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COMITÉ EXÉCUTIF
DU FONDS MULTILATÉRAL AUX FINS
D'APPLICATION DU PROTOCOLE DE MONTRÉAL
Soixante-quinzième réunion
Montréal, 16 – 20 NOVEMBRE 2015

PROPOSITION DE PROJET : AFRIQUE DU SUD

Le présent document contient les observations et la recommandation du Secrétariat du Fonds sur la proposition de projet suivante :

Mousse

- Projet de démonstration sur les avantages techniques et économiques de l'injection assistée sous vide dans une usine de panneaux discontinus, reconvertie du HCFC-141b au pentane — ONUDI

FICHE D'ÉVALUATION DU PROJET – PROJET NON PLURIANNUEL

AFRIQUE DU SUD

TITRE(S) DU PROJET | **AGENCE BILATÉRALE/D'EXÉCUTION**

a)	Projet de démonstration sur les avantages techniques et économiques de l'injection assistée sous vide dans une usine de panneaux discontinus, reconvertie du HCFC-141b au pentane	ONUDI

ORGANISME NATIONAL DE COORDINATION	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 DU MOIS D'OCTOBRE 2015)

HCFC	238,58

B : DONNÉES SECTORIELLES DU PROGRAMME DU PAYS (TONNES PAO, 2014, EN DATE DU MOIS D'OCTOBRE 2015)

HCFC-22	142,36
HCFC-123	1,33
HCFC-141b	93,5
HCFC-142b	1,71
HCFC-225	1,90

Consommation restante de HCFC admissible au financement (tonnes PAO)	193,34

AFFECTATIONS DANS LE PLAN D'ACTIVITÉS DE L'ANNÉE EN COURS		**Financement ($US)**	**Élimination — tonnes PAO**
	a)	s. o.	s. o.

Titre du projet	
SAO utilisées à l'entreprise (tonnes PAO) :	4,18
SAO à éliminer (tonnes PAO) :	4,18
SAO à introduire (tonnes PAO) :	s. o.
Durée du projet (mois) :	24
Montant initial demandé ($US) :	372 366
Total des coûts d'appui ($US) :	
Surcoût d'investissement :	418 000
Imprévus (10 %) :	41 800
Surcoût d'exploitation :	(87 434)
Coût total du projet :	372 366
Participation locale (%) : 100 %	100
Élément d'exportation (%)	s. o.
Subvention demandée ($US) :	372 366
Rapport coût-efficacité ($US/kg) :	9,79
Coût d'appui de l'agence d'exécution ($US) :	26 066
Coût total pour le Fonds multilatéral ($US) :	398 432
Financement de contrepartie confirmé (O/N) :	O
Étapes de suivi du projet incluses (O/N) :	O

RECOMMANDATION DU SECRÉTARIAT DU FONDS	Pour examen individuel

DESCRIPTION DU PROJET

1. Au nom du gouvernement de l’Afrique du Sud, l’ONUDI, à titre d’agence d’exécution principale désignée, a présenté à la 75e réunion une demande de financement pour un projet de démonstration sur les avantages techniques et économiques de l’injection assistée sous vide dans une usine de panneaux discontinus, reconvertie du HCFC-141b au pentane, d’un montant de 372 366 $US, plus les coûts d’appui de l’agence de 26 066 $US.

2. Conformément à la décision 72/40[1], le Comité exécutif a approuvé le financement pour la préparation du projet d’un montant de 40 000 $US, étant entendu que son approbation ne signifie pas l’approbation du projet ou de son niveau de financement lorsqu’il a été présenté (décision 74/33 a) vii)). La proposition est comprise dans l’annexe I au présent document.

Description du projet

3. Ce projet vise à évaluer les avantages de l’injection assistée sous vide dans une usine de panneaux discontinus utilisant du pentane comme agent de gonflage pour une entreprise de fabrication d’équipement de réfrigération commerciale. La technologie d’injection assistée sous vide est censée fournir un avantage à l’utilisation du cyclopentane ordinaire qui peut entraîner une augmentation de l’efficacité thermique (c.-à-d. des valeurs lambda inférieures), une meilleure distribution de la mousse, une réduction du temps de fabrication et la réduction des quantités de matières premières. Ces améliorations pourraient donner lieu à des améliorations techniques importantes dans les produits finaux.

4. Le projet devrait entraîner l’élimination de 38,04 tonnes métriques (tm) de HCFC-141b, contribuant ainsi à l’objectif de 2018 de la phase I du plan de gestion de l’élimination des HCFC (PGEH) du pays.

Objectifs

5. Les objectifs du projet sont :

a) De démontrer les avantages de l’utilisation de l’injection assistée sous vide avec du pentane en remplacement du HCFC-141b en termes de propriétés isolantes;

b) De démontrer l’applicabilité pratique de la technologie dans le secteur des panneaux discontinus, et la reproductibilité des résultats;

c) De démontrer dans quelle mesure la structure de coûts peut être allégée par la réduction du temps de moussage, une densité de mousse inférieure, une conductivité thermique plus faible; et

d) De définir la possibilité de réduire le coût du système de ventilation des gaz d’échappement par la conversion des usines à base de pentane, réduisant ainsi les coûts d’investissement supplémentaires.

[1] Le Comité exécutif a décidé notamment de tenir compte, à ses 75e et 76e réunions, des propositions pour des projets de démonstration à faible potentiel de réchauffement de la planète en remplacement des HCFC selon le cadre établi, et des critères fournis pour ces projets.

Méthodologie

6. Le projet sera mis en œuvre chez Dalucon Refrigeration Products (DRP), une entreprise qui avait fait part de son engagement à participer au projet de démonstration en utilisant une chaîne de leur processus de production. L'entreprise a également convenu d'éliminer 38,0 tonnes de HCFC-141b lorsque l'efficacité de la technologie d'injection assistée sous vide aura fait ses preuves.

7. Au niveau de l'entreprise, les éléments suivants seront mis en œuvre : la conversion au pentane comprendra la fourniture de polyols prémélangés à base de cyclopentane; la modernisation ou le remplacement de l'unité de dosage; la modernisation des presses existantes pour la technologie d'injection assistée sous vide en utilisant un ensemble qui comprend un dispositif de mise sous vide, une installation de fabrication par le vide et des moules à vide; des critères de sécurité pour l'utilisation d'un agent d'expansion inflammable (panneau de contrôle de sécurité, capteurs de gaz, ventilateurs); assistance technique; rapport de sécurité et de certification finale.

8. Des tests et des essais du produit seront entrepris, ainsi que la formation du personnel sur l'utilisation et l'adaptation de la technologie d'injection assistée sous vide. DRP est également tenu de participer au cofinancement du projet (estimé à 112 200 $US).

Budget du projet

9. Le tableau 1 résume les coûts du projet.

Tableau 1. Coûts du projet proposé

Élément de coût	Coût estimé ($US)
Production	
Modernisation d'une machine à haute pression à fabriquer de la mousse	80 000
Modification d'une presse pour injection assistée sous vide*	80 000
Ensemble de profils latéraux (60 et 80 mm)	20 000
Unité de prémélange	84 000
Réservoir pour pentane et accessoires, incluant une pompe	20 000
Système d'alimentation en azote	2 000
Sécurité de l'usine	
Système de ventilation et d'échappement (ventilateurs, tuyauterie, mise à la terre, panneaux électriques/branchements) complet	95 000
Capteurs de gaz, alarme, système de surveillance	52 000
Audit de sécurité/Inspection et certification de sécurité	2 000
Travaux généraux	
Transfert de technologie/Formation	25 000
Essais et mise en service	60 000
Total partiel	**520 000**
Imprévus	52 000
Total général	**572 000**
Coûts du projet moins la part du bénéficiaire	**459 800**
Estimation des coûts d'exploitation	(87 434)
Budget total disponible pour le projet de conversion	**372 366**

*****dispositif de mise sous vide (35 000 $US), installation de fabrication par le vide (24 000 $US) et moules ou profilés à vide (21 000 $US)

OBSERVATIONS ET RECOMMANDATIONS DU SECRÉTARIAT

OBSERVATIONS

10. À la 74e réunion, le Comité exécutif a convenu que le concept pour un projet de démonstration en Afrique du Sud pourrait être mis en œuvre dans les limites du financement de la préparation du projet, en soulignant que le Secrétariat avait indiqué, après son évaluation, que le projet était de faible priorité en vertu de la décision 72/40, car il concerne le secteur des mousses. De plus, alors que le projet pourrait entraîner une réduction des coûts d'exploitation, il pourrait toutefois augmenter les coûts d'investissement. Il a aussi indiqué qu'il n'y avait plus de consommation admissible restante de HCFC-141b pour l'Afrique du Sud, car la phase I du PGEH[2] tenait compte de la conversion globale de l'industrie de la mousse de polyuréthane rigide (PU), donc les 4,18 tonnes PAO utilisées par l'entreprise ne peuvent pas être déduites. Comme convenu dans le cadre de la phase I, l'Afrique du Sud interdira les importations et les exportations de HCFC-141b, sous forme pure ou comme composant des polyols prémélangés, pour une utilisation dans la production de mousses ou de solvants ou toute autre application, à compter du 1er janvier 2016. La conversion devrait se dérouler au moins un an après l'entrée en vigueur de l'interdiction, ce qui suggère que la conversion des HCFC-141b de l'entreprise devrait déjà avoir eu lieu.

11. En examinant le projet, le Secrétariat a indiqué que la chaîne de production envisagée pour la conversion n'était pas admissible, car elle a été mise en service en 2012 seulement. L'ONUDI a expliqué qu'une erreur typographique s'était glissée par inadvertance dans la proposition et que la chaîne no 1, utilisant une machine à mousse Cannon A-100 achetée en 2006, serait utilisée.

12. Le Secrétariat a également indiqué que la technologie d'injection assistée sous vide semble être utilisée par plusieurs entreprises dans au moins un pays visé par l'article 5 pour diverses applications.

13. Le Secrétariat a indiqué que la technologie proposée se traduira par une importante amélioration technique dans les produits finaux à base de mousse. Cependant, la technologie est indépendante de l'agent d'expansion utilisé (par exemple, HCFC-141b ou autre), et constituerait une mise à niveau de la technologie et, conformément à la décision 18/25 a), ne serait pas admissible. L'ONUDI a souligné que l'utilisation de l'injection assistée sous vide dans le cadre du projet fera la démonstration d'une nouvelle technologie qui permettra d'améliorer la technologie de gonflage à base de cyclopentane, et pourrait réduire l'exposition à des gaz dangereux (par exemple, isocyanate) et améliorer la rétention de l'agent d'expansion inflammable. L'ONUDI a suggéré que l'élimination accélérée des HCFC n'aurait pas été possible si les coûts « évitables » avaient été considérés comme inadmissibles et que la mise en œuvre du Protocole de Montréal a permis un certain nombre de modifications techniques, technologiques et techno-économiques. L'ONUDI a réaffirmé être convaincue que le projet est admissible.

14. En soulignant que la phase I du PGEH pour l'Afrique du Sud comprend la conversion totale de l'industrie de la mousse PU, le Secrétariat a demandé si le financement préalablement approuvé pour DRP serait retourné au Fonds lors de l'approbation du projet. L'ONUDI a indiqué qu'un montant de 16 400 $US, alloué à l'entreprise en vertu de la phase I, serait retourné lors de l'approbation du projet. L'Afrique du Sud ne dispose pas de consommation restante de HCFC-141b admissible à un financement.

Conclusion

15. Le Comité exécutif pourrait envisager d'approuver ce projet à la lumière des lignes directrices et des autres projets à l'étude dans le cadre de l'allocation de 10 millions $US à cette fin.

[2] UNEP/OzL.Pro/ExCom/67/29.

RECOMMANDATION

16. Le Comité exécutif pourrait envisager :

a) Le projet de démonstration sur les avantages techniques et économiques de l'injection assistée sous vide dans une usine de panneaux discontinus modernisée du HCFC-141b au pentane en Afrique du Sud, dans le contexte de la discussion sur les propositions de projets de démonstration de solutions de remplacement à faible potentiel de réchauffement global aux HCFC, comme décrits dans le document sur la liste des questions soulevées pendant l'examen des projets (UNEP/OzL.Pro/ExCom/75/27);

b) Approuver le projet de démonstration sur les avantages techniques et économiques de l'injection assistée sous vide dans une usine de panneaux discontinus modernisée du HCFC-141b au pentane en Afrique du Sud, d'une somme de 372 366 $US, plus les coûts d'appui d'agence de 26 066 $US pour l'ONUDI, conformément à la décision 72/40; et

c) Prendre note du remboursement de 16 400 $US par l'ONUDI à la 75e réunion, plus les coûts d'appui d'agence de 1 230 $US associés à la conversion au Dalucon Refrigeration Products en vertu de la phase I du plan de gestion de l'élimination des HCFC pour l'Afrique du Sud.

Annex I

PROJECT COVER SHEET

COUNTRY:	**South-Africa**
IMPLEMENTING AGENCY:	UNIDO
PROJECT TITLE:	Demonstration project on the technical and economic advantages of the Vacuum Assisted Injection in discontinuous panel's plant retrofitted from 141b to pentane

PROJECT IN CURRENT BUSINESS PLAN	Yes
SECTOR	Foams and commercial refrigeration
SUB-SECTOR	PU Discontinuous Sandwich Panel
ODS USE IN SECTOR (Average of 2009-10)	850 MT of HCFC-141b
ODS USE AT ENTERPRISES (Average of 2014)	38.04 MT
PROJECT IMPACT	38.04 MT (4.18 ODP tones) of HCFC-141b
PROJECT DURATION	24 months
TOTAL PROJECT COST:	
Incremental Capital Cost	US$ 418,000
Contingency	US$ 41,800
Incremental Operating Cost	US$ -87,434
Total Project Cost	US$ 372,366
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	Nil
REQUESTED GRANT	US$ 372,366
COST-EFFECTIVENESS	US$ 9.79/ kg
IMPLEMENTING AGENCY SUPPORT COST (7.5%)	US$ 27,927
TOTAL COST OF PROJECT TO MULTILATERAL FUND	US$ 400,294
STATUS OF COUNTERPART FUNDING	
PROJECT MONITORING MILESTONES	Included
NATIONAL COORDINATING/ MONITORING AGENCY	Ozone Office

Project summary
HCFC-141b used in the manufacturing of PU Discontinuous Sandwich Panel for insulation at Dalucon, company will be phased-out by converting to Vacuum Assisted Injection (VAI)/Cyclopentane technology. The chosen technology is a novel method for the batch production of insulating panels. These panels for refrigerated trucks, reefers, walk-in refrigerators and industrial cold stores will be using the industrially proven VAI technology. This technology will enhance Cyclopentane blowing technology, which is a definitive alternative under the Montreal Protocol and additionally has a positive impact on climate, in compliance with MOP Decision XIX/6.
Impact of project on Country's Montreal Protocol Obligations
Immediate impact of this individual project is the phase-out of 38.04 MT of HCFC-141b, thereby, contributing to the country's HPMP Stage I reduction target in 2018. With the successful implementation of this project, there will be no consumption of HCFC-141b for foam blowing at Dalucon company.

Prepared by: UNIDO Date: 07 September 2015
Reviewed by: Date: ______________

1 BACKGROUND AND JUSTIFICATION

In 2007, the Parties to the Montreal Protocol agreed to accelerate the phase-out of the hydrochlorofluorocarbons (HCFCs) as the main ozone depleting substances largely because of the substantive climate benefits of the phase-out. In the following years, Parties operating under the Montreal Protocol's Article 5 (mostly developing countries) have formulated their HCFC Phase-out Management Plans (HPMPs) for implementation under financial assistance from the Multilateral Fund for the implementation of the Montreal Protocol (MLF).

The Executive Committee in decision 72/40 agreed to consider proposals for demonstration projects for low-GWP alternatives and invited bilateral and implementing agencies to submit demonstration project proposals for the conversion of HCFCs to low-global warming potential (GWP) technologies in order to identify all the steps required and to assess their associated costs.

In particular, Par (b)(i)a. of the Decision 72/40 indicates that project proposals should propose options to increase significantly in current know-how in terms of a low-GWP alternative technology, concept or approach or its application and practice in an Article 5 country, representing a significant technological step forward.

The use of the vacuum assisted technology for the application of alternatives to HCFCs fully fits the actual ExCom decision on Demonstration project proposals as defined in ExCom Decision 72/40.

The Executive Committee of Multilateral Fund for the Implementation of the Montreal Protocol approved at its 74th meeting held in Montreal, Canada in May 2015, the preparation of the demonstration project for foam and refrigeration sectors. The project was approved for UNIDO implementation in the republic of South Africa.

2 OBJECTIVE

- Demonstrate benefits from the application of the vacuum assisted injection in replacement of HCFC-141b with pentane in term of insulation properties in the panel's sector
- Demonstrate the easy applicability of the technology and, consequently, the replicability of the results
- Demonstrate that lower cost structure can be obtained by means of shorter foaming time, lower foam density, lower thermal conductivity
- Objectively analyze, if the incremental capital cost could be reduced overall in similar future projects by means of using Vacuum Assistance applied in the foaming process automatically used also for suction of flammable and harmful gaseous substances. Thus, providing means of reducing the cost of exhaust ventilation system in the hydrocarbon based plant conversions.

3 METHODOLOGY

Intention of this demonstration project is to provide means for the evaluation of sandwich panels manufactured with new technology in comparison and in regards to;

- Thermal transmittance
    - Measurement of lambda values (thermal conductivity W/mK)
    - Ageing of lambda value

- Mechanical resistance of the panels and its core material
    - Shear strength and shear modulus
    - Compressive strength
    - Cross panel tensile strength
    - Bending moment and wrinkling stress
- Foam density distribution through the foam matrix in various positions of the panels

All tests above will be conducted according to EN 14509 (Self-supporting double skin metal faced insulating panels - Factory made products – Specifications)

3.1 Description of process expectations

Quality of PU panel relies, in most of the application, on the insulation property. Considering the PU physical properties, insulation of final products can be influenced by the: a) thermal conductivity of the blowing agent b) thermal conductivity polymer matrix and c) overall foam structure, its uniformity and homogeneity. These factors of thermal conductivity then determine the thickness of the foam insulation.

Therefore, one of the critical points in the retrofitting from 141b to blowing agents with higher thermal conductivity value (e.g. pentane), is the losses in insulation properties.

Aim of this demonstration project is to evaluate the advantages of Vacuum Assisted Injection (VAI) in discontinuous panel production process, when using Cyclopentane as foam blowing agent instead of HCFC-141b.

The Vacuum injection technology will give advantages to a standard pentane converted plant in term of:

- Decreased lambda value
- Better overall foam structure/ foam distribution
- Decreased demolding time of 30%

The above is expected to generate substantial technical improvements in the final products as well as reduction of operation costs (reduction of time for manufacturing as well as reduction of raw materials imputs).

The project results will be extremely relevant for those sectors where insulation property of final products is crucial and thickness of panels cannot be increased (e.g. panels for refrigerated trucks, refrigerated containers, etc.)

3.2 Detailed description of Methodology

In the selection of the most suitable partner for the application of the vacuum assisted technology, priority was given a company, which is eligible and willing for the pentane conversion.

Dalucon is willing and eligible beneficiary which was selected and the project will include the implementation of:

1- Pentane conversion of the plant
2- Retrofitting kit to vacuum injection technology of the existing presses

The pentane conversion will include: Provision of Cyclopentane preblended polyol, Dosing unit (retrofit or substitute the existing one), Safeties for the use of flammable blowing agent (safety control panel, gas sensors, ventilators…), engineering services for the pentane conversion, safety report and White book and certification (TUV or similar).

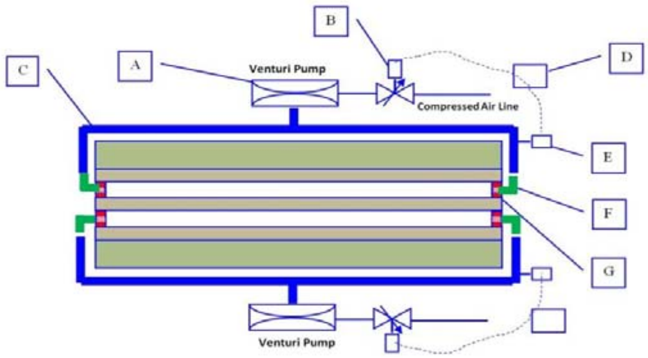
1- Retrofitting kit to vacuum injection technology

The retrofitting kit to vacuum injection technology will include three main components: vacuum unit, vacuum plant and vacuum molds, (as explained below).

VACUUM UNIT

System where the vacuum is generated and controlled.

This includes vacuum pumps, control valves, sensors, control hardware and software. The unit can control the level of vacuum in the cavity, the duration of the process and can store different recipes according to different kind of panel models, with optimized parameters.



VACUUM PLANT

This part is to connect the vacuum up to the cavities where PU foam is injected. Objective is to keep the normal movement of the press and the press platens and reduce costs of retrofitting.

VACUUM MOULDS (SIDE MOULDS OR PROFILES)

Molds are to define the shape of the panel, especially its external shape and dimensions. The scope of supply considers a complete additional set of molds designed to create the vacuum inside the press cavity.

Each side mold will be equipped with connections for connecting the cavity to the vacuum plant, vacuum distribution in the whole cavity and a dedicated injection holes able to maintain the vacuum level even at the insertion of the injection head.

4 COMPANY BACKGROUND

Dalucon Refrigeration Products (DRP) is a family owned business, originally founded by Aldo Martinelli in 1991 with combined company knowledge between its members of over 50 years. Their core focus is on quality and delivery time and therefore DRP has set a benchmark for all of its products that competitors find hard to match. DRP remains a successful business employing over 110 staff members and are situated in Centurion, with over 10,000 m² of manufacturing space available; 800m² office space; 3000 m² storage, assembly and stock area. DRP is situated in Highway Business Park, Centurion, Gauteng – a gateway between Johannesburg and Pretoria, which forms a natural extension to the rest of South Africa.

Address:

P.O. Box 7827
Centurion
0046
Tel: 012 661 8480/1/2
Fax: 012 661 0354
Website: www.dalucon.co.za
Members: A. Martinelli, M. Martinelli, S. Martinelli
Reg No: 2006-089100-23
Vat No: 444 0126 730

4.1 PRODUCTION PROCESS

The raw materials, including polyol blend with HCFC-141b as a pre-blend from the local system house, and isocyanate is being procured in 1,000 liter IBC containers. The polyol-blend, once received, is shifted to the polyol tank of 1,000 liters through pneumatic pump. This tank is kept in the temperature-controlled storage room. The blend of poly and HCFC-141b is taken to the day tank of the foaming machine. Iso is taken in similar process from the tank of 1,000 liter to the Iso day tank of the foaming machine. The plant has 3 foaming lines and 3 units 2 +2 Manni presses. The chemical is poured discontinuously in the panel in the desired quantity to achieve the required foam parameters. The production process is to a large extent automated.

The production cycle is as follows:

- Warehouse and storage for metal coils
- Cutting and profiling to length of the metal sheets
- Assembly of the panels
- Movement to the foaming tables of the press
- Foaming
- Extraction and transport to the warehouse for shipment

The chemical composition of various chemical uses in the manufacturing PU sandwich panels is provided in the table below:

Description	HCFC 141b	Polyol	Isocyanate
%age mixing ratio	11.90%	36.71%	51.39%

The higher than normal content of HCFC-141b is found and proven to provide the optimum thermal transmittance for the panels and enhanced PU mixture flowability, which is required, in particular in the transport vehicle use of insulated sandwich panels.

The description of the foaming machine, press and storage tanks are provided below.

Baseline Equipment

Sr. #	Type of Equipment	Model	No.	Design Capacity	Manufacturer Type	Commissioning Year
1	Polyol Preblend Storage Tank	Dalucon Stainless Steel	2	1000 liter	Dalucon	2006
2	Isocyanate Storage Tank	Dalucon Stainless Steel	2	1000 liter	Dalucon	2006
Foaming Line 1 (Mainly for the refrigerated truck panels) and subject for the conversion and demo project						

Sr. #	Type of Equipment	Model	No.	Design Capacity	Manufacturer Type	Commissioning Year
1	Polyol Day Tank	Cannon, Italy	1	200 liter	Cannon, Italy	2006
2	Isocyanate Day Tank	Cannon, Italy	1	200 liter	Cannon, Italy	2006
3	PU Foaming Machine with mixing heads	Cannon A-100 Basic, Italy	1	100 kg/min	Cannon, Italy	2006
4	Manni 2+2 Press	Manni/Cannon, Italy	1	9.5x1.45 meter	Cannon, Italy	2006
Foaming Line 2 for longer panels						
1	Polyol Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2012
2	Isocyanate Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2012
3	PU Foaming Machine with mixing heads	Cannon A-200 CMPT, Italy	1	200 kg/min	Cannon, Italy	2012
4	Manni 2+2 Press	Manni/Cannon, Italy	1	13.5x1.45 meter	Cannon, Italy	2012
Foaming line 3						
1	Polyol Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2015
2	Isocyanate Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2015
3	PU Foaming Machine with L-14 mixing head	Cannon A-100 Basic, Italy	1	100 kg/min	Cannon, Italy	2012
4	Manni 2+2 Press	Manni/Cannon, Italy	1	13.5x1.45 meter	Cannon, Italy	2015

The Cannon A-200 can be converted with lowest cost of Dalucon foaming machines for the pentane duty, and will be moved on the Foaming line 1 during the conversion implementation. Further, the electrical system of the hydraulic control of the presses needs to be adapted to ATEX requirement.

Few photographs taken at the plant is provided below:

4.2 ANNUAL PRODUCTION PROFILE IN 2014

Panel thickness mm	Capacity m2 / 8 hrs	Share of production %	PU m3	PU kgs	PU total kg/a	HCFC-141b kg	HCFC-141b Total / a
40	500	10,0	2,0	83,2	20800,0	9,9	2475
50	500	5,0	1,3	52,0	13000,0	6,2	1547
60	450	30,0	8,1	337,0	84240,0	40,1	10025
80	400	30,0	9,6	399,4	99840,0	47,5	11881
100	380	20,0	7,6	316,2	79040,0	37,6	9406
125	350	5,0	2,2	91,0	22750,0	10,8	2707
		100,0	30,7	1278,7	319670,0	152,2	38041

5 TECHNOLOGY OPTION FOR VACUUM ASSISTED INJECTION TECHNOLOGY (VAI)

5.1 Overview of alternatives to HCFC-141b for PU foam application

HCFC-141b has mainly been used as a blowing agent in various formulations in the manufacturing of PU foam for the production of PU sandwich panels for various sizes and thickness in South-Africa.

Factors that influence the technology selection include consideration of the following major features for PU foam.

- Mechanical properties
- Density
- Insulation properties
- Costs

5.2 Alternate Technologies Considered

In accordance with the 2014 report of the rigid and flexible foams technical options committee, there are a number of alternatives that are available to replace the use of HCFC 141b in rigid polyurethane foam. Several foaming technologies including the following are used as alternate technology.

- Cyclopentane
- HFC-245fa
- HFC-365mfc/227ea
- HFC-134a
- Methyl formate
- CO_2 (Water)
- u-HFC
- Liquid unsaturated HFC/HCFC (HFOs) as emerging technology

The below table provides an overview of the blowing agents that has been used in various sub-sectors of foam sector.

Sector	***HCFCs***	***HFCs***	***HCs***	***HCOs***	***HFOs***	***CO2-based***
PU Appliances	HCFC-141b HCFC-22	HFC-245fa HFC-365mfc/227ea	cyclo-pentane cyclo/iso-pentane	Methyl Formate	HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Board	HCFC-141b	HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	
PU Panel	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane /iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Spray	HCFC-141b	HFC-245fa HFC-365mfc/227ea			HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)* Super-critical CO2
PU In-situ / Block	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Integral Skin	HCFC-141b HCFC-22	HFC-245fa HFC-134a		Methyl Formate Methylal		CO2 (water)*

Sector	***HCFCs***	***HFCs***	***HCs***	***HCOs***	***HFOs***	***CO2-based***
XPS Board	HCFC-142b HCFC-22	HFC-134a HFC-152a		DME	HFO-1234ze(E)	CO2 CO2/ethanol
Phenolic	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	

*CO_2 (water) blown foams rely on the generation of CO_2 from reaction of isocyanate with water in the PU system itself.

The pros & cons for commercially available options as well as emerging options as highlighted in the UNEP 2014 report of the rigid and flexible foams technical options committee for the manufacturing of PU foam are provided in the below tables:

Commercially Available Options

Option	**Pros**	**Cons**	**Comments**
Cyclopentane & n-Pentane	Low GWP	High flammable	High incremental capital cost, may be uneconomic for SMEs
	Low operating costs		
	Good foam properties		
HFC-245fa, HFC-365mfc/227ea, HFC-134a	Non-flammable	High GWP	Low incremental Capital Cost
	Good foam properties	High Operating Cost	Improved insulation (cf. HC)
CO2 (water)	Low GWP	Moderate foam properties -high thermal conductivity-	Low incremental Capital Cost
	Non-flammable		
Methyl Formate/Methylal	Low GWP	Moderate foam properties -high thermal conductivity-	Moderate incremental capital cost (corrosion protection recommended)
	Flammable although blends with polyols may not be flammable		

Emerging Options

Option	**Pros**	**Cons**	**Comments**
Liquid Unsaturated HFC/HCFC (HFOs)	Low GWP	High operating costs	First expected commercialization in 2013
	Non-flammable	Moderate operating costs	Trials in progress
			Low incremental capital cost

The Indicative assessment of criteria for commercially available options as well as emerging alternatives in PU foam is provided in the table below:

Assessment of criteria for commercially available options

	c-pentane	**i-pentane n-pentane**	**HFC-245fa**	**HFC365mfc/ 227ea**	**CO_2 (water)**	**Methyl Formate**
Proof of performance	+	++	++	++	++	+
Flammability	---	---	++	+(+)	+++	--
Other Health & Safety	0	0	+	+	-	0
Global Warming	+++	+++	--	---	++	++
Other Environmental	-	-	0	0	++	-
Cost Effectiveness (C)	--	---	++	++	++	0
Cost Effectiveness (O)	++	+++	--	--	+	+
Process Versatility	++	++	+	++	+	+

Assessment of criteria for Emerging Technology options

	HFO-1234ze(E)	**HFO-1336mzzm(Z)**	**HFO-1233zd(E)**
	Gaseous	liquid	Liquid
Proof of performance	0	+	+
Flammability	++	+++	+++
Other Health & Safety	+	+	+
Global Warming	+++	+++	+++
Other Environmental	+	+	+
Cost Effectiveness (C)	++	++	++
Cost Effectiveness (O)	--	--	--
Process Versatility	+	+	+

IOC comparison between major alternatives

IOC	HCFC-141b			HFO-1233zd			c-pentane / vacuum			Water-blown / Formic Acid		
	Formula	%	Cost/kg	Formula	%	Cost/kg	Formula	%	Cost/kg	Formula	%	Cost/kg
Polyol	100	36,71%	2,70	100	38,17%	2,70	100	37,88%	2,70	100	37,95%	2,70
B.A	32,42	11,90%	2,70	22	8,40%	13,00	9	3,41%	2,68	3,5	1,33%	2,70
MDI	140	51,39%	2,50	140	53,44%	2,50	155	58,71%	2,50	160	60,72%	2,50
Total	**272,42**	**100,00%**	**2,60**	**262**	**100,00%**	**3,46**	**264**	**100,00%**	**2,58**	**263,5**	**100,00%**	**2,58**
Thermal conductivity mW/mK			**23**			**21**			**23**			**31**
Foam density			42			42			37,8			
Equivalent cost USD			**2,60**			**3,16**			**2,32**			**3,48**
Total PU consumption 2015	319670	38,04	830253	319670		1009300	287703		742819	319670		1110996
IOC / year USD						**179047**			**-87434**			**280744**

5.3 Selection of alternative technology for the VAI

The technology chosen has been Cyclopentane due to the following:

- Experience has been gained and training, technology options costs are lower
- Cyclopentane is a well-established technology with zero ODP and is a low GWP
- The existing (VAI) foam formulations in the manufacture of domestic refrigerators and sandwich panels are based on the utilization of c-pentane as core foaming agent

6 Activities required for conversion

6.1 Modification of production process

The following modification and replacements in the existing process is assumed to implement the conversion.

- Retrofit of existing foam dispenser where applicable
- Replacement of pre-mixing unit, however, at Dalucon, the c-pentane polyol preblend will be supplied as preblend from the local nearby System House
- Modification of Press
- Hydrocarbon tank and accessories (piping and pumps, ventilation), however, at Dalucon, the c-pentane polyol preblend will be supplied as preblend from the local nearby System House
- Buffer tank for polyol, however, at Dalucon, it will not be required, since the storage tank of polyol blend will act as buffer tank
- Nitrogen supply system

- The following features need to be introduced

  - Ventilation system
  - Safety system controls
  - Adaptation of foaming equipment controls (software) and electrical equipment in order to comply with ATEX or equivalent safety regulations
  - Suitability of pressure equipment to comply with the regulations
  - Control of emissions of the equipment used which includes magnetic joints on electrical motors and EX parts for all equipment in contact with the liquid
  - Safety verification by the supplier or independent entity like TUV.

The training of the beneficiary staff for the adaptation of new technology is covered in this project. Further, the trials and testing of the product is also covered. Once the plant is put in commercial operation, the safety verification by the safety certifier shall be carried out and is being covered in the cost of the project.

After the successful completion of testing and commercial production, the removed equipment will be destroyed.

7 PROJECT COST

7.1 Project Cost as per MP Guideline decision 55/47

The conversion plan and costs are following the guidelines of decision 55/47 to the extent possible. Based on table **I**.1 (Sectoral cost-effectiveness threshold values established by the Executive Committee) of above referenced guideline, the sectoral cost effectiveness threshold value established by the executive committee for the PU foam is US$ 7.83 per kg.

Recently, in accordance with clause 162 (C) (i, iii & iv) of UNEP document 3 UNEP/OzL.Pro/ExCom/74/56 (Decision 74/50), the cost effective threshold is US$7.83/kg for phasing out of HCFCs in Stage-II HPMP projects. Further, the following is stipulated:

- Funding of up to a maximum of 25 per cent above the cost-effectiveness threshold is available for projects when needed for the introduction of low-GWP alternatives; however, for SMEs in the foam sector with consumption of less than 20 metric tonnes, the maximum would be up to 40 per cent above the cost-effectiveness threshold.

The cost effective threshold for this sub-sector is US$9.79/ kg (US$7.83+25%) for consumption greater than 20 metric ton and US$10.96/ kg (US$7.83+40%) for consumption less than 20 metric ton. In this demonstration project at Dalucon, the cost-effectiveness threshold of US$9.79/kg is applied.

7.2 Incremental capital cost

The foaming line 1 shall be converted to the use of Cyclopentane from HCFC-141b with VAI technology. Funds are requested to cover the modification, provision of the VAI Kit and retrofit of existing A-200 CMPT foaming machine and the provision of necessary equipment, accessories as well as technology transfer, training, trials and commissioning. The ICC calculation is based on Appendix-I of the above referenced guidelines. These guidelines are based on 2008 cost.
While calculating the incremental capital cost for each plant, the cost provided for 2008 basis has to be adjusted according to the inflation rate as a matter of acceptance of principles of market economy, as also manufacturers of equipment adjust to inflation.
The ICC of this project is calculated using only the base cost figures as provided in the guideline 55/47.

All cost in US$

	Guidelines US$	Project cost US$	With cost sharing US$
Production			
Retrofit of High pressure foaming machine A-CMP 200	100 000	80 000	80 000
Modification of press for VAI (detailed in table XX in project document)	80 000	80 000	80 000
Set of side profiles (60 and 80 mm)	20 000	20 000	20 000
Premixing unit	84 000	84 000	0
Hydrocarbon tank and accessories including polyol-pentane drum pump	55 000	20 000	20 000
Buffer tank for pentane-polyol tank 1,000 liters	100 000	0	0
Nitrogen supply system	15 000	2 000	3 000
Plant Safety			
Ventilation and exhaust system (fans, piping, ductworks, grounding, electrical boards/connection) complete	115 000	95 000	80 000
Gas sensors, alarm, monitoring system for entire plant	57 000	52 000	48 000
Fire protection/control system for the plant	10 000	0	0
Lightning protection and grounding	15 000	0	0

Antistatic floor	5 000	0	0
Safety Audit / Safety Inspection and certification	20 000	2 000	2 000
Stand by electric generator	15 000	0	0
General Works			
Civil work / Plant modifications	25 000	0	0
Technology transfer / training	25 000	25 000	25 000
Trials and commissioning*	60 000	60 000	60 000
Total	801 000	520 000	418 000
Contingency	80 100	52 000	41 800
Grand Total	**881 100**	**572 000**	**459 800**
IOC estimate (see para 7.3)			-87 434
Total project budget available for the conversion US$			**372 366**

***Trials and commissioning include testing mentioned in the methodological chapter(3):**

- Thermal transmittance
  - Measurement of lambda values (thermal conductivity W/mK)
  - Ageing of lambda value
- Mechanical resistance of the panels and its core material
  - Shear strength and shear modulus
  - Compressive strength
  - Cross panel tensile strength
  - Bending moment and wrinkling stress
- Foam density distribution through the foam matrix in various positions of the panels

7.3 Incremental operating cost

In calculating the Incremental Operating Costs it has been assumed based on the commercial Vacuum Assisted Injection (VAI) projects that:

- The use of Cyclo-Pentane is only about 28.6% of the use of HCFC 141b.

- The conversion of technology to VAI / Cyclo-pentane system shall reduce the density of the foam to 90% of present HCFC-141b based formulations.

Incremental operating cost related to the conversion of the foaming technology was calculated based on the formulations as applicable at Dalucon. Current prices are as follows:

- HCFC-141b: US$ 2.70/kg
- Polyol: US$ 2.70/ kg
- Isocyanate: US$ 2.50/ kg
- Cyclo-Pentane: US$ 2,68/kg (in preblend)

Chemicals	**R-141b system**			**VAI/Cyclo-pentane system**		
	Amount Kg	**Price US$/kg**	**Cost US$**	**Amount Kg**	**Price US$/kg**	**Cost US$**
Polyol	0.367	2.70	0.99	0.379	2.70	1.02
Isocyanate	0.514	2.50	1.28	0.587	2.50	1.47
Blowing agent	0.119	2.70	0.32	0.034	2.68	0.09
Total	**1.000**		**2.60**			**2.58**
				Difference per kg		**-0.02**

The IOC is calculated based on 1 year as provided in the table below

	Before conversion	**Year I**
Foam production [kg]	319,670	287,703
Total annual cost of chemicals used	830,253	742,819
Cost difference per annum - Total IOC, US$		-87,434

7.4 Total project cost

	US$
Incremental Capital Cost (ICC)	459,800
Incremental Operating Cost (IOC)	-87,434
Total Cost	**372,366**

7.5 Cost Effectiveness

The total HCFC-141b planned to be phased out in this demonstration project is 38.04 MT and grant requested is **US$ 372,366**. Thus, representing of Cost Effectiveness of US$9,79/kg phased out of HCFC-141b.

8 GLOBAL WARMING IMPACT ON THE ENVIRONMENT

8.1 Project Impact on the Environment

The project impact on the environment was studied for both the chemicals i.e. HCFC 141b and Cyclopentane. The CO_2 emission before conversion (using HCFC 141-b as blowing agent with Global Warming Potential of 713) is expected as 27,123 metric ton per year whereas after conversion to Cyclopentane with GWP 25, it is estimated 245 metric ton per year. The net impact on the environment is positive. The CO_2 emission is expected to be reduced by 26,878 MT after implementing the new technology. The net effect is provided in the table below:

Name of Industry	**Substance**	**GWP**	**Phase out amount MT/ year**	**Total equivalent warming impact CO2 eq. MT/ year**
Before Conversion				
Total CO_2 emission in M tonnes	HCFC 141b	713	38.04	27,123
After Conversion				
Total CO_2 emission in M tonnes	Cyclopentane	25	9.81	245

Net Impact				-26,878

9 PROJECT IMPLEMENTATION MODALITIES

9.1 Implementation structure

The National Ozone Unit reporting to the Department of Environmental Affairs, Government of South-Africa is responsible for the overall project, coordination, assessment and monitoring. The National Ozone Unit (NOU) cleared the Letter of Commitments with Dalucon DRP. NOU will clear Agreement on Implementation Procedures with the counterpart and other partners of this project (if any), to ensure that project objectives are met. Terms of Reference (TOR) for the implementation of this demonstration project will be prepared by UNIDO in close collaboration with his technology originator and provider(s) of equipment and Dalucon (recipient company). Main objective of this Plan is to ensure project successful implementation and provision of process replication to other companies in South-Africa and other Article 5 countries.

UNIDO as the implementing agency is responsible for the financial management of the respective grant. UNIDO will also assist the Dalucon in equipment procurement, technical information update, monitoring the progress of implementation, and reporting to the ExCom. The counterpart/enterprise is responsible to achieve the project objective by providing financial and personnel resources required for smooth project implementation. Financial management will be administered by UNIDO following UNIDO's Financial Rules and Regulation.

9.2 Working arrangement for implementation

After the approval of the project by the Executive Committee, the working arrangement will be signed by the above parties, where the roles and responsibilities of each party are detailed.

9.3 Modification of production process

Procurement of equipment required for the production line modification will be done through a single source purchase, however according to respective regulation stipulated by UNIDO's Financial Rules and Regulations. Smaller equipment and parts may be procured locally, if local procurement is found to be more economical. Local procurement will also be done based on UNIDO's Financial Rules and Regulations. This applies also for contracting with contractors for provision of technical services. Terms of references and technical specifications for the procurement of contracts and equipment will be prepared by UNIDO in consultation and agreement with the enterprise and the NOU.

9.4 Project monitoring

Project monitoring is done by the executing and implementing agencies through regular missions to the project site and continuous communications through e-mails and telephone/skype discussion. Occasional visits and communication by the NOU are also to be done to ensure adequate project implementation.

9.5 Project completion

Project completion report will be submitted by UNIDO within 6 months after project completion. Necessary data and information for the preparation of the project completion report is to be provided by the enterprise/NOU.

9.6 Timetable for implementation

Milestone	2015	2016				2017				2018			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Approval													
Working arrangement													
Preparation of TORs													
Bidding & contract award													
Equipment Delivery													
Modification of line													
Staff training													
Safety certificate													
Project completion													

In conformity with the Montreal Protocol Executive Committee's decision 23/7 on standard components on monitoring and evaluation, milestones for project monitoring are proposed as follows:

Sr. #	Milestone	Months
1	Project approval	-
2	Start of implementation	1
3	Grant agreement submitted to beneficiary	2
4	Grant agreement signature	3
5	Bids prepared and requested	9
6	Contracts awarded	14
7	Equipment delivered	20
8	Commissioning and trial runs	22
9	De-commissioning/destruction of redundant baseline equipment	24
10	Submission of project completion report	24-30