MINISTRY OF ENVIRONMENT AND WATER
REPUBLIC OF BULGARIA

THE DANISH ENVIRONMENTAL PROTECTION AGENCY

Bulgarian HCFC Phase-out strategy

December 2003

The Bulgarian HCFC Phase out Strategy has been developed with the exclusive expertise and financial support of the Danish Environmental Protection Agency by RE-A-CT – Specialists in Refrigeration and Cellular Technologies – Denmark in collaboration with two Bulgarian partners:

- **The Air Protection Directorate to the Ministry of Environment and Water and**
- **The Institute of Refrigeration and Air Conditioning in Sofia**

The key study team members are:

From RE-A-CT:

- **Mr. Ole Reinholdt Nielsen, Managing Director- Project Manger**

From the Bulgarian Ministry of Environment and Water:

- **Mrs. Lidia Assenova – Head of Global Atmospheric Processes Department to the Air Protection Directorate**

From the Institute of Refrigeration and Air Conditioning in Sofia:

- **Dr. Peter Vassilev – Technical Director**

Table of contents

List of abbreviations

DEPA	Danish Environmental Protection Agency
MoEW	Ministry of Environment and Waters
MP	Montreal Protocol
EU	European Union
GEF	Global Environmental Facility
UNEP	United Nations Environmental Programme
TEAP	Technology and Economic Assessment Panel
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Program
ODS	Ozone Depleting Substances
CFC	Chloro Flouro Carbons
HCFC	Hydro Chloro Flouro Carbons
HFC	Hydro Flouro Carbons
MT	Metric tons
VAT	Value added tax
SME	Small- and medium-sized enterprise

Background

Introduction

During the 1980'ies concern on the increasing depletion of ozone in the stratosphere initiated the introduction of a regulatory framework for phase-out of ozone depleting substances (ODS). In 1987 the Montreal Protocol (MP) – setting up a reduction scheme of the usage of ODS – was agreed upon. The MP has later been amended (London, Copenhagen, Montreal and Beijing) with stricter requirements for ODS phase-out, inclusion of additional substances to be controlled and also with a financial mechanism supporting developing countries and countries with economies in transition (CEIT's) with financial assistance for compliance of the Montreal Protocol.

The MP classifies the substances according to their influence on the ozone depletion. Substances with relevance to this strategy are:
Annex A – Group I substances (CFC-11, CFC-12, CFC-113, CFC-114 and CFC-115);
Annex C - Group I substances (HCFC's)
Of mentioned groups only financial assistance to phase-out of the Annex A – Group I substances has been provided.

Bulgaria initiated the preparation of a Country ODS Phase out Program in early 1990'ies supported by the Danish Government. Subsequently a number of sub-projects being part of the Country Program were developed – also with Danish assistance. In May 1995 the Global Environmental Facility (GEF) approved the Bulgarian ODS phase-out project with an allocation of 10.5 mill. USD.

The Bulgarian ODS phase-out project was successfully implemented by April 30, 2000.

However, companies not covered by the Bulgarian ODS phase-out project have shifted to HCFC's themselves, being the only easy reachable and cost effective technology available in the absence of CFC's. HCFC's are, however, also to be phased-out according to the requirements of Montreal Protocol on Substances that Deplete the Ozone Layer (Copenhagen Amendment). Bulgaria, in terms of Montreal Protocol, has to meet same requirements and phase-out schedules as developed countries.

According to the requirements of the Montreal Protocol, Bulgaria has to phase-out HCFC's by year 2030. Bulgaria is in the pipeline for EU membership in 2007 and has therefore decided to adopt an accelerated phase-out schedule in line with EU legislation. The Bulgarian legislation aims at complete HCFC phase-out in year 2010.

In Europe most countries have adopted an accelerated HCFC phase-out schedule, where front-runners banned HCFC's by January 1, 2000.

Montreal Protocol HCFC phase-out schedule

According to MP the HCFC phase-out schedule shall be based on consumption in 1989. The baseline HCFC figure is calculated as follows:

Baseline HCFC = HCFC consumption (1989) + 2.8% of CFC consumption (1989)

Bulgaria consumed in 1989 157 MT HCFC and 2,653 MT CFC giving a baseline HCFC consumption of 231 MT.

The phase-out schedule is as follows:

Table 1 - MP HCFCs phase-out schedule

Year	Baseline	Reduction	Allowed quantity
1996	1989	0 %	231 MT
2004	1989	35 %	150 MT
2010	1989	65 %	81 MT
2015	1989	90 %	23 MT
2020	1989	99.5 %	1 MT
2030	1989	100 %	-

The schedule is shown graphically in figure 1.

European Union HCFC phase-out schedule

According to EU (EC 2037/2000) the HCFC phase-out schedule shall be based on consumption in 1989. However, EU operates with two baseline figures, the 1989 baseline and the 2001 baseline. These are calculated as follows:

1989 Baseline HCFC = HCFC consumption (1989) + 2.6% of CFC consumption (1989)

2001 Baseline HCFC = HCFC consumption (1989) + 2.0% of CFC consumption (1989)

Using above 1989 consumption figures, the 1989 baseline HCFC consumption is 226 MT and the 2001 baseline HCFC consumption is 210 MT.

The phase-out schedule is as follows:

Table 2 - EU HCFCs phase-out schedule

Year	Baseline	Reduction	Allowed quantity
1996	1989	0 %	226 MT
2001	2001	0 %	210 MT
2002	2001	15 %	179 MT
2003	2001	55 %	95 MT
2004	2001	70 %	63 MT
2008	2001	75 %	53 MT
2010	2001	100 %	-

The schedule is shown graphically in figure 1.

Bulgarian HCFC phase-out schedule

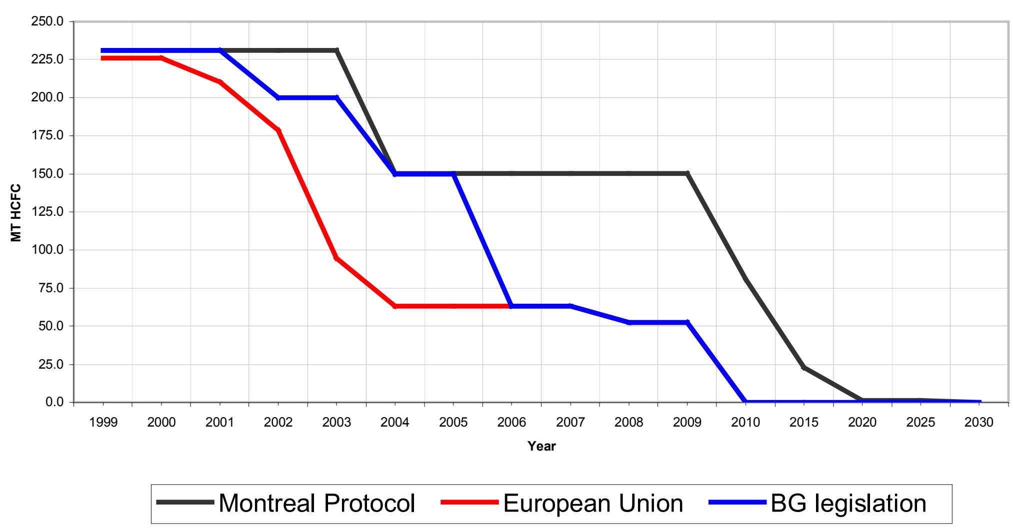
Bulgaria has adopted a HCFC phase-out schedule (Decree 254/99) that meets the EU schedule in 2006 as follows.

Table 3 - Bulgarian HCFC phase-out schedule

Year	Baseline	Reduction	Allowed quantity
1996	1989	0%	231 MT
2001	2001	0%	210 MT
2002	2001	5%	200 MT
2004	2001	29%	150 MT
2006	2001	70 %	63 MT
2008	2001	75 %	53 MT
2010	2001	100 %	-

Below figure 1 shows the MP, EU and Bulgarian phase-out schedules

Figure 1 - HCFC phase-out schedules



HCFC consumption

HCFC import

Bulgaria introduced in 1999 a comprehensive licensing scheme for HCFC's (Ministerial Decree 254/1999). This scheme includes 3 different measures to identify and control HCFC usage.

1. Import quota: Every company wishing to import HCFC shall apply MoEW for a quota. Actual imported quantities shall be reported to MoEW the following year.
2. Control by regional inspectorates of MoEW: The regional inspectorates of MoEW shall every March report on imported, exported, recycled and used quantities of HCFC. The data are obtained at licensed importers and registered HCFC consumers.
3. Reporting by customs: The customs department report every March on imported and exported quantities.

So far a few issues have been identified and resolved by MoEW:

- Initially pre-blended HCFC and polyol (used for polyurethane foam operations) was not included – and hence, not reported. Importers are the 3 companies: BASF, Bayer and ICI. This has been corrected.
- Some substances do not have their own customs code. Hence, customs officials could not report these. A comprehensive customs code system developed by UNEP/TEAP is planned to be implemented when available (expected 2003).

Table 4 and 5 provides details on licensed and actual import in 2000.

Table 4 - licensed import for 2000

Metric tonnes

Importer	HCFC-22	HCFC-141b	Premix polyol / HCFC-141b	HFC-134a	HFC-404A	HFC-407C	HFC-23
Inst. Of Refrigeration	2,176			544	3,488		
Seaborne Ltd.	10,000			10,000			
Prista Oil Ltd.	39,520			12,720	1,308	113	
Sokem B&D	7,500			550	800	240	
Akvachim							
Helpman	60,000			30,000		1,000	500
Nat. Electricity Company							
Chimatech		2,350		2,700			
Kremikovtzi							
CCS Bulgaria							
Total	**119,196**	**2,350**	**0**	**56,514**	**5,596**	**1,353**	**500**

Table 5 - realized import for 2000

Metric tonnes

Importer	HCFC-22	HCFC-141b	Premix polyol / HCFC-141b	HFC-134a	HFC-404A	HFC-407C	HFC-23
Inst. Of Refrigeration	2,176			544	3,488		
Seaborne Ltd.	10,000			10,000			
Prista Oil Ltd.	31,520			12,720	1,308	113	
Sokem B&D	2,507			550	800	240	
Akvachim							
Helpman	35,900			30,000		1,000	500
Nat. Electricity Company							
Chimatech		2,350		2,700			
Kremikovtzi							
CCS Bulgaria							
Pluimers Isolation			2,800				
BASF			4,500				
Bayer			4,370				
ICI			0				
Exported	-3,640						
Total	**78,463**	**2,350**	**11,670**	**56,514**	**5,596**	**1,353**	**500**

HCFC users

By means of above-mentioned reports, Bulgarian technical expertise, interviews and site visits the HCFC users have been mapped. Table 6 provides details on the users.

Table 6 - HCFC user distribution

Metric tonnes

	HCFC-22				HCFC-141b			
Company	**1998**	**1999**	**2000**	**Installed capacity**	**1998**	**1999**	**2000**	**Installed capacity**
Torgoterm					36	72	144	5,600
NAGI	216	324	378	2,700	520	780	910	6,500
Incoms					70	80	90	5,100
TEOTO					200	400	800	5,440
Lucky Polyus					3,000	3,000	3,600	6,000
GBS					1,292	967	252	7,200
Metal Panels & Constr.					4,000	2,200	3,000	250,000
Hebar					1,260	950	632	9,360
Install Eng.					770	1,265	1,980	5,775
Eldominvest					2,200	1,925	1,760	5,500
Pluimers						2,240	2,800	6,720
Chimatech					2,350	2,350	2,350	23,500
Frigoterm		2,500	2,500	2,500				
Aisberg		3,000	3,000	3,000				
Pinguin		3,500	3,500	3,500				
Frigus		1,500	1,500	1,500				
Valko-V		800	800	800				
TORO		600	600	600				
150 SME's		37,500	37,500	37,500				
Service		32,325	32,325	32,325				
Exported		-3,640	-3,640	-3,640				
Total	**216**	**78,409**	**78,463**	**80,785**	**15,698**	**16,229**	**18,318**	**336,695**

The installed capacity of companies having production is based on data collected at the enterprises. Installed capacity of companies doing installation/service or export is taken as 2000 consumption under the assumption that they operate at full capacity.

Figure 2 shows the geographical location of main HCFC users.

Figure 2 - Geographical location of main HCFC users

Sector description

HCFC's in Bulgaria are consumed for production of foam appliances, refrigerating appliances as well as aerosol cans. Furthermore majority of current HCFC consumption is consumed for installation and servicing of refrigerating appliances. The following paragraphs describe the sectors.

Foams sector

The foams sector comprise several applications:

- Sandwich panels;
- Insulation of water heaters;
- Insulation of district heating pipes; and
- Building insulation.

Sandwich panels

Three companies are producing sandwich panels by means of HCFC-141b blown polyurethane foam. The companies are:

- GBS;
- Hebar; and
- Metal Panels and Construction.

All companies operate at a low utilization rate. Baseline is rather old and not suitable for operation with flammable blowing agents.

Insulation of water heaters

One company, EldomInvest, is producing water heaters. Insulation of these is made with HCFC-141b blown polyurethane foam.

EldomInvest has recently installed a new foam dispenser in addition to an old one. Nevertheless, both dispensers are not suitable for usage with flammable blowing agents.

Insulation of district heating pipes

One company, Install Engineering, is engaged in this activity. HCFC-141b is used as foam blowing agent.

Baseline equipment is rather old and not suitable for usage with flammable blowing agents.

Install Engineering is planning a production of sandwich panels. The company has been informed on the Bulgarian HCFC legislation and has been advised to select a non-HCFC technology for this production.

Building insulation

One company, Pluimers Isolation, is engaged in building insulation. Plumier Isolation has a foam dispenser installed in a van, which is taken to building sites. Foam is sprayed on building parts.

Pluimers Isolation is a daughter company of a Dutch company, which also provides chemicals and technology.

Baseline equipment is rather old and due to the type of operation, flammable blowing agents are not to be considered. Pluimers Isolation should consult the Dutch mother company on alternative technologies.

Refrigeration sector

The refrigeration sector comprise the following sub sectors:

- Manufacturer of commercial refrigerating appliances;
- Large companies doing installation of refrigerating appliances and service; and
- Small and medium sized companies doing installation and service of refrigerating appliances.

Manufacturer of commercial refrigerating appliances

The following companies are involved in manufacture of commercial refrigerating appliances:

- Torgoterm;
- NAGI;
- Incoms;
- Teoto; and
- Lucky Polyus.

All companies are currently using HCFC-141b for insulation foam and HCFC-22 as well as HFC-134a and HFC-404A as refrigerant. Whereas NAGI, Teoto and Lucky Polyus have commercial refrigeration as their core business, the companies Torgoterm and Incoms are basically manufacturing other appliances and the refrigerating appliances production comprise only a minor part of their activities.

Baseline equipment for companies Torgoterm, NAGI, Incoms and Teoto is old and for some part homemade, whereas Lucky Polyus has new production equipment received under the Bulgarian ODS phase-out program financed by the Global Environmental Facility, GEF and that equipment should be able to work with the new HFC's, e.g. HFC-245fa or HFC-365.

Large companies doing installation and service

The survey identified 6 companies in this sub sector. These are:

- Frigoterm;
- Aisberg;
- Pinguin;
- Frigus;
- Valko-V; and
- TORO

These companies are all relatively advanced and do already have operations with HCFC alternatives, HFC's and ammonia.

Small and medium sized companies doing installation and service

According to Bulgarian expertise there is around 150 SME's doing installation and servicing of refrigerating appliances. These do operate with a minimum of equipment and are in general not ready to handle HCFC alternatives, neither knowledge- nor equipment wise.

Aerosol sector

One company, Chimatech, is producing aerosols using HCFC-141b and HFC-134a as solvent and propellant. Chimatech is producing technical aerosols like silicon sprays, anti-adhesives and mold releasing sprays.

Aerosols are filled in two sites. Filling lines are both around 15-20 years old.

Due to the application of Chimatech's products, filling with hydrocarbons (propane/butane) is not possible. A possible propellant could be CO_2, but this is to be investigated.

ODS inventory

An ODS management strategy was formulated in 2001. According to this strategy there is a substantial inventory of both CFC and HCFC. Table 7 below provides an overview of the inventory with breakdown on sectors.

Table 7 - ODS inventory

Sector	Quantity of appliances	Charge of ODS	Inventory in MT	
			CFC	HCFC
Domestic refrigeration	1,500,000	120 gram	180	1
Commercial refrigeration	300,000	1 kg	220	80
Industrial refrigeration	200	N/A	30	70
Air conditioning and heat pumps				
- Central	400	N/A	15	75
- Individual	80,000	950 gram	-	76
Transport refrigeration	2,500	8 kg	5	15
Insulation foam	N/A	N/A	500	50
TOTAL			**950**	**447**

The inventory for refrigerating appliances needs service. It is noticed that in addition to the around 400 MT HCFC-22 inventory, there is also around 450 MT CFC inventory. To ensure HCFC phase-out but also to minimize illegal import of CFC’s, this must be addressed.

Technical alternatives

Foams sector

The technical options are as follows:

HCFC-141b used for blowing of insulation foam can be replaced by:

- Water. The application of water-based technology is an environmental neutral technology. However, insulation properties of water-based insulation foam are around 30% poorer compared to HCFC-141b blown foam. Increasing the insulation thickness can compensate the reduced insulation efficiency. However, certain appliances like display cabinets are manufactured according to standardized sizes and cannot allow for thicker insulation. Furthermore the increased insulation thickness will also lead to increased consumption of raw materials – and thereby increase production costs. The water-based polyurethane system is more viscous than HCFC-141b system and therefore a high-pressure foam dispenser is required.
- Liquid HFC's. The chemical industry has developed a few alternatives to HCFC-141b, the so-called liquid HFC's. Two candidates, HFC-245 and HFC-365 are currently being marketed, but still in relatively small quantities. Consequently the price is still rather high – around 10 US$ per kg. The liquid HFC's can be used directly without any major modifications. However, since the blowing agent is rather costly, it's recommended to have proper foam dispensing equipment both to reduce losses but also to ensure proper mixing and thereby optimum blowing agent use.
- Hydrocarbons. The most used hydrocarbons for foam blowing is in the pentane group. Whereas cyclopentane was the first candidate, mixtures of different pentanes are also now being marketed. Insulation foam using pentane as blowing agent has properties similar to HCFC-141b blown foam – though is the insulation properties slightly poorer (2-5%). Due to flammability, the usage of pentane requires substantial safety measures. These are basically nitrogen blanketing of all vessels containing pentane or pentane/polyol mixtures, vented enclosures of pentane and polyol tanks, vented enclosure of the foaming area, gas detection and warning system for whole foam installation and grounding of whole foam installation. Furthermore, since pentane and polyol is not a stable mixture, a premixer is required to be installed. Finally a special pentane storage tank is required. Most foam equipment designed for either CFC-11 or HCFC-141b is not suitable for usage with pentane, so normally all foam equipment needs to be replaced as well. The application of pentane is therefore were costly.

Refrigeration sector

The technical options for replacement of HCFC-22 used as refrigerant are as follows:

- HFC's. This is the most common technology. Potential HCFC-22 alternatives are HFC-404A and HFC-407C. However, for some special applications, HFC-134a or HFC-410 can be used. HFC's require synthetic oil for good miscibility whereas HCFC-22 normally operates with mineral oil. The synthetic oil is very hygroscopic and technicians should be careful not to expose the oil to air/humidity. Operation with HFC's do require better evacuation prior to charging. All HFC's have a substantial global warming potential and they are regulated in a few countries in Europe.
- Hydrocarbons. Propane does have properties reasonably close to HCFC-22 and can in some applications be applied. Propane operates with mineral oil as HCFC-22. However, propane is highly flammable and special attention should be paid both during installation but especially during servicing. In Europe is propane allowed to be applied with no restrictions if the charge does not exceed 150 g. However, for larger charges, application is not allowed in areas with public access.
- Ammonia. Ammonia is widely used for industrial refrigerating appliances. Ammonia has good properties, but is also toxic. Therefore certain safety rules apply to ammonia applications. Further, ammonia is aggressive towards copper (which is used in most HCFC refrigerating systems). Further the compressor needs to be replaced, since ammonia compressors have special design especially with respect to lubrication. Therefore conversion into ammonia will require completely new design of the refrigerating system.

Aerosol sector

For aerosol production a combination of two chemicals are usually used. One chemical is the propellant and the second is a solvent that ensures that the active component is well mixed with propellant.

Alternatives to HCFC's in aerosol sector are as follows:

- HFC's. Replacement of HCFC-141b could potentially be done by usage of HFC-245 or HFC-365. However, such a solution would provide for increased operating costs. Further, due to the global warming potential of HFC's, there may be a negative environmental effect.
- Propane/butane. This is the most common substitute technology for personal care aerosols. It requires substantial safety measures in the filling area. However, propane/butane cannot always be applied for technical aerosols, since usage may take place in locations with ignition sources.
- Compressed gases (e.g. CO_2 or N_2). These gases are cheap and will likely provide for operating savings. However, they have some disadvantages, which are: 1) Higher pressure compared to HCFC; 2) Extended head space of the aerosol can (which makes the can feel lighter); and 3) Reduced performance during lifetime caused by decreased pressure in the can.
- Mechanical pumps. This is a not-in-kind solution, which can be applied. However, due to poorer spraying effect, it is not used extensively for technical aerosols.

HCFC phase-out strategy

The HCFC phase-out strategy will be based on sector approaches rather than individual enterprise activities. The sector wise HCFC consumption is as follows.

Table 8 - Sector wise HCFC consumption in 2000

Sector	HCFC-22	HCFC-141b
Producers of commercial refrigeration (5 companies)	378 kg	5,544 kg
Producers of insulation foam (6 companies)	-	10,424 kg
Producer of aerosols (1 company)	-	2,350 kg
Large companies doing installation/servicing (6 companies)	11,900 kg	-
Small companies doing installation/servicing (150 comp.)	69,825 kg	-
Export	3,640 kg	-
TOTAL	**78,463 kg**	**18,318 kg**

According to table 6 the total installed capacity is 417 MT HCFC, which means that companies runs at around 23 % utilization of their capacity. This figure is a conservative utilization rate, since the installation/servicing companies are assumed to operate at full capacity.

Consumption scenarios

To evaluate the impact of the Bulgarian HCFC phase-out, 4 scenarios are used. It is assumed that only the sector comprising large installation/servicing companies can phase-out without assistance, since they are already having experience with HCFC alternatives. It is therefore assumed that the 11,9 MT HCFC-22 consumed by that sector will be gradually phased-out until 2006.

Actual consumption forecast is therefore based on above reduction until 2006 and unchanged capacity utilization at remaining industries.

Scenario 1 to 4 foresees a certain industry growth as follows:

- Scenario 1: 1 % annual industry growth;
- Scenario 2: 2 % annual industry growth;
- Scenario 3: 3 % annual industry growth; and
- Scenario 4: 4 % annual industry growth

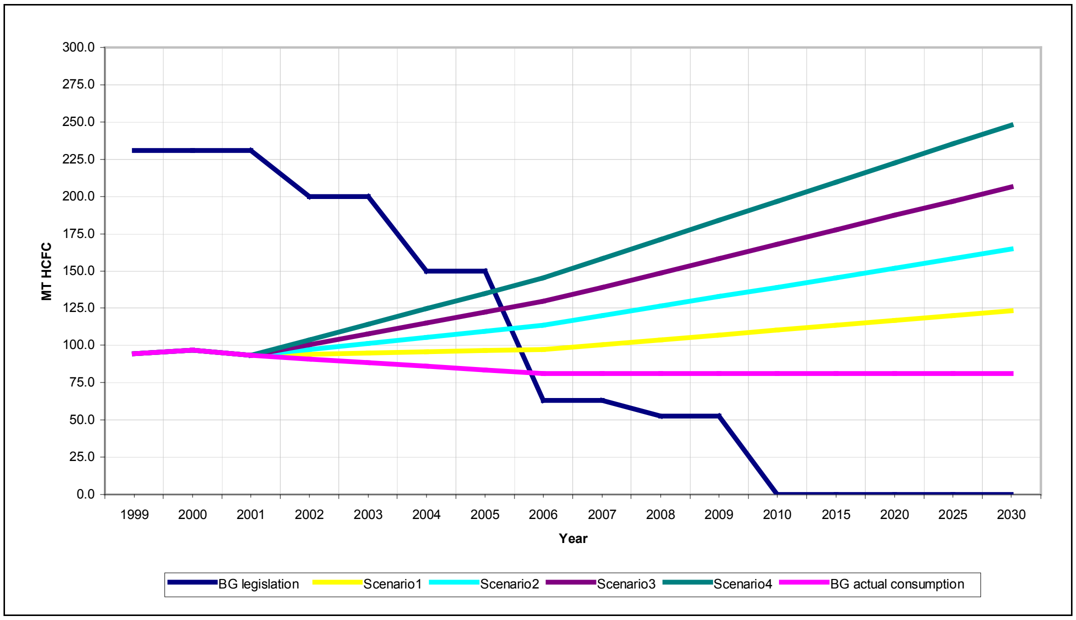
Industry growth scenarios are based on expert assessment from MoEW and Bulgarian Chamber of Machine Building, where 4% is considered the maximum expected increase in industry production.

Since the Bulgarian industry operates at a low utilization rate, no negative growth is foreseen. With negative growth, operation of enterprises may not be feasible anymore.

Figure 3 shows the HCFC consumption forecasts according above 4 scenarios. The Bulgarian HCFC phase-out schedule is also shown.

It should be noted that for all scenarios, problems would occur in 2005 or 2006, where the forecasted HCFC demand will exceed the allowed quantities to be imported into Bulgaria.

Figure 3 - HCFC consumption scenarios



Foams sector

The foams sector is the major consumer of HCFC-141b used as blowing agent.

The application of hydrocarbons as HCFC-141b replacement blowing agent, e.g. cyclopentane, will require extensive measures for safe operation. In addition to the high investment costs the energy consumption of the foam plant will also increase. Hence, the direct environmental gain from replacing HCFC-141b will result in increased indirect CO_2 emission from the foam plant due to the energy consumption increase.

The application of water-based technology is applicable where end-product dimensions are not critical. This will result in positive environmental impact on both ozone depletion and global warming. However, water-based foams do have around 30% poorer insulation properties resulting in increased raw materials consumption. Consequently this will also increase the operational costs of the companies.

The application of liquid HFC will reduce the ozone depletion effect, but will only slightly increase the global warming.

Table 9 - Environmental impact per kg foam blowing agent

Technology	Ozone depleting impact	Global warming impact
CFC-11	1	Direct: 3,400
HCFC-141b	0.11	Direct: 700
Hydrocarbons	0	Direct: 3 Excess indirect[1]: 109
Water-based	0	Direct: 0
Liquid HFC (HFC-245fa)	0	Direct: 816

The strategy is to replace HCFC-141b with water-based formulations where possible. For operations where end product dimensions are critical, liquid HFC technology should be utilized.

Refrigeration sector

The strategy for refrigeration sector is divided into two parts:

- Manufacturing companies; and
- Installing/servicing companies.

Manufacturing companies

The manufacturing companies use HCFC both as foam blowing agent and as refrigerant.

The strategy for the foam part is similar to the foams strategy, namely to utilize water based formulations where possible (e.g. display cases) and in cases where dimensions are critical utilize liquid HFC's (e.g. display cabinets).

[1] Based on: Excess energy for ventilation, conditioning and safety: 100 kW per plant; 8 potential plants; Production time: 8 hours/day x 200 days/year = 1,600 hours. Total excess energy = 8 plants x 1,600 hours x 100 kW = 1,280 MWh. Total emission = 1,280 MWh x 1.1 ton CO_2/kWh = 1,408 ton CO_2. Mentioned 8 plants use 12,934 kg HCFC-141b so indirect emission is 109 kg CO_2/kg HCFC-141b replacement.

As to the replacement of HCFC-22 used as refrigerant, only one company, NAGI, has this operation.

The optimal technology in terms of environmental impact is to replace HCFC-22 with hydrocarbons, e.g. propane. This will require substantial investments and subsequently also increased energy usage, so that the gain in direct emission reduction will be spent in increased indirect emission. Furthermore, since hydrocarbons are highly flammable, proper and safe servicing will require substantial re-education and re-equipping of the service technicians.

A replacement into HFC, typically HFC-134a for middle/high temperature applications and HFC-404A/407C for low temperatures will eliminate the ozone depleting impact, but will in case of HFC-404A increase the direct global warming effect.

Table 10 - Environmental impact per kg refrigerant

Technology	Ozone depleting impact	Global warming impact
CFC-12	1	Direct: 7,100
HCFC-22	0.05	Direct: 1,600
Hydrocarbons	0	Direct: 3 Excess indirect[2]: 4.4
HFC-134a	0	Direct: 1,300
HFC-404A	0	Direct: 3,750
HFC-407C	0	Direct: 1,610
HFC-410	0	Direct: 1,890

The strategy is to replace HCFC-22 with HFC-134a/404A/407C as appropriate to the appliance.

Installing/servicing companies

For installation operations the only safe HCFC-22 replacements are in the group of HFC refrigerants. Depending on application these are typically HFC-134a, HFC-404A, HFC-407C or HFC-410. Hence, strategy is to utilize these refrigerants.

For service operations only HFC refrigerants are applicable. The strategy is to stimulate retrofit operations into these refrigerants.

Aerosol sector

There is only one producer of aerosol cans in Bulgaria. Since the product is a technical aerosol, the usage of hydrocarbons (propane/butane) is not acceptable for safety reasons. Therefore strategy encourages the aerosol producer to source a suitable and environmental friendly alternative.

[2] Based on: Excess energy for ventilation: 0.5 kW per installation; 1 installation (NAGI); Production time: 8 hours/day x 200 days/year = 1,600 hours. Total excess energy = 1,600 hours x 0.5 kW = 800 kWh. Total emission = 800 kWh x 1.1 kg CO_2/kWh = 880 kg CO_2. 378 kg HCFC-22 equals 200 kg hydrocarbon so indirect emission is 4.4 kg CO_2/kg refrigerant.

Inventory

The major HCFC consumption is related to service of existing installations. It has been noticed that in addition to HCFC inventory, there is also a substantial CFC inventory in Bulgaria. The strategy will aim at not only to reduce the HCFC needed for service but also CFC through stimulation of retrofit into alternatives.

For domestic refrigerators it is likely not feasible to retrofit since costs would be relatively high. Furthermore, assuming an average lifetime of around 15 years, and taking into account, that Bulgaria banned import of CFC based refrigerators in 1996 domestic refrigerators would likely be replaced through normal market forces within 10 years.

As for commercial refrigerating appliances, retrofit into HFC refrigerants is an option. This is especially applicable to non-serial produced appliances. Lifetime of such appliances can span from 5-20 years depending on application. A retrofit will eliminate ozone depletion impact and also influence on direct global warming impact. The strategy will target stimulation of retrofit of especially newer installations.

As for industrial refrigerating appliances and central air conditioning systems retrofit into HFC refrigerants are an option. Since these installations may vary substantially both in terms of size and configuration the strategy will initially target installations utilizing centrifugal compressors, since replacement of these can provide substantial energy savings, which will be attractive for the owners.

Individual air conditioners, typically wall or window mounted, have a relatively short lifetime. The alternative to HCFC-22 for such installations is HFC-410, which is a high-pressure refrigerant. Due to this retrofit is not possible. Strategy will assume that these installations will continue to be serviced with HCFC-22.

Transport refrigerating installations have a relatively short lifetime and strategy assume that they will continue to be serviced with HCFC-22.

Impact on industry

Foams industry

The strategy aims at utilizing HCFC alternatives that requires modest or possibly no investments for equipment. Main impact to the foams industry will be sourcing applicable foam formulations and do trials with this/these.

Refrigeration industry

Producers of commercial refrigerating appliances

Two of the 5 producers of commercial refrigeration, Torgoterm and Incoms, do not have such production as their core business. Hence, impact is limited to sourcing of alternatives and doing trials with these.

The company, Lucky Polyus, does have new production equipment financed through the Bulgarian ODS phase-out project, so impact is here also limited to sourcing of alternatives and doing trials with these.

The remaining two companies, Nagi and Teoto, operate with homemade equipment and here transition into HCFC alternatives will require some investments, basically relating to refrigerant charging equipment, leak detection equipment, vacuum pump and foam dispensing equipment. Also sourcing of alternatives and trial production with these is required.

Large installation/servicing companies

These companies do already operate with HCFC alternatives so in terms of investments these are minimal or even not required. However, these companies may play an important role in the attempts to reduce inventory, so equipment that facilitates retrofit is required. This especially relates to flushing equipment, that allows for cost effective retrofit operations.

SME installation/servicing companies

SME's are not ready to operate with HCFC alternatives, since these require improved evacuation and in general more careful operation by the technician. Therefore these companies will need training and in addition also basic tools like vacuum pump, charging manifold, scale and leak detector.

Aerosol industry

Since the alternative is unknown, impact cannot be evaluated. However, the aerosol company will definitely need assistance to source a suitable replacement technology as well as trial production.

Institutional strengthening

The following activities are foreseen to support the implementation of the strategy.

Public awareness raising campaign

The sector approach requires comprehensive information to especially industries and organizations using HCFC's. This information should contain legal requirements and impact on production/operations. Further a more broad awareness raising to the Bulgarian population is required to stimulate purchase of non-HCFC appliances.

Training of MoEW regional inspectors

Since the regional inspectorates of MoEW plays a central role in the Bulgarian ODS legislation, these needs to be trained in requirements relating to the HCFC phase-out. MoEW will carry out the training.

Customs training

It has been informed that there is illegal import of especially CFC-12. A customs training activity was implemented through the Bulgarian ODS phase-out project. However, it is proposed to enforce this activity. The customs-training component will also include equipment for detection of refrigerants.

Regional network participation

Since Bulgaria is surrounded by countries, where both CFC's and HCFC's are still allowed, it is proposed to establish a regional network to coordinate activities, especially relating to import/export issues.

Strategy costs

Implementation of the strategy will require some investments. A summary is provided in table 11 below and attachment 1 to 8 provides details for each activity.

Table 11 - Strategy costs - summary

Activity	Costs in US$
1) Foam industries	
- Formulation assistance	60,000
- Test and trials	60,000
Subtotal	120,000
2) Producers of commercial refrigerating appliances	
- Formulation assistance	50,000
- Test and trials	50,000
- Equipment	200,000
Subtotal	300,000
3) Large installation/servicing companies	
- Equipment	25,000
4) SME's	
- Training	30,000
- Equipment	150,000
Subtotal	180,000
5) Aerosol industry	
- Formulation assistance	20,000
- Test and trials	10,000
Subtotal	30,000
6) Inventory	
- Retrofit activities for large appliances	1,500,000
7) Institutional strengthening	
- Ozone Task Force	124,000
- Public awareness raising campaign	50,000
- Customs training incl. equipment	250,000
- Training of regional inspectorates of MoEW	20,000
- Regional network participation	30,000
Subtotal	474,000
Contingencies (10%)	262,900
TOTAL	**2,891,900**

Cost effectiveness

The cost effectiveness for the strategy is as follows:

CE_{ODP} = 210 US$/kg ODP (excluding inventory)
CE_{ODP} = 64.7 US$/kg ODP (including inventory)

CE_{CO2} = 141 US$/ton CO_2 (excluding inventory)
CE_{CO2} = 9.0 US$/ton CO_2 (including inventory)

Attachment 8 provides details of the cost effectiveness calculation.

Implementation modalities

The HCFC phase-out strategy is based on active participation from enterprises in the covered sectors. Instead of the traditional approach where enterprises are identified and individual projects prepared for each individual enterprise, the sector approach requires enterprises to be proactive and apply for funds based on rules, guidelines and standardized application forms established as part of the program. Within the funds available the most cost effective applications – in terms of environmental impact – will be chosen for participation. This modality is normally called "bidding" or "auction" implementation. The main advantage is that enterprises are required to provide a realistic and modest funding request in order to be considered part of the project. Further it will facilitate easy project management.

The sector approach do therefore require substantial information and promotion of the strategy in order to ensure that the industry is fully informed about the phase-out program, the short term and long term implication to the industry and the possibilities to obtain funding to cover some of the cost faced and problems encountered when HCFC's are not longer available in Bulgaria.

An exception to above general principle will apply to the SME's, since they are small and may not have the necessary management capacity to participate. For SME's MoEW and its regional inspectorates as well as the Institute of Refrigeration will play an active role.

Except for inventory activities, funding support is planned to be of grant type.

Revolving fund for inventory replacements/retrofits

Servicing of commercial and industrial refrigerating appliances constitute the main HCFC and CFC consumption in Bulgaria. Hence, it is not possible to implement the strategy without addressing these appliances.

Especially replacements of industrial refrigerating and air conditioning appliances are economical beneficial due to energy savings. This is particularly applicable to installations using centrifugal compressors. Based on information available from chiller suppliers, the owners will be able to recover an investment within 2 to 5 years depending on the actual circumstances. In this chillers replacement program, it is assumed that replacement contracts will be signed between the building owners and the MoEW on the following terms:

- The program will cover a certain amount per compressor – depending on capacity - in order to replace an existing installation. As the lifetime of these installations are assumed to be from 10 years to 20 years, it has been agreed that this program shall address primarily existing installations between 10 and 15 years old, which will provide the highest cost effectiveness.

- The owner will be invited to submit request for financial support for replacement of existing installations meeting the general requirements. MoEW will sign an agreement that the beneficiary will repay the funds in four equal installments starting one year after the new installation is operational. In addition a annual 5% service fee for banking transactions will be paid by the beneficiary. Recovered funds will be utilized for further retrofits/replacements.

All ODS contained in the replaced/retrofitted installations will be recovered and used for servicing of remaining systems.

Critical issues

The most critical issue is to perform actions as soon as possible. According to the consumption situation and the scenarios for future, Bulgaria will not be able to meet European Union legislation. As seen on figure 3 HCFC needs will exceed allowed quantities to be imported not later than 2006. The economical situation of Bulgaria is not so, that enterprises can be expected to replace HCFC's by themselves. Therefore external financial assistance is needed.

Further there is a critical issue regarding illegal import. Most neighboring countries are allowed to use not only HCFC but also CFC for several years. There is – according to information obtained – already illegal import of CFC, despite efforts to eliminate this. Therefore it's needed to enforce the activities performed at the customs points. Another important activity is to reduce the need for import. This is best done through inventory retrofits/replacements, which is the major component of this strategy.

Attachment 1 – Foam industries

The actions needed for foam industries are limited to technical assistance for identification of suitable alternative formulations as well as chemicals for test and trials with these formulations.

The costs for this activity are as follows:

Formulation assistance for 6 companies @ 10,000 US$	=	60,000 US$
Chemicals for test and trials for 6 companies @ 10,000 US$	=	60,000 US$
Total activity costs:	=	120,000 US$

Cost effectiveness for the activity is calculated as follows:

ODS phase-out:

Phase-out of 10,424 kg HCFC-141b @ 0.11 kg ODP/kg	=	1,147 kg ODP
Activity costs (incl. 10% contingency)	=	132,000 US$
Cost effectiveness:	=	115 US$/kg ODP

CO_2 emission:

Phase-out of 10,424 kg HCFC-141b @ 700 kg CO_2/kg	=	7,296 ton CO_2
Usage of 5,212 kg HFC-245fa @ 816 kg CO_2/kg[3]	=	4,253 ton CO_2
Net CO_2 emission reduction:	=	3,043 ton CO_2
Activity costs (incl. 10% contingency)	=	132,000 US$
Cost effectiveness:	=	43.4 US$/ton CO_2

[3] 50% of production will be converted to water based formulations and 50% to liquid HFC formulations

Attachment 2 – Producers of commercial refrigerating appliances

The activities relating to producers of commercial refrigerating appliances relate both to conversion of their PU foam installations and equipment to handle HCFC-22 alternatives. The sector comprises 5 companies, but only two companies needs equipment to replace HCFC-22 and HCFC-141b (Teoto and Nagi). All 5 companies needs formulation assistance for PU operations and another TA component for selection and handling of HCFC-22 alternatives.

The costs for this activity is as follows:

2 x charging station @ 18,000 US$	=	36,000 US$
2 x vacuum pump @ 1,000 US$	=	2,000 US$
2 x production leak detector @ 1,000 US$	=	2,000 US$
2 x HP PU dispenser @ 80,000 US$	=	160,000 US$
5 x formulation assistance (PU) @ 5,000 US$	=	25,000 US$
5 x technical assistance @ 5,000 US$	=	25,000 US$
5 x chemicals for test and trials @ 5,000 US$	=	25,000 US$
5 x certification fee @ 5,000 US$	=	25,000 US$
Total activity costs:	=	300,000 US$

Cost effectiveness for the activity is calculated as follows:

ODS phase-out:

Phase-out of 5,544 kg HCFC-141b @ 0.11 kg ODP/kg	=	610 kg ODP
Phase-out of 378 kg HCFC-22 @ 0.05 kg ODP/kg	=	19 kg ODP
Total ODP phase-out:	=	629 kg ODP
Activity costs (incl. 10% contingency)	=	330,000 US$
Cost effectiveness:	=	525 US$/kg ODP

CO_2 emission:

Phase-out of 5,544 kg HCFC-141b @ 700 kg CO_2/kg	=	3,881 ton CO_2
Phase-out of 378 kg HCFC-22 @ 1,600 kg CO_2/kg	=	605 ton CO_2
Usage of 2,772 kg HFC-245fa @ 816 kg CO_2/kg[4]	=	2,262 ton CO_2
Usage of 170 kg HFC-134a @ 1,300 kg CO_2/kg[5]	=	221 ton CO_2
Usage of 136 kg HFC-407C @ 1,610 kg CO_2/kg[6]	=	219 ton CO_2
Usage of 34 kg HFC-404A @ 3,750 kg CO_2/kg[7]	=	128 ton CO_2
Net CO_2 emission reduction:	=	1,656 ton CO_2
Activity costs (incl. 10% contingency)	=	330,000 US$
Cost effectiveness:	=	199 US$/ton CO_2

[4] 50% of production will be converted to water based formulations and 50% to liquid HFC formulations
[5] 50% of production with HCFC-22 will be converted to HFC-134a
[6] 40% of production with HCFC-22 will be converted to HFC-407C
[7] 10% of production with HCFC-22 will be converted to HFC-404A

Attachment 3 – Large installation/servicing companies

The larger installation companies have already started working with HCFC alternatives. However, retrofit costs are high due to several oil changes, and it is proposed to stimulate retrofit by providing the mentioned companies with flushing units.

The costs for this activity is as follows:

5 x flushing unit to facilitate retrofit @ 5,000 US$	=	25,000 US$
Total activity costs:	=	25,000 US$

Cost effectiveness for the activity is calculated as follows:

ODS phase-out:		
Phase-out of 11,900 kg HCFC-22 @ 0.05 kg ODP/kg	=	595 kg ODP
Activity costs (incl. 10% contingency)	=	27,500 US$
Cost effectiveness:	=	46 US$/kg ODP

CO_2 emission:		
Phase-out of 11,900 kg HCFC-22 @ 1,600 kg CO_2/kg	=	19,040 ton CO_2
Usage of 5,355 kg HFC-134a @ 1,300 kg CO_2/kg[8]	=	6,962 ton CO_2
Usage of 4,284 kg HFC-407C @ 1,610 kg CO_2/kg[9]	=	6,897 ton CO_2
Usage of 1,071 kg HFC-404A @ 3,750 kg CO_2/kg[10]	=	4,016 ton CO_2
Net CO_2 emission reduction:	=	1,165 ton CO_2
Activity costs (incl. 10% contingency)	=	27,500 US$
Cost effectiveness:	=	23 US$/ton CO_2

[8] 50% of production with HCFC-22 will be converted to HFC-134a
[9] 40% of production with HCFC-22 will be converted to HFC-407C
[10] 10% of production with HCFC-22 will be converted to HFC-404A

Attachment 4 – SME's

The 150 SME's doing both installation and servicing of refrigerating appliances hesitate using HCFC alternatives, since they do not have the sufficient equipment for this. Therefore the activity targeting SME's will include basic equipment (vacuum pump, charging scale, gauge manifold and hoses, leak detector). All companies should also attend a one-day course to get acquainted with the particularities of HCFC alternatives. The training course can be provided locally by the Institute of Refrigeration and Air conditioning engineering.

The costs for this activity is as follows:

150 x vacuum pump @ 500 US$	=	75,000 US$
150 x charging scale @ 200 US$	=	30,000 US$
150 x gauge manifold + hoses @ 100 US$	=	15,000 US$
150 x leak detector @ 200 US$	=	30,000 US$
1 day training course for 150 companies @ 200 US$	=	30,000 US$
Total activity costs:	=	180,000 US$

Cost effectiveness for the activity is calculated as follows:

ODS phase-out:		
Phase-out of 69,825 kg HCFC-22 @ 0.05 kg ODP/kg	=	3,491 kg ODP
Activity costs (incl. 10% contingency)	=	198,000 US$
Cost effectiveness:	=	57 US$/kg ODP

CO_2 emission:		
Phase-out of 69,825 kg HCFC-22 @ 1,600 kg CO_2/kg	=	111,720 ton CO_2
Usage of 31,421 kg HFC-134a @ 1,300 kg CO_2/kg[11]	=	40,848 ton CO_2
Usage of 25,137 kg HFC-407C @ 1,610 kg CO_2/kg[12]	=	40,471 ton CO_2
Usage of 6,284 kg HFC-404A @ 3,750 kg CO_2/kg[13]	=	23,566 ton CO_2
Net CO_2 emission reduction:	=	6,835 ton CO_2
Activity costs (incl. 10% contingency)	=	198,000 US$
Cost effectiveness:	=	29 US$/ton CO_2

The effect of the training is not included in the CO_2 emission reduction.

[11] 50% of production with HCFC-22 will be converted to HFC-134a
[12] 40% of production with HCFC-22 will be converted to HFC-407C
[13] 10% of production with HCFC-22 will be converted to HFC-404A

Attachment 5 – Aerosol industry

The actions needed for aerosol industry are limited to technical assistance for identification of suitable alternative propellant/solvent as well as chemicals for test and trials with these formulations.

The costs for this activity are as follows:

Formulation assistance for one company	=	20,000 US$
Chemicals for test and trials for one company	=	10,000 US$
Total activity costs:	=	30,000 US$

Cost effectiveness for the activity is calculated as follows:

ODS phase-out:

Phase-out of 2,350 kg HCFC-141b @ 0.11 kg ODP/kg	=	259 kg ODP
Activity costs (incl. 10% contingency)	=	33,000 US$
Cost effectiveness:	=	127 US$/kg ODP

CO_2 emission:

Phase-out of 2,350 kg HCFC-141b @ 700 kg CO_2/kg	=	1,645 ton CO_2
Activity costs (incl. 10% contingency)	=	33,000 US$
Cost effectiveness:	=	20.1 US$/ton CO_2

Attachment 6 – Inventory

To reduce the needs for servicing of refrigerating appliances a retrofit/replacement scheme is planned. Total costs for the retrofit scheme is 1,500,000 US$.

The inventory program is planned to run for 10 years providing interest free loans to project participants. Payback terms are preliminarily set as follows:

- First year: Free; and
- 2nd and 3rd year: Payback in total of 4 installments

A revolving fund will be established and planned cash flow through this fund is as follows:

Year	Fund disbursement [US$]	Fund balance [US$]
1	500,000	1,000,000
2	500,000	500,000
3	500,000	250,000
4	500,000	500,000
5	500,000	500,000
6	500,000	500,000
7	500,000	500,000
8	500,000	500,000
9	500,000	500,000
10	500,000	500,000
11		1,000,000
12		1,500,000
Total	5,000,000	

It is estimated that annually 1,500 kg CFC-12 and 1,000 kg HCFC-22 will be phased-out through the activity. Additionally – assuming a service demand of 15% per year – 225 kg CFC-12 and 150 kg HCFC-22 will be phased-out annually. This will bring the total phase-out during the activity's lifetime (10 years) at 37,500 kg CFC-12 and 25,000 kg HCFC-22.

It is estimated that the annual support will target installations consuming a total of 2 MW. Energy savings are estimated at 15%, which for large installations may be a conservative value. However, the 15% is in line with measured energy savings from the Institute of Refrigeration in Sofia. Thus annually a total of 720 MWh is expected to be saved, based on:

- Reduced power requirement: 15% of 2 MW = 300 kW;
- Running hours: 12 hours/day; 200 days/year

During the project lifetime a total accumulated energy saving is calculated as below:

Year	Energy saving [MWh]	Accumulated [MWh]
1	720	7,200
2	720	6,480
3	720	5,760
4	720	5,040
5	720	4,320
6	720	3,600
7	720	2,880
8	720	2,160
9	720	1,440
10	720	720
Total		39,600

In Bulgaria CO_2 emission is 1.1 ton CO_2 per MWh, so total CO_2 reduction through energy savings during the project will be 43,560 ton CO_2. Further - due to the phase-out of both CFC-12 and HCFC-22 – 306,250 ton CO_2. However, only the service demand will impact the CO_2 reduction fully. The inventory will be replaced with likely HFC refrigerants. It is assumed that inventory will utilize the HFC's as follows: HFC-134a (50%); HFC-407C (40%) and HFC-404A (10%). A reduction of the charge of 10% is included.

Cost effectiveness for this component is calculated as follows:

ODS phase-out:	
37,500 kg CFC-12 @ 1 kg ODP/kg	= 37,500 kg ODP
25,000 kg HCFC-22 @ 0.05 kg ODP/kg	= 1,125 kg ODP
Total ODS phase-out:	= 38,750 kg ODP
Project costs (incl. 10% contingency):	= 1,650,000 US$
Cost effectiveness:	= 42.6 US$/kg ODP

CO_2 reduction:	
37,500 kg CFC-12 @ 7,100 kg CO_2/kg:	= 266,250 ton CO_2
25,000 kg HCFC-22 @ 1,600 kg CO_2/kg:	= 40,000 ton CO_2
11,250 kg HFC-134a @ 1,300 kg CO_2/kg:	= -14,625 ton CO_2
9,000 kg HFC-407C @ 1,610 kg CO_2/kg:	= -14,490 ton CO_2
2,250 kg HFC-404A @ 3,750 kg CO_2/kg:	= -8,438 ton CO_2
Total CO_2 emission reduction:	= 268,697 ton CO_2
Project costs(incl. 10% contingency):	= 1,650,000 US$
Cost effectiveness:	= 6.14 US$/ton CO_2

Attachment 7 – Institutional strengthening

The institutional strengthening component has no direct influence on either HCFC phase-out or energy efficiency improvement and CO_2 emission reduction. However, it's necessary to implement a number of support activities as follows:

ODS Task Force (OTF)

Presently, the OTF comprises of one expert from the MOEW. Depending on the load of the wqork the OTF should be enlarged.

The OTF has to carry out the following assignments:

- Ensure a gradual reduction and final halt of HCFCs consumption in accordance to the Decrees of the Council of the Ministers 224/2002 and 254/1999 on the control and management of the substances that deplete the ozone layer;
- Harmonize and up-date the Bulgarian ODS legislation in accordance to the decision of the Meeting of the parties to the Montreal Protocol;
- Monitor the trade and the consumption of ODS;
- Monitor the implementation of the Strategy of HCFCs Phase out;
- Administration of economic support from international sources to finance HCFCs replacement projects at industry level;
- Initiate and conduct the dialogue between agencies involved in HCFCs phase out including manufacturers associations and enterprises;
- Advise the MOEW in negotiations with the HCFCs users industries on HCFCS conservation, bans, voluntary agreements etc.
- Host seminars and distribute information on HCFCS issues and project results within all HCFCS branches.

The OTF will serve under the direct responsibility of the Minister (or Deputy Minister) of the Environment. It comprises of a Head of OTF from the Global Atmospheric Processes Department to the Air Protection Directorate to the MOEW, an accountant, an administrative assistant and technical consultant.

Below is a 3 years budget for OTF

Administrative assistant (expert)	18,000 US$
Accountant – part time	12,000 US$
	12,000 US$
Local technical consultant - part time	
	18,000 US$
Two computers and printers incl. software	
	3,000 US$
Notebook	
	5,000 US$
Fax and copiermachine	
	5,000 US$

Office supplies

3,000 US$

Service and maintains of the office equipment

6,000 US$

Translation service and printing materials

6,000 US$

Communications

36,000 US$

Sundry cost

TOTAL **124,000 US$**

Public awareness campaign

It is planned to initiate an information campaign on environmental initiatives and requirements being a consequence of EU membership. This would put a pressure on both manufacturer but also service companies to shift to HCFC alternatives.

The estimated costs for a public awareness raising campaign are: = 50,000 US$

Customs training

It has been informed that there is illegal import of CFC's into Bulgaria despite the import ban of 1996. It is very difficult to avoid this, since countries, where CFC usage is still permitted, surround Bulgaria. It is expected that it will be even more difficult to introduce a HCFC import ban, since mentioned neighboring countries all will be allowed to use HCFC's until at least 2030.

Therefore the customs officers should be trained in finding and identifying HCFC's. A similar customs training component was implemented through the Bulgarian ODS programme. However, personnel may have changed and legislation will be amended with other substances to be checked, so additional training is needed. Further, the equipment purchased for detection of refrigerants is not capable of detecting HCFC.

The estimated costs are:

Training of representatives from 120 customs points	=	40,000 US$
120 x refrigerant identifiers for customs @ 1,500 US$	=	180,000 US$
20 x refrigerant identifiers for MoEW @ 1,500 US$	=	30,000 US$
Total activity cost:	=	250,000 US$

Training of regional inspectorates of MoEW

Regional inspectorates of MoEW will check that Bulgarian legislation is not violated. In order to inform of new initiatives regarding HCFC phase-out the inspectors needs to be trained.

According to Bulgarian legislation (amendment 224 of October 1, 2002) all refrigerating installations with a charge exceeding 3 kg shall be inspected annually and checked for leakages. This new legislation needs to be enforced and planned training will also emphasize on this.

MoEW will coordinate and conduct the training.

The estimated costs for training of inspectors of MoEW are: = 20,000 US$

Participation in regional network
Since Bulgaria is surrounded by countries where both CFC but also HCFC usage will be permitted in several years, it's considered necessary to establish contact with Ozone Officers in these countries and coordinate activities. A network for Article 5 countries (as per Montreal Protocol definitions) is already being established by UNEP. This component will allow Bulgaria also to participate. Costs will be basically be travel and lodging costs.

The estimated costs for participation are: = 30,000 US$

Total activity cost **=** ***474, 000 US$***

Total activity cost incl. 10% contingency **=** ***521,400 US$***

Attachment 8 – Cost effectiveness

Cost effectiveness is calculated against ODS phase-out and reduction in CO_2 emission. Furthermore, cost effectiveness is calculated exclusive and inclusive inventory actions.

ODS Phase-out

Cost effectiveness without inventory actions is calculated as follows:

Substance to be phased-out	**ODP value**	**Total**
78,460 kg HCFC-22	*0.05*	3,923 kg ODP
18,318 kg HCFC-141b	0.11	2,015 kg ODP
Total ODP		5,938 kg ODP
Activities cost		1,251,400 US$
Cost effectiveness		**210 US$/kg ODP**

Cost effectiveness including inventory actions is calculated as follows:

Substance to be phased-out	**ODP value**	**Total**
78,463 kg HCFC-22	*0.05*	3,923 kg ODP
18,318 kg HCFC-141b	0.11	2,015 kg ODP
37,500 kg CFC-12 through inventory[14]	1.00	37,500 kg ODP
25,000 kg HCFC-22 through inventory	0.05	1,250 kg ODP
Total ODP		44,688 kg ODP
Activities cost		2,891,900 US$
Cost effectiveness		**64,7 US$/kg ODP**

CO_2 emission reduction

Cost effectiveness without inventory actions is calculated as follows:

Substance to be phased-out	**GWP value**	**Total**
10,963 kg HCFC-22[15]	*1,600*	17,541 ton CO_2
4,933 kg HFC-134a (50% of HCFC-22)	1,300	-6,413 ton CO_2
3,947 kg HFC-407C (40% of HCFC-22)	1,610	-6,354 ton CO_2
987 kg HFC-404A (10% of HCFC-22)	3,700	-3,700 ton CO_2
18,318 kg HCFC-141b	700	12,822 ton CO_2
9,159 kg H_2O (50% of HCFC-141b)	0	0 ton CO_2
9,159 kg liq. HFC (50% of HCFC-141b)	816	-5,026 ton CO_2
Net CO_2 reduction		8,870 ton CO_2
Activities cost		1,251,400 US$
Cost effectiveness		**141 US$/ton CO_2**

[14] See attachment 6 – inventory - for details
[15] Service demand – 67.5 MT – equal to 15% of inventory (450 MT) subtracted

Cost effectiveness including inventory will be as follows:

Substance to be phased-out	**GWP value**	**Total**
10,963 kg HCFC-22[16]	*1,600*	17,541 ton CO_2
4,933 kg HFC-134a (50% of HCFC-22)	1,300	-6,413 ton CO_2
3,947 kg HFC-407C (40% of HCFC-22)	1,610	-6,354 ton CO_2
987 kg HFC-404A (10% of HCFC-22)	3,700	-3,700 ton CO_2
18,318 kg HCFC-141b	700	12,822 ton CO_2
9,159 kg H_2O (50% of HCFC-141b)	0	0 ton CO_2
9,159 kg liq. HFC (50% of HCFC-141b)	816	-5,026 ton CO_2
Reduction through inventory phase-out[17]		268,697 ton CO_2
Reduction through energy savings[18]		43,560 ton CO_2
Net CO_2 reduction		321,127 ton CO_2
Activities cost		2,891,900 US$
Cost effectiveness		**9,0 US$/ton CO_2**

[16] Service demand – 67.5 MT – equal to 15% of inventory (450 MT) subtracted
[17] See attachment 6 – inventory – for details
[18] See attachment 6 – inventory – for details