofluoro-oléfines pour des panneaux en discontinu dans les pays Parties visées à l'article 5, en ayant recours à des formules présentant un bon rapport coût-efficacité	PNUD

ORGANISME NATIONAL DE COORDINATION	Ministère de l'Environnement, Unité nationale d'ozone

DERNIÈRES DONNÉES DÉCLARÉES SUR LA CONSOMMATION DE SAO PRISES EN COMPTE DANS LE PROJET

A: DONNÉES DE L'ARTICLE 7 (TONNES PAO, 2014, EN DATE DE MARS 2016)

HCFC	156,03

B: DONNÉES SECTORIELLES DU PROGRAMME DE PAYS (TONNES PAO, 2014, EN DATE DE MARS 2016)

HCFC-22	67,4
HCFC-123	2,1
HCFC-141b	86,3
HCFC-142b	0,3

Consommation restante de HCFC admissible au financement (tonnes PAO)	146,63

AFFECTATIONS DANS LE PLAN D'ACTIVITÉS DE L'ANNÉE EN COUR S		Financement (millions $US)	Élimination (tonnes PAO)
	(a)	n/a	n/d

TITRE DU PROJET:	
SAO utilisées à l'entreprise (tonnes PAO):	13,27
SAO à éliminer (tonnes PAO):	n/d
SAO à introduire (tonnes PAO):	0,00
Durée du projet (mois):	12
Montant initial demandé ($US):	459 450
Coût final du projet ($US) :	
Surcoût d'investissement :	
Imprévus (10 %):	
Surcoût d'exploitation:	
Suivi et compte rendu :	
Coût total du projet :	248,380
Participation locale (%):	100%
Élément d'exportation (%):	0%
Subvention demandée ($US):	248 380
Rapport coût-efficacité ($US /kg):	n/d
Coût d'appui de l'agence d'exécution ($US):	22 354
Coût total pour le Fonds multilatéral ($US):	270 734
Financement de contrepartie confirmé (O/N):	O
Étapes de suivi du projet incluses (O/N):	O

RECOMMANDATION DU SECRÉTARIAT	Pour examen individuel

DESCRIPTION DU PROJET

Historique

1. 1. Au nom du gouvernement de la Colombie, le PNUD a soumis à la 74e réunion un projet de démonstration sur la validation de l'utilisation d'hydrofluoro-oléfines (FOD) dans les panneaux en discontinu et la mousse vaporisée fabriqués dans les pays Parties visées à l'article 5, en ayant recours à des formules présentant un bon rapport coût-efficacité, pour un montant de 459 450 $UD, plus des coûts d'appui d'agence de 32 162 $US, selon la demande initiale[1]. À l'issue d'un débat, le Comité exécutif a décidé, à la lumière de la décision 74/21[2], que le projet de démonstration pourrait être soumis de nouveau à sa 75e réunion (décision 74/38).

2. Comme suite à la décision 74/38, le PNUD a soumis de nouveau, à la 75e réunion, le projet de démonstration susmentionné, pour un coût total de 335 280 $US, dont 282 480 $US, plus des coûts d'appui d'agence de 19 774 $US, ont été demandé au Fonds multilatéral[3]. À l'issue de débats tenus au sein d'un groupe de contact établi afin d'examiner tous les projets de démonstration de technologies à faible PRG soumis à la 75e réunion, le Comité exécutif a décidé de reporter à la 76e réunion l'examen des sept projets de démonstration, incluant le projet de mousses pour la Colombie (décision 75/42).

3. Donnant suite à la décision 75/42, le PNUD a soumis de nouveau, à la 76e réunion, le projet de démonstration présenté à la 75e réunion. La proposition de projet soumise figure à l'Annexe I au présent document.

Objectif du projet

4. Durant la phase I de leur plan de gestion de l'élimination de HCFC (PGEH), plusieurs pays visés à l'article 5 ont reconverti leurs plus grandes entreprises de mousses à l'utilisation d'agents de gonflage à base d'hydrocarbures. Durant la phase II, ces pays doivent se concentrer sur la consommation restante de HCFC-141b utilisé pour la production de panneaux en discontinu et des mousses vaporisées et à pellicule externe incorporée, par des entreprises micro, petites et moyennes (PME) qui ne disposent pas des ressources techniques et financières requises pour assurer la sécurité de l'usage d'agents de gonflage inflammables. Les FOD récemment développés présentent de meilleures performances thermiques dans les applications de mousse de polyuréthane (PU) rigide que les HFC saturés à haut PRG; leur introduction est malheureusement limitée par leur coût unitaire élevé et l'absence d'expérience de leur utilisation dans les pays visés à l'article 5.

5. Sur cette base, le projet de démonstration vise ce qui suit : valider l'utilisation des formules de PU formulations dans les panneaux en discontinu avec des FOD réduit (à savoir FOD-1233ze(E) et FOD-1336mzzm(z)); optimiser le rapport coût-performance afin d'obtenir des performances thermiques similaires à celles offertes par les formules à base de HCFC-141b; réaliser une analyse de coût des FOD et de diverses formules à base d'eau par rapport aux systèmes à base de HCFC-141b. Les résultats de ce projet peuvent être reproduits avec d'autres applications de mousse en Colombie et d'autres pays visés à l'article 5.

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[1] UNEP/OzL.Pro/ExCom/74/25.

[2] Le Comité exécutif a décidé entre autres d'autoriser la soumission à sa 75e réunion d'un nombre limité de demandes supplémentaires pour la préparation de projets de démonstration de technologies à faible potentiel de réchauffement global (PRG) dans le secteur de la fabrication de climatiseurs, la nouvelle soumission de deux projets complets de démonstration (dont un projet pour la Colombie), ainsi que des études de faisabilités supplémentaires sur le refroidissement urbain.

[3] UNEP/OzL.Pro/ExCom/75/42.

6. L'entreprise participante est Espumlatex[4], une société de formulation dotée de 18 réservoirs de mélange et d'un laboratoire certifié de contrôle de la qualité, laboratoire de contrôle qualité certifié, où l'on peut tester les propriétés fondamentales des formules de polyuréthane (densité d'expansion libre, réactivité, conductivité thermique de la mousse, résistance à la compression, stabilité dimensionnelle et vieillissement accéléré).

Mise en œuvre du projet

7. Les activités ci-après seront exécutées:

(a) Élaboration d'un protocole expérimental (procédure et conditions d'application, propriétés à tester et méthode d'essai); et préparation d'échantillons de mousse à Espumlatex, en ayant recours à un distributeur haute pression et à un moule classique;

(b) Acquisition d'un équipement de laboratoire supplémentaire pour mesurer la friabilité de la mousse (propriété cruciale étant donné la teneur en urée obtenue avec les formules de polyuréthane à forte teneur en eau) et mise à l'essai des propriétés critiques de la mousse (comme la conductivité thermique, la résistance à la compression et la stabilité dimensionnelle);

(c) Essais sur le terrain à ABC Poliuretanos, un fabricant local de panneaux en discontinu, avec une réduction associée de 4 tm de HCFC-141b (0,44 tonnes PAO);

(d) Deux ateliers de diffusion à l'intention de l'industrie colombienne et d'Amérique latine.

8. Le projet devrait durer 12 mois.

Budget du projet

9. Le coût détaillé du projet, soumis initialement à la 76e réunion, est résumé dans le tableau 1 ci-après.

Tableau 1. Coût du projet par activité ($US)

Description	Coût unitaire	Quantité	Fonds	Contribution	Coût total
Assistance technique internationale	30 000	1	30 000		30 000
Planification	5 000	1	5 000		5 000
Élaboration de formules	110 000	1	110 000	36 000	74 000
Testeur de friabilité	10 000	1	10 000		10 000
Essais de mousse			30 000	10 000	20 000
Matériel - Élaboration de formules	240	20	4 800		4 800
Matériel – Essais sur le terrain	4	1 000	4 000		4 000
Essais1Évaluation de mousses	5 000	1	5 000	2 000	3 000
Diffusion de la technologie	20 000	2	40 000		40 000
Consultant local	36 000	1	36 000		36 000
Suivi et compte rendu	30 000	1	30 000		30 000

[4] Au cours de la phase de passage du CFC-11 aux HCFC, deux projets ont été menés à Espumlatex : « Financement rétroactif de la reconversion des systèmes utilisant le CFC-11 à une technologie à base d'eau pour la fabrication de mousse souple moulée et de mousse à pellicule externe incorporée à Espumlatex-Promicolda » (COL/FOA/32/INV/49) et « Reconversion du CFC-11 au HCFC-141b et à une technologie à base d'eau pour la fabrication de diverses mousses de polyuréthane par 25 petites entreprises centrées autour de la société de formulation à Espumlatex » (COL/FOA/32/INV/48). Espumlatex a par ailleurs assuré la fonction de société de formulation locale en 2011-2013 pour un projet de démonstration de la technologie CO_2 supercritique pour la mousse pulvérisée réalisé dans le cadre d'un programme bilatéral Japon-Colombie en collaboration avec Achilles Corp. (COL/FOA/60/DEM/75)

Description	Coût unitaire	Quantité	Fonds	Contribution	Coût total
Total partiel			304 800	48 000	256 800
Imprévus (10%)			30 480	4 800	25 680
Coût total			335 280	52 800	282 480

OBSERVATIONS ET RECOMMANDATION DU SECRÉTARIAT

OBSERVATIONS

10. Le Secrétariat a noté avec satisfaction que le PNUD a préparé la proposition de projet soumise initialement à la 74e réunion et soumise de nouveau aux 75e et 76e réunions, sans recourir aux fonds de préparation du Fonds multilatéral. Le Secrétariat a constaté en outre que conformément à la décision 74/21 c)[5], la proposition a été révisée uniquement en ce qui concerne les panneaux en discontinu, ce qui a réduit en conséquence la subvention demandée à une valeur de 282 480 $US, au lieu du montant initial de 459 450 $US qui couvrait les panneaux en discontinu et la mousse vaporisée. La contribution de contrepartie d'Espumlatex a été évaluée à 52 800 $US.

11. Les entretiens entre le Secrétariat et le PNUD sur le projet de démonstration soumis aux 74e, 75e et 76e réunions portaient essentiellement sur le chevauchement potentiel des activités prévues durant la phase II du PGEH de la Colombie[6] présentée à la 75e réunion, visant l'élimination complète du HCFC-141b comme agent de gonflage, et celles du projet de démonstration proposé. Sur cette question, le PNUD a précisé que les travaux de formulation d'Espumlatex proposés dans la phase II du PGEH visaient à répondre aux demandes particulières de plusieurs clients pour différentes applications, incluant des panneaux en discontinu, tandis que le projet de démonstration visait à répondre aux critères généraux liés aux panneaux en discontinu. Les deux types de travaux de formulation, de nature différente, étaient requis. Comme chaque entreprise de formulation a ses propres formules correspondant aux demandes particulières de ses clients, le projet de démonstration servira de guide général sur les performances des systèmes de FOD réduits. Le projet fournira les preuves empiriques pour servir de point de départ à l'optimisation.

12. Dans des entretiens ultérieurs sur la rationalisation des coûts, le PNUD est convenu d'ajuster davantage le coût total, aboutissant à une demande de 248 380 $US plus les coûts d'appui d'agence. Le Secrétariat a souligné que, selon les directives du Comité exécutif destinées à assurer la soumission des meilleures propositions de projets de démonstration, il conviendrait de tenir compte en outre de la représentation régionale et de la répartition géographique (paragraphe 97 e) du document UNEP/OzL.Pro/ExCom/73/62). À sa 75e réunion, le Comité exécutif a approuvé le projet de démonstration de l'utilisation du R-290 (propane) comme frigorigène de remplacement dans la fabrication de climatiseurs commerciaux à Industrias Thermotar ltda en Colombie.

Conclusion

13. Le Secrétariat constate que le projet propose de démontrer une solution à faible PRG pour remplacer le HCFC-141b dans la production de panneaux en discontinu, qui est une application communément utilisée dans plusieurs pays visés à l'article 5. L'entreprise de formulation Espumlatex a démontré son engagement ferme à mettre en œuvre le projet en apportant un financement de contrepartie évalué à plus de 211 000 $US. Les essais sur le terrain par les fabricants locaux de panneaux en

[5] Dans la décision 74/21 c), il a été demandé aux agences bilatérales et d'exécution d'une part, de rationaliser les coûts des projets de démonstration, afin de permettre l'approbation d'un plus grand nombre de projets de démonstration avec les fonds disponibles de 10 millions $US, conformément à la décision 72/40, et d'autre part, d'envisager d'autres sources de financement.
[6] UNEP/OzL.Pro/ExCom/75/42.

discontinu permettront d’éliminer 0,44 tonnes PAO de HCFC-141b; cette consommation ne peut cependant pas être déduite de la consommation restante de HCFC admissible aux fins de financement de la Colombie, puisque le gouvernement s’est engagé à éliminer complètement sa consommation de HCFC-141b durant la phase II de son PGEH. À sa 75e réunion, le Comité exécutif a approuvé le projet de démonstration de l’utilisation du HC-290 (propane) comme frigorigène de remplacement dans la fabrication de climatiseurs commerciaux à Industrias Thermotar ltda en Colombie.

RECOMMANDATION

14. Le Comité exécutif est invité à envisager les mesures suivantes :

(a) Examiner le projet de démonstration visant à valider l’utilisation d’hydrofluoro oléfines (FOD) dans les panneaux en discontinu fabriqués dans les pays visés à l’article 5 en ayant recours à des formules présentant un bon rapport coût-efficacité en Colombie, dans le contexte de ses débats sur les propositions de projets de démonstration de solutions de remplacement à faible PRG pouvant remplacer les HCFC, décrits dans le document « Aperçu des problèmes identifiés durant l’examen des projets » (UNEP/OzL.Pro/ExCom/76/12); et

(b) Déterminer s’il approuve ou non le projet de démonstration visant à valider l’utilisation d’hydrofluoro oléfines dans les panneaux en discontinu fabriqués dans les pays visés à l’article 5 en ayant recours à des formules présentant un bon rapport coût-efficacité en Colombie, conformément à la décision 72/40.

Annex I

PROJECT COVER SHEET

COUNTRY: Colombia **IMPLEMENTING AGENCY:** UNDP

PROJECT TITLE: Demonstration project to validate the use of Hydrofluoro Olefins (HFO) for discontinuous panels in Article 5 parties through the development of cost effective formulations

PROJECT IN CURRENT BUSINESS PLAN	
SECTOR	Foam
SUB-SECTOR	Rigid PU (discontinuous panels)
ODS USE IN SECTOR (2014)	668 metric tons (HCFC-141b)
ODS USE AT ENTERPRISE (2014)	120.6 MT of HCFC-141b
PROJECT DURATION	12 months
TOTAL PROJECT COST:	
Incremental Capital Cost	US $ 304,800
Contingency	US $ 30,480
Total Project Cost	US $ 335,280
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	0 % to non-A5
REQUESTED GRANT	US $ 282,480
COST-EFFECTIVENESS	Non applicable
IMPLEMENTING AGENCY SUPPORT COST	US $ 19,774
TOTAL COST OF PROJECT TO MULTILATERAL FUND	US $ 302,254
STATUS OF COUNTERPARTS FUNDING	Received letter of commitment Included
NATIONAL COORDINATING AGENCY	Ministry of Environment - National Ozone Unit

Project summary

This project undertakes the validation of the Hydrofluoro Olefins (HFOs), a low GWP and non-flammable option, for discontinuous panels in the scenario of the Article 5 parties through the development of polyurethane (PU) foam formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance while achieving a similar foam thermal performance to that of HCFC-141b based formulations.

Impact of project on Country's Montreal Protocol Obligations

The project aims to contribute to the country obligation to reduce the HCFC consumption as per the Montreal Protocol obligation by converting the current HCFC-141b foam blowing technology to the HFO based formulations. The Colombian discontinuous panels subsector used 98.5 tonnes of HCFC-141b in 2014. With the results of this project, a significant portion of this HCFC-141b consumption would be replaced by this technology during the second stage of the HPMP. A direct impact of this project is the conversion of ABC Poliuretanos, 5.2 tonnes of HCFC-141b, in the mentioned second stage.
The results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries.

Prepared by: Mr Miguel W. Quintero Date: September 11, 2015

1. BACKGROUND

1.1. PROJECT BACKGROUND

This project has been prepared as response to the Executive Committee Decision 72/40. It is part of a set of projects with the objective to validate chemical systems for use with non-HCFC blowing agents in the context of Decision XIX/6.
The developing countries will address in the short term the second phase of the HPMP (2015-2020) in the foam sector. One of the most critical subsectors that still uses HCFC-141b and accounts for a significant market portion is the manufacture of **discontinuous panels** for the construction and the commercial and industrial refrigeration industries. It is characterized by a great number of small and medium enterprises without the sufficient knowledge and discipline to handle flammable substances. This factor along with the lack of economies of scale prevents the adoption of hydrocarbons and the introduction of high GWP alternatives such as HFCs would result in a negative climate impact.
This projects undertakes the validation of the Hydrofluoro Olefins (HFOs), a low GWP and non-flammable option, for discontinuous panels in the scenario of the Article 5 parties through the development of polyurethane (PU) formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance while achieving a similar foam thermal performance to HCFC-141b based formulations.
Further, the project aims to contribute to the country obligation to reduce the HCFC consumption as per the Montreal Protocol obligation by converting the current HCFC-141b foam blowing technology to the HFO based formulations. The Colombian discontinuous panels subsector used in 2014 98.5 tonnes of HCFC-141b. With the results of this project, a significant portion of this HCFC-141b consumption would be replaced by this technology during the second stage of the HPMP.

It is important to note that the results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries. Therefore, the results should be seen in a broader perspective.

1.2. SECTOR BACKGROUND IN COLOMBIA

Colombia became a party to the Vienna Convention and Montreal Protocol on October 16, 1990 and on March 6, 1994 respectively. Colombia also ratified the London, Copenhagen, Montreal and Beijing Amendments. The country is fully committed to the phase-out of HCFCs and willing to take the lead in assessing new HCFC phase-out technologies, particularly in the foam sector.

The Colombian PU market can be spread out in three different industrial sectors: flexible foam (flex-slab and moulded and integral skin), rigid foam and microcellular elastomers (shoe soles). HCFCs are used in rigid foam for thermal insulation and, in marginal quantities, in integral skin.

In PU rigid foam three different segments can be differentiated: domestic refrigeration (refrigerators and freezers), commercial refrigeration (mainly bottle and commercial displays) and industrial thermal insulation for the refrigeration and construction sectors (continuous and discontinuous panels, transportation and spray). While the domestic refrigeration and most of the commercial refrigeration have been converted to hydrocarbons the remaining market players still use HCFC-141b. The main suppliers are local "system houses" (Espumlatex, GMP, Olaflex,

Química Industrial y Comercial) that sell two-component systems: a fully formulated polyol, which includes the blowing agent (HCFC-141b), and an isocyanate (Polymeric MDI).
A recent market survey showed that in 2014 out of a total of 784.25 tonnes of imported HCFC-141b, 668 were used in foam manufacture. Table 1 shows the distribution by application. Discontinuous panels account for 15% of the total HCFC-141b consumption.

TABLE 1. 2014 USE OF HCFC-141b IN THE COLOMBIAN FOAM MARKET		
Foam Application	HCFC-141b, kg	%
Commercial Refrigeration	66,390	9.94%
Continuous Panels	80,920	12.12%
Industrial Refrigeration & Construction (Discontinuous Panels)	98,589	14.76%
Spray	51,958	7.78%
Integral Skin	3,428	0.51%
Polyol formulation	366,495	54.89%
TOTAL	667,780	100.0%

Source: Imports Declarations, Database of the Ministry of Commerce, Industry and Tourism. Personal interviews with key market players (system houses and end users)

2. PROJECT DESCRIPTION

2.1. PROJECT OBJECTIVES

The objectives of this project are:

1. To validate the use as foam blowing agents of the recently developed HFOs in blends with CO_2 for the production of discontinuous panels in the context of an Article 5 party. The aim is to optimise the HFO/CO_2 ratio in the cell gas to get a similar thermal performance to HCFC-141b at a minimum incremental operating cost. The results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries.
2. To make a cost analysis of the different HFO/CO_2 formulations versus the currently used HCFC-141b based system.

2.2. JUSTIFICATION

The Article 5 parties are in the process of preparing the second stage of the HPMPs to be implemented in the 2016-2020 period. Taking into account the priorities defined in Decision XIX/6, particularly those referred to ODP and climate change impact, the developing countries opted for converting in the first phase (2011-2015) the largest foam enterprises typically found in the domestic refrigeration and continuous panels sectors. Hydrocarbons, basically pentanes, were the substances of choice based on their favourable cost/performance balance at large size operations.
Situation is different at the second stage where the countries have to address the remaining foam sectors still using HCFCs. These sectors (discontinuous panels, spray, integral skin) are characterised by a multitude of micro, small and medium size enterprises that do not have the

adequate knowledge and operating discipline to handle flammable substances in a safe manner. This factor along with the lack of economies of scale prevents the adoption of flammable blowing agents, while the introduction of high GWP alternatives such as HFCs results in high climate impact within processes which are typically less well engineered.
The recent developed unsaturated HFCs and HCFCs (commonly called HFOs), 1233zd(E) and 1336maam(z), marketed under the trademarks Forane (Arkema), Formacel (DuPont) and Solstice (Honeywell), have shown in rigid PU foam applications such as domestic refrigeration and spray a better thermal performance that the high GWP-saturated HFCs currently used in the developed countries. Their general properties are shown in table 2. They offer a unique opportunity for introducing safe non-flammable technologies that while enhancing energy efficiency will have a positive effect on climate change in terms of greenhouse emissions. Based on the physical properties of these substances (non flammability and relatively high boiling points) it is anticipated that their application does not require the retrofit of the foaming equipment currently in use. This is particularly true and important at the level of small and medium enterprises. Commercial availability has already been established for HFO-1233zd(E). Pilot scale production of HFO-1336mzzm(Z) commenced in late 2014, with full commercialisation expected in 2016. Although for these options availability is likely to be targeted mostly in markets within non-Article 5 Parties where the requirement for improved thermal efficiency is best identified, the demand to leapfrog high GWP alternatives to HCFCs could accelerate distribution to Article 5 regions. There are not legal or commercial barriers for the introduction of these products.

TABLE 2. HFO PROPERTIES			
	Formacel® 1100	***Solstice® Liquid BA***	***Forane® 1233zd***
Common name	1336mzz(Z)	1233zd(E)	1233zd(E)
Chemical Formula	Cis-CF_3-CH=CH-CF_3	Trans-ClCH=CH-CF_3	Trans-ClCH=CH-CF_3
Molecular weight	164	130.5	130.5
Boiling Point (°C)	33	19	19
GWP (100 years	2	1	<7

From the three market sectors mentioned above, the discontinuous panels application was chosen for the development of this project taking into consideration the high volume involved. According to the last FTOC assessment report (2010), in 2008 around 7,300 tonnes of CFCs and HCFCs were used in the discontinuous panels subsector in the developing countries.

Two are the main barriers for the introduction of these substances:
1. Their high unitary cost that is reflected in the final cost of the PU formulation.
2. The minimum experience with these products in developing country conditions. This technology has not been demonstrated in conditions prevailing in Article 5 parties.

The main objective of this project is precisely to remove or attenuate the mentioned obstacles. The formulation science associated to the PU technology and the excellent foam thermal characteristics provided by HFOs open the door for the development of PU formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance of these substances, achieving a similar foam thermal behaviour to HCFC-141b at the lowest possible cost, and, simultaneously, to carry out a comprehensive assessment of the HFO performance at developing countries conditions. The project will be conducted at Espumlatex, a recognised local system house equipped with the required injection and testing laboratory facilities, and a field test with selected formulations will be done at ABC Poliuretanos, a typical small manufacturer of discontinuous panels.

2.3. METHODOLOGY

With the aim of analysing the two HFO molecules, 1233zd(E) from Honeywell or Arkema and 1336maam(z) from Chemours, in comparison with HCFC-141b, six steps are contemplated for the project development:

1. PLANNING. A statistical experimental design (DOE) will be designed having as factors (or independent variables) the type of molecule and the composition of the cell gas (mole fraction of the physical blowing agent). The responses (or dependent variables) will be the foam properties critical for this application (Lambda value, compression strength, dimensional stability, friability). A commercial HCFC-141b based formulation will be used as control.
2. FORMULATION DEVELOPMENT. The resulting formulations will be prepared at laboratory scale and injected with a conventional high-pressure dispenser. Catalysis and overall blowing agent amounts will be adjusted to have among formulations a similar reactivity and free-rise density. A typical Brett or Lance mould with temperature control will be used to manufacture the panels to test the foam properties. Samples for testing will be done by duplicate.
3. TESTING. The critical immediate and aged foam properties for this application (Lambda value, compression strength, dimensional stability, friability) will be tested following ASTM or ISO standard procedures.
4. ANALYSIS OF RESULTS: foam performance and formulation cost. A detailed analysis of the resulting foam properties at different HFO levels and the associated formulation cost will be carried out. A typical HCFC-141b formulation will be used as standard.
5. FIELD TEST. A field test with selected formulations will be done at ABC Poliuretanos, a small manufacturer of discontinuous panels with typical market characteristics.
6. TECHNOLOGY REPLICATION/DISSEMINATION OF RESULTS. One of the critical outcomes of a demonstration project is the definition of the possibility to replicate the technology in other enterprises, in other regions and in other applications. In the case of HFOs, having in mind that the main barrier for their introduction is the associated formulation cost, it is anticipated that if results are positive and an adequate cost/performance balance is achieved, there is a great potential for the technology to be replicated in other system houses in the country, in Latin America and other regions, and even in other applications such as commercial refrigeration and spray. To assure this, it is planned to conduct two workshops, a first one at local level with the participation of the other Colombian system houses (GMP, Olaflex, Química Industrial y Comercial) and interested end users, and a second one at regional level, where regional system houses, importers and end users will be invited. It is important to note that all the Colombian and several Latin American system houses have shown interest in these products. In addition to the seminars, a detailed technical report will be written with the results of the project. Information on the performance of the HFOs at different mole fractions in the cell gas along with the associated formulation cost (incremental operation cost compared to HCFC-141b) will be delivered. It will serve as starting point for the other system houses to design/develop appropriate HFO based formulations.

2.4. INFORMATION ON PARTICIPATING COMPANIES

Espumlatex

Espumlatex was established in 1959 to serve the automotive industry in Colombia as the main supplier of PU based materials: RIM and sound insulation parts and flex moulded foam for car seats. Throughout all these years it became the leader of PU suppliers in the Andean countries with annual sales of 52 million dollars in 2008. It is certified QS9000/ISO9000, EAQF level Q1 status, ISO14000.

At the end of the eighties Espumlatex expanded its activities to formulate PU systems for the manufacture of thermal insulating and integral skin foams. Its current capacity is estimated in 500 MT per month with an annual current production of 4,000 MT of PU systems, from which 2,000 MT are dedicated to rigid foam materials. 15 % of their PU systems production is exported to Ecuador, Peru and Venezuela. Additional to PU systems they manufacture PU rigid foam sheets for insulation purpose in a process that involves the production of large foam blocks and their subsequent cutting.

The system house production facilities are equipped with 18 blending tanks with capacities that go from 1,500 to 3,000 l. They have mechanical agitation, recirculation and a direct feeding system from the raw materials drums as well as a closed pumping system for raw materials loading. The basic properties of the PU systems (free rise density, reactivity, foam thermal conductivity, compression strength, dimensional stability and accelerated aging) are tested in a certified quality control laboratory.

The consumption of chemicals for the PU systems sold for the manufacture of discontinuous panels during the last 5 years was:

Table 3. Consumption of PU chemicals for Discontinuous Panels at Espumlatex, tonnes

Substance	2009	2010	2011	2012	2013
Polyol	327	381	425	423	462
HCFC-141b	82	96	107	106	115
Polymeric MDI	445	518	578	575	628
TOTAL	854	995	1,110	1,104	1,205

During the transition from CFC-11 to HCFCs the following two projects were carried out with Espumlatex:

- The project COL/FOA/32/INV/49, "Retroactive funding for the conversion from CFC-11 to water-based technology in the manufacture of flexible molded and integral skin foam at Espumlatex-Promicolda", retroactively funded one of the Espumlatex´ divisions, Promicolda, for the conversion from CFC-11 to water and HCFC-141b based technologies in the manufacture of flexible molded and integral skin foam respectively. Promicolda is the Expumlatex´ division that manufactures the car seats and several parts based on integral skin foam for the automotive industry in the Andean Countries. The grant received by Promicolda was US$ 82,020.00.
- The project COL/FOA/32/INV/48, "Conversion from CFC-11 to HCFC-141b and water based technology in the manufacture of various polyurethane foam applications at 25 small enterprises centred around their systems house Espumlatex", was an umbrella project where 25 SMEs -centred around Espumlatex as the system house- were successfully converted from CFC-11 to HCFC-141b and water based technologies. Total cost of the project was US$ 332,768.00. Espumlatex received funds for the project administrative expenses and a laboratory equipment (one K factor indicator not suitable to measure lambda values at different temperatures).

Espumlatex also served in 2011-2013 as the local system house host for the demonstration project on Supercritical CO_2 technology for spray foam undertaken under a Japan-Colombia bilateral with Achilles Corp.

The company is fully committed to test new HCFC alternatives of low GWP and has the required capability (laboratory facilities, technical knowledge and human resource). Its contribution to the project has been quantified in US$ 52,800 (see table 5).

3. PROJECT IMPLEMENTATION MODALITY

Project will be implemented by UNDP as an executing agency. Relevant activity such as equipment procurement, recruitment of experts, foam testing will be arranged under the UNDP Financial Rule and Regulation.

The following activities will be executed:

- Work arrangement with local System House to be signed between UNDP and the beneficiary as well as the National Ozone Unit (NOU).
- Development of the experimental protocol which includes application procedure and conditions, properties to test, testing methods etc.
- Formulation development and foam sample preparation to be done at Espumlatex laboratory facilities using a high-pressure dispenser and a conventional Brett mould. Procurement of a laboratory equipment to measure foam friability. This foam property is considered critical having in mind the high urea content typical of PU high water formulations.
- Testing of foam critical immediate and aged properties such as thermal conductivity, compression strength, dimensional stability and friability.
- Conduction of a field test at ABC Poliuretanos, a local discontinuous panels manufacturer.
- Delivery of two dissemination workshops to the Colombian and Latin American industry.

<u>Project implementation time schedule</u>

Table 4. Project Implementation Time Schedule

ACTIVITY	2015	2016			
	Q4	Q1	Q2	Q3	Q4
Approval	*				
Grant transfer to UNDP		*			
Work Arrangement between UNDP and beneficiary		*			
Detailed project planning. Development of experimental protocol		*			
Import of HFO samples		*			
Procurement & delivery of equipment to measure friability		*	*		
Formulation Development		*	*	*	
Foam testing		*	*	*	
Analysis of results: performance versus cost				*	
Field testing at a local discontinuous panels manufacturer					*
Dissemination workshops					*
Reporting & Final review					*

4. PROJECT BUDGET

The summary of the project cost is as follows:

Table 5. Project cost by activity

Activity	Specification or detail	Unit cost, US$	Quantity	Total Cost US$	Espumlatex contribution US$	MLF US$
International technical assistance		30,000	1	30,000		30,000
Planning	Participation of Espumlatex, National Ozone Unit (NOU) and international consultant	5,000	1	5,000		5,000
Formulation Development	Estimated that one man year effort of a qualified engineer and lab technician are required	110,000	1	110,000	36,000	74,000
Acquisition of Friability tester		10,000	1	10,000		10,000
Foam Testing	It is anticipated that around 120 foam samples (5x3x4x2) x2 will be tested for lambda, value, compression strength, dimensional stability and friability			30,000	10,000	20,000
PU material for formulation development	Estimated that 60 kg of PU system (US$ 4/kg) are required for each trial	240	20	4,800		4,800
PU material for field testing	Estimated that 1000 kg (4 drums) are required	4	1,000	4,000		4,000
Foam testing - Field evaluation	Resulting foam will be tested for lambda, value, compression strength, dimensional stability and friability	5,000	1	5,000	2,000	3,000
Technology Dissemination Workshops	For Colombian industry and Latin American countries		2	40,000		40,000
Local Consultant	Technical support to project implementation.	36,000	1	36,000		36,000
Project monitoring & reporting		30,000	1	30,000		30,000
Sub-total Incremental Capital Cost				304,800	48,000	256,800
Contingencies (10%)				30,480	4,800	25,680
Total Cost				335,280	52,800	282,480

Notes:

Formulation Development: The formulations will be prepared at Espumlatex laboratory facilities by company personnel.

Provision of equipment: The project plans to acquire a laboratory equipment to measure foam friability according to ASTM test.

Foam testing: All the foam properties will be determined at Espumlatex laboratory facilities by company technicians.

Dissemination workshop: Cost to organize the dissemination workshops is included. Two workshops will be organized, both in Colombia, a first one for the local industry and a second one for Latin America.